The Pennsylvania State University
The Graduate School
College of Agricultural Sciences

PREVENTION OF RESPIRATORY DISEASES IN AGRICULTURAL AND RELATED INDUSTRIES

A Thesis in
Agricultural and Extension Education
by
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The study employed a descriptive correlational approach to explore perceived beliefs of agricultural workers regarding the use of respiratory protection. Factors that explained the variance in preventive behaviors among the workers were explored as well. Based on the identified respirator use beliefs, educational topics were identified and selected to design a respiratory safety training module for the workers.

A criterion-based sampling technique was used to select agricultural workers in the College of Agricultural Sciences at the Pennsylvania State University for the needs assessment phase of the study. Seventy-three usable questionnaires were returned for data analysis. For the program implementation phase, research participants were invited to sign up to attend the respiratory safety program. Fourteen workers participated, including 13 workers who took part in the needs assessment.

The results showed that a typical agricultural worker who perceived him or herself to be vulnerable to respiratory disease hazards, and was aware of the consequences (perceived severity) of being affected by the hazard, and had a positive perception about the benefits of using respiratory protection tended to rate the educational topics high on importance and relevance for the respiratory safety program. The worker’s perceived vulnerability to respiratory hazards and perceived benefit to be derived by using respiratory protection tended to influence the mean ratings of all the educational topics that were listed. Also, current beliefs regarding the use of respiratory protection among the agricultural workers were influenced by the type of job performed and this tended to influence behavior towards respirator use.
Factors influencing the choice of behavior were identified as: 1) work policy stipulating use of respirators; 2) availability of respirators, 3) job types that required the use of respirators/dust masks; and 4) perceived control or self-efficacy belief the worker had over using respiratory protection. These factors explained 64.1% of the variance in preventive behavior. Two of these factors were negatively related to preventive behavior – perceived availability of respirators and job type requiring respirator usage. Work policy stipulating the use of respiratory protection contributed 42.3% to the parsimonious model. Perceived control belief significantly contributed to the variance in preventive behavior. These results demonstrate the need for agricultural workers at the Pennsylvania State University to acquire the requisite knowledge about the type of respirators available and the kind of protection they offer. It is evident that training in the use of the types of agricultural respirators becomes very essential in addition to acquiring the knowledge of how respirators work to reduce respiratory hazards.
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Chapter 1
INTRODUCTION

In agriculture, workers are potentially exposed to a wide range of respiratory toxins, many in concentrations higher than in other industries (Kirkhorn & Schenker, 2002). While the acceptable levels of contaminants such as dust and harmful gases are legally controlled in many industries, this is not the case in agriculture (AgrAbility Quarterly, October, 2004). Within modern livestock confinement housing, dust and other gases can easily rise to harmful levels for both animals and their human handlers. Inhalation of these toxins has been the primary cause of respiratory diseases among agricultural workers. The kinds of work most commonly associated with respiratory problems include grain production and handling, working in animal confinement units, dairy farming, and pesticide applications.

Among the agricultural population, the most affected group is in concentrated animal feeding operations (CAFOs). These include farmers working with cattle, swine, and poultry and in facilities such as silos and feed mills. Activities in these confined facilities produce much dust and other particles which when not controlled can cause serious respiratory problems.

Dust exposures may be divided into those primarily consisting of organic components and those consisting of inorganic components. Field dust is the primary source of inorganic dust exposures. Inorganic dusts come primarily from soil components and are dominated by silicates but may include significant concentrations of crystalline silica (Nieuwenhuijsen & Schenker, 1999). Exposures of agricultural workers
to inorganic dusts, which are often mixed with organic dusts and other components, may result in macules, nodules, and interstitial fibrosis (Schenker, 2000).

Organic dusts are those carbon-based dusts derived predominantly from plant and animal sources (Donham, 1986). Organic dust is a major respiratory exposure to agricultural workers. Farmers handling animal feed, grains, hay and silage are at risk of respiratory exposure to organic dusts. Examples of this type of exposure include uncappping a non-air tight silo and handling moldy grain or spoiled hay in a confined space. According to the literature, dust levels are very high in these settings (e.g. 10 to 20 mg/m$^3$), have very high microbial content (e.g. $10^6$ to $10^9$ microbes/m$^3$), and have high endotoxin content (e.g. 1000 to 10, 000 EU/m$^3$). Disorders caused by this type of exposures include organic dust toxic syndrome (ODTS) and hypersensitivity pneumonitis (Von Essen & Donham, 1997). Long-term exposure can lead to congestion, coughing or wheezing, sensitivity to dust, frequent respiratory infections such as colds, bronchitis, and pneumonia. Overexposure to dust can result in serious respiratory illnesses such asthma, emphysema, chronic bronchitis, and other irreversible or incurable ailments.

A common exposure pattern identified with agricultural workers is the daily exposure to a lower level of organic dust. According to the literature, typically total dust levels are 2 to 9 mg/m$^3$, microbe counts are at $10^3$ to $10^5$ organisms/m$^3$ and endotoxin concentration is 50 to 900 EU/m$^3$. Examples of such exposures include work in a swine confinement unit, a dairy barn, or a poultry growing facility. Usual symptoms seen with these exposures include acute and chronic bronchitis, an asthma-like syndrome and symptoms of mucus membrane irritation such as rhinitis (Von Essen & Donham, 1997).
Gases also cause lung disorders to workers in agricultural settings. In swine confinement buildings and in poultry facilities, ammonia levels often contribute to respiratory problems. Exposure to the anhydrous ammonia fertilizer in warehouses has both acute and long-term effects on the respiratory tract. Ammonia, hydrogen sulfide, carbon dioxide, and carbon monoxide also have serious effects on both humans and animals. Exposure to these gases above the permissible or recommended levels can result in serious health problems or even death. Acute poisoning from hydrogen sulfide gas released from manure storage facilities in dairy barns and swine confinement units can cause fatalities. Inhalation of insecticidal fumigants can also lead to death (Von Essen & Donham, 1997).

In the United States, an estimated 700,000 people work in livestock confinement operations including owners/operators, family members, and agricultural employees and an additional 250,000 individuals in swine confinement facilities (Von Essen & Donham, 1999). Workers in large swine operations often spend 40 or more hours per week inside facilities (Kirkhorn & Schenker, 2002). Thorne and others (1995) have suggested that long-term exposures for two hours per day for six or more years in swine confinement facilities is associated with several respiratory conditions including sinusitis, mucous membrane inflammation syndrome, non-immunogenic bronchospasm and bronchitis.

Disabling effects of asthma and chronic obstructive pulmonary disease (COPD – primarily chronic bronchitis and emphysema) may in many cases drive a person out of a line of work or out of work completely. The farm machine operator who becomes asthmatic from breathing droplets of cutting fluids, and the veterinary doctor whose allergic reaction to certain air particles while handling animals in a barn, (having been
exposed to these health hazards unprotected) may have to relinquish their skilled profession. The agricultural worker with an obstructive lung disease may become unemployable. These personal effects have serious business consequences beyond issues of medical costs and workers’ compensation. Employee turnover in highly skilled professions is especially costly.

In 2006, the National Safety Council (NSC) estimated that “the true cost to the nation, to employers, and to individuals of work-related deaths and injuries was much greater than the cost of workers’ compensation insurance alone” (NSC, 2006, p.51). The report indicated that the total cost in 2004 was $142.2 billion, which includes the cost of wages and productivity losses of $73.3 billion, medical costs of $26.0 billion, and administrative expenses of $31.0 billion. Other costs such as employers’ uninsured costs of $7.9 billion were represented as the money value of time lost by workers other than those with disabling injuries, who are directly or indirectly involved in injuries, and the cost of time required to investigate injuries, write up injury reports and other related issues.

Leigh, Markowitz, Fahs, Shin, and Landrigan, (1997) reported that in1992; the combined U. S. economic burden for occupational illnesses and injuries was estimated at $171 billion. Leigh, Romano, Schenker, and Kreiss (2002) also reported an estimated cost for occupational COPD and asthma in the United States in 1996 was at $6.6 billion, and this was likely to rise with the increasing prevalence of these diseases, which therefore warrants preventive intervention. Thus, every effort needs to be made towards preventing work-related injuries and illnesses especially respiratory diseases in farmers/agricultural workers – the producers of our foods, fats and fibers.
Statement of the Problem

A considerable amount of research has been completed on the epidemiology of farm-related injuries and illnesses. This literature suggests that scientific safety and health evaluation is not yet a part of the culture of agricultural safety and health professionals, whether they are agriculturally-based or public health-based (Murphy, 2003). A review of agricultural safety and health injury/illness prevention research literature identified frequent flaws or limitations in research design and data analyses procedures (DeRoo, & Rautianen, 2000; Keifer, 2000). The flaws or limitations were lack of randomization of subjects and/or use of control groups, no baseline measurements for intervention, same day pre- and post-tests, a lack of objective outcome measures, and inadequate data for process evaluation. Furthermore, influencing the attitudes of the farming population is laborious and implementing safety regulations and enforcement can be daunting and perhaps culturally unacceptable. Thus, new approaches to farm injury/illness management and handling of farm safety issues need to be continuously pursued.

In an attempt to remedy the above-mentioned problems, the National Institute for Occupational Safety and Health (NIOSH) proposed a conceptual model (Godenhar, LaMontagne, Katz, Heaney & Landsbergis, 2001: Figure 1) to assess the effectiveness of intervention programs in safety and health. This model identifies three phases: developmental, implementation, and effectiveness research.

Each phase has five intervention research tasks to be addressed during program development, implementation, and evaluation. These tasks include conducting needs
assessments, developing partnerships, and selecting appropriate methodologies or research design for intervention programs.

![Image of Intervention Effectiveness Research (IER) conceptual framework](image)

**Figure 1:** Intervention Effectiveness Research (IER) conceptual framework Reproduced with permission from the author.

**The Need for the Study**

Even though there is much literature on respiratory diseases, little has been done to assess the effectiveness of intervention programs to reduce respiratory diseases in agricultural and related industries. Studies that reviewed agricultural safety and health intervention programs have recommended a great need for implementing feasible intervention research to reduce respiratory disease exposures. Essen and Romberger (2001) have recommended the need for implementing feasible interventions to reduce symptomatic respiratory diseases resulting from working in swine confinement facilities. Studies have recommended pragmatic intervention research to alleviate respiratory
disease exposures among agricultural workers. This study will add to the body of knowledge by developing a training module based on the importance and relevance of the identified topics for the respiratory safety/protection program, which would serve as an educational resource and reference manual to agricultural workers.

**Purpose of the Study**

The purpose of this study was to use the proposed conceptual model to develop a respiratory safety program based on perceived beliefs of farm and/or agricultural related workers about using respirators and/or following respiratory protective procedures to prevent respiratory hazards exposures. In addition, the relationship between agricultural workers’ perceived beliefs regarding the use of respirators and/or adopting preventive behavior are explored and used to develop a framework for the respiratory safety training module.

The following are research questions that guided the study:

1. What educational needs/topics should be included in a respiratory safety program?

2. What are current beliefs about the risks of respiratory diseases and the use of protective procedures among agricultural workers?

3. What are the perceived barriers to the use of respirators and/or following protective behaviors to prevent respiratory problems?

4. What factors influence the choice of behavior among the agricultural workers?

5. What are the program outcomes on the beliefs and behaviors of program participants after participating in a respiratory safety program?
**Research Hypotheses**

The following hypotheses were tested:

\( H_{01} \): There is a positive correlation between respondents’ perceived beliefs (e.g. perceived susceptibility to respiratory disease) and ratings of topics to be included in a respiratory safety program.

\( H_{02} \): Agricultural workers who perceive themselves to be at risk of getting respiratory disease are more likely to follow precautions for respiratory protection than those who do not perceive themselves to be at risk of getting respiratory disease.

\( H_{03} \): There is no significant difference in perceived beliefs and/or preventive behaviors among agricultural workers who participated in the respiratory safety program and those who did not participate.

\( H_{04} \): Agricultural workers receiving the program intervention are likely to adopt recommendations provided in the respiratory safety program.

**Assumptions of the Study**

The study assumed that participants provided frank and honest responses to the items in the questionnaires to the best of their knowledge and ability to provide the basis for using the outcome of the needs assessment to develop the respiratory safety program to meet their needs. It was also assumed that the responses received from each respondent were the individual’s personal view and not what others perceived.

**Limitations of the Study**

The study is limited to agricultural workers engaged in work related to crop and animal production at the Pennsylvania State University. It is limited to part-time and full-time agricultural workers employed who participated in the study from December 2006 to June 2007. Also, since the perceptions and beliefs about the use of respirators may vary from individual to individual over time, the findings could only apply to the agricultural workers at the Pennsylvania State University. Findings will also be limited
to what the research participants believed and perceived about the respiratory safety issues at the time of participating in this study.

Operational Definitions

Attitude: A complex mental state involving beliefs and feelings, values and dispositions to act in certain ways. It is a psychological tendency that is expressed through evaluating a particular behavior with some degree of favor or disfavor.

Behavior: Any observable, recordable, and measurable movement, response, or verbal or nonverbal act demonstrated by an individual. According to the theory of planned behavior, behavior is a direct result of behavioral intention. Intentions, in turn, reflect consideration of relevant attitudes and beliefs about the behavior and its outcome.

Behavioral belief: An individual’s associations towards using respirators and/or following respiratory protection procedures while working in confined facilities or in areas identified to expose that individual to respiratory hazards.

Behavioral intention: The immediate determinant of an individual performing or not performing the behavior of using respiratory protection or following recommended procedures to prevent respiratory diseases exposure.

Beliefs: They are assumptions, theories, explanations, conclusions and states of mind which an individual may choose at some level as frameworks to help him/her make sense out of his/her experiences. Beliefs often become so ingrained, due to repeated situations which seem to "prove" their legitimacy that they are tended to be confused with facts.
In this study, the belief constructs used are those suggested as applicable to workplace safety self-protective behavior from a review of four expectancy-value models.

**Control beliefs**: Beliefs about the likelihood that one possesses the resources and opportunities thought necessary to execute the behavior.

**Intention**: An anticipated outcome that is intended or that guides one’s planned actions.

**Motivation to comply**: The extent to which a person feels inclined to match his or her behavior to various sources of social pressure.

**Norms**:

*Descriptive* – Perceptions about what important people actually do.

*Injunctive* – Perceptions about what important people think a person should do.

*Subjective* – Perceived social pressure to perform a behavior.

**Normative beliefs**: Perceptions of significant others’ preferences about whether one should perform a behavior.

**Perceived control**: An individual’s perception of the level of control he/she has over performing or not performing the act of using respiratory protection or following recommendation procedures to prevent respiratory hazards.

**Preventive behavior**: A positive response taken by an individual towards the performance of an action to reduce or eliminate any hazards or threats that exposes that individual to risk.

**Respirator**: Any device designed to provide the wearer with respiratory protection against inhalation of a potentially hazardous atmosphere (Bureau of Labor Statistics, 2002).
Respirator Usage:

Voluntary use – employee decides to use a respirator (with the employer’s approval) for personal reasons (e.g., allergy, desire to reduce exposure beyond that required by regulation).

Required non-emergency use – respirator use for exposure to known substances, which is required by regulation or by the employer.

Required emergency use – respirator use as a result of an unplanned situation, including escape from or entry into a potentially hazardous environment (BLS, 2002).

Respiratory Protection Procedures: The steps that employees follow while working in potentially hazardous environment to reduce or eliminate exposure to respiratory hazards. These steps include administrative and/or engineering controls recommended to eliminate or reduce air contaminants to permissible standards.

Respiratory Safety Program: A training module that was developed based on the beliefs of sampled research subjects and their perceived ratings of the importance and relevance of educational topics that were identified and included in the program.

Response efficacy: The individual’s perceived belief as to whether a recommendation of an action or strategy is effective in preventing or eliminating a threat or hazard. This term is used synonymously to perceived benefits the individual derives as a result of adopting a recommended action or behavior.

Self-efficacy: The conviction that one can successfully execute a given behavior.

Subjective norm: An individual’s perception of the general social pressures to either perform or not to perform the behavior of using approved respirators while
working in confined (animal) facilities or following approved respiratory protection procedures in that confined facility. In this study, subjective norm was computed by combining normative beliefs and motivation to comply.
Chapter 2

REVIEW OF THE LITERATURE

Respiratory diseases are among the top ten death causing diseases worldwide (WHO, 2007), and there has been growing concerns about the prevalence of occupational respiratory diseases among agricultural workers. One way of curbing the incidence of occupational respiratory diseases among workers who are at risk is to have and use respiratory protection advices any time workers are exposed to potentially hazardous environments. Although the use of respirators in agricultural settings is not mandatory in all farm operations, there are some operations that are guided by regulations to provide respirators for employee protection. In certain instances, employees may require voluntary use after being tested to be medically fit for its use. Yet, some workers believe they might not require respirators, but will follow established procedures to get protection from potentially hazardous environment.

This review of the literature examines theoretical models of health behavior and workplace self-protective behaviors in studies that used these models to predict behaviors relative to intervention programs. Similar studies that used these models to predict the use of protective devices among workers in related occupations are also reviewed. The strengths and limitations of the models reviewed are presented. Studies on the association of respiratory diseases/illnesses and the type of chores agricultural workers perform that could likely expose them to risk are also included in this review of the literature. This review helps to create an understanding of the risk factors related to farming operations in the agricultural industry.
Theoretical Models of Health Behaviors

A variety of models have been developed to explain why people do or do not engage in various health enhancing and medically beneficial activities. These models have been applied to a wide variety of preventive and lifestyle behaviors (e.g., seat belt usage, vaccination, smoking, helmet usage), screening or early detection activities (breast self-examination, cholesterol and blood pressure testing), sick-role behaviors (e.g. clinic utilization, physician visits), and adherence to medical and other therapeutic regimens (e.g., hypertension, diabetes). According to DeJoy (1996), there appears to be a link between these models and workplace self-protective behavior although very little attention has been given to examining how they might apply to actions that workers are asked to take to protect themselves from job-related hazards.

Expectancy-value models are based upon the premise that people estimate the seriousness of risks, evaluate costs and benefits of various actions, and then choose a course of action that will maximize the expected outcome (Cleary, 1987). Expectancy-value models have taken a variety of forms, most prominent examples include the Health Belief Model (Becker, 1974), Theory of Reasoned Action (Ajzen & Fishbein, 1980), Theory of Planned Behavior (Ajzen, 1985, 1988), and Protection Motivation Theory (Rogers, 1983). Differences exist in these models to some extent but they all emphasize the individual’s threat-related beliefs or perceptions.

Weinstein (1993) propounds that expectancy-value models have four common characteristics: 1) that motivation for self protective behavior arises from the anticipation of negative consequences and the desire to minimize these outcomes, 2) the impact of an anticipated negative outcome on motivation depends on beliefs about the likelihood that
this outcome will occur, 3) that motivation to act arises from the expectation that the action will reduce the likelihood or severity of harm, and 4) that the benefits of a particular action must be weighted against the expected cost of taking the action.

The expectancy-value model thus suggests that “people orient themselves to the world according to their expectations (beliefs) and evaluations”. Utilizing this approach, behavior, behavioral intentions, or attitudes are seen as a function of “(1) expectancy (or belief) – the perceived probability that an object possesses a particular attribute or that a behavior will have a particular consequence; and (2) evaluation – the degree of affect, positive or negative, toward an attribute or behavioral outcome” (Palmergreen, 1984).

The Health Belief Model (HBM):

The HBM is believed to have produced the largest body of health-related research. The HBM is also classified as one of the oldest social cognitive models (Mullen, Hershey, & Iverson, 1987; Norman & Conner, 1996) used to predict whether individuals choose to engage in a healthy action in order to reduce or prevent the likelihood of disease or premature death. According to the HBM two main types of beliefs influence people to take preventive action: 1) beliefs related to readiness to take action, and 2) beliefs related to modifying factors that facilitate or inhibit action. The variables that are used to measure readiness to take action are perceived susceptibility to the illness (for example, breast cancer) and the perceived severity of the illness. The benefits, i.e. the perceived advantages of action, and the barriers, i.e. the perceived costs or constraints of the specific action, are the main modifying variables (Sheeran & Abraham, 1996; Rosenstock, Strecher, & Becker, 1988).
According to Abraham and Sheeran (2000), the health belief model highlights threat perceptions as a central component of motivation and conceptualizes such appraisals in terms of beliefs about the extent of perceived susceptibility to and severity of a health problem. Susceptibility and severity are “outcome expectancies i.e. beliefs about what will happen if the person does or does not perform a particular action or sequence of actions” (Abraham & Sheeran, 2000, p.4).

Published reviews of the HBM literature (Becker, 1974; Harrison, Mullen, & Green, 1992; Janz and Becker, 1984) found weak relationships between the variables predicting behavior across studies and offered some general conclusions about the importance of its components. For instance, perceived severity was found to correlate poorly with behavior (Maddux & Rogers, 1983; Schwarzer, 1992; Schwarzer & Fuchs, 1996; Wurtele & Maddux, 1987) because perceptions of severity only influence motivation when severity exceeds a certain threshold, and once this threshold is reached perceived susceptibility may be a more important component (Sheeran & Abraham, 1996; Weinstein, 1988).

The HBM variables have been moderately successful in predicting a variety of behaviors including risky sexual behavior (Basen-Engquist & Parcel, 1992; Hingson, Strunin, Berlin, & Heeren, 1990); exercise, eating sweet and fried foods and smoking (Mullen, Hersey, & Iverson, 1987); sunbathing and sunscreen use (Keesling & Friedman, 1987); driving while intoxicated (Beck, 1981).

One of the major criticisms of the HBM is that it does not specify relationships among the variables. It has sometimes been referred to as a list of variables rather than a theoretical model (Wallston & Wallston, 1984; Weinstein, 1993). Most applications of
the HBM combine the variables in a linear or additive fashion to test the model
\[ \text{susceptibility} + \text{severity} + (\text{benefits} - \text{barriers}) \] (Witte, Stokols, Ituarte, & Schneider, 1993; Wyper, 1990). However, earlier studies that used the model appeared to suggest a multiplicative model \[ \text{susceptibility} \times \text{severity} \times (\text{benefits} - \text{barriers}) \] (Haefner & Kirscht, 1970; Hill, Gardner, & Rassaby, 1985; Conner & Norman, 1994), or by subtracting barriers from benefits (Oliver & Berger, 1979; Rutledge, 1987; Wyper, 1990). Also, there are no strict guidelines as to how the different variables are to be measured to predict behaviors. There has also been some debate about the meaning of correlations between variables such as perceived susceptibility to a health hazard and preventive action and about the most appropriate measures of susceptibility beliefs (Gerrard, Gibbons & Bushman, 1996; Weinstein, 1988; Weinstein & Nicolich, 1993).

Comparative studies using the health belief model (HBM) and theory of planned behavior (TPB) have suggested that both HBM and TPB can be used to identify variables that are important predictors of intention and behavior, thus offering useful indicators as to how effective behavior change interventions should be planned (Nejad, Wertheim, & Greenwood, 2005; Quine, Rutter, & Arnold, 2000).

*The Theory of Reasoned Action (TRA):*

The TRA posits that behavioral intention is the immediate determinant of behavior and that all factors that influence a particular behavior mediated through intention. Intention is determined by two components: 1) attitude toward the behavior, which consists of beliefs about the consequences of performing the behavior and evaluation of the consequences; and 2) subjective norms, which consists of normative beliefs about what salient others think and the individual’s motivation to comply with
those wishes. According to the TRA, intention can be predicted by the linear combination of attitude and normative beliefs multiplied by motivation to comply with the beliefs. The model is expressed as a multiple regression equation, with the weights assigned to the major components determined by multiple regression procedures.

The TRA has been used with much success to a number of health behaviors, including exercise, weight loss, child safety seat, smoking, condom usage (Sheeran, Abraham & Orbell, 1999), and alcohol and drug use (Cleary, 1987; Kirscht, 1988).

Besides the focus on behavioral intention, the difference between the TRA and HBM is that the TRA includes subjective norms as a major determinant of health-related behavior. The TRA also goes further to specify how the belief constructs should be measured and how they should be combined to form behavioral intention. A limitation identified in the use of the TRA was that most studies using the model limited it to predicting behavioral intention rather than the actual behavior (Baranowski, 1992-1993).

Later versions of both the HBM (Rosenstock, Strecher, & Becker, 1994) and TRA (Ajzen, 1985) added self-efficacy (Bandura, 1986) as an important component. The principal argument for including self-efficacy was that people must feel confident that they are capable of performing the behaviors required to produce the desired outcomes. Self-efficacy appeared especially important for lifestyle modifications and other behaviors that involved long-term change and maintenance (Strecher, DeVellis, Becker, & Rosenstock, 1986).

*The Theory of Planned Behavior (TPB):*

The TPB (Ajzen, 1985, 1988, 1991) and its predecessor the Theory of Reasoned Action are the most influential and widely used social cognition models of the attitude-
behavior. The TPB represents an extension of the original TRA that is designed to allow for the fact that not all behaviors are entirely under volitional control. The TPB proposes that the immediate determinant of human behavior is behavioral intention, which is in turn determined by the individual’s attitude towards the behavior in question by his or her subjective norm. Attitude towards the behavior is itself a product of a small set of salient behavioral beliefs about the consequences of not performing the behavior, weighted by an evaluation of each of these consequences. Subjective norm is determined by a small set of salient normative beliefs, i.e. the person’s beliefs about the perceived wishes of salient others weighted by his or her motivation to comply with these others’ expectation. The product of each behavioral belief multiplied by the person’s corresponding outcome evaluations gives a set of behavioral beliefs, the sum of which forms the overall attitude of the behavior. Similarly, the summed product of each normative belief multiplied by the person’s motivation to comply gives belief-based measures of subjective norm.

To these two determinants of intention, has been added a third component--perceived behavioral control-- which refers to the degree to which a person feels that performance of the behavior is under his or her volitional control. Measurement of perceived behavioral control is designed to assess a person’s beliefs about the ease or difficulty of performing the behavior (Ajzen, 1988). According to Ajzen (1988), “among the beliefs that determine intention and action is a set that deals with the presence or absence of requisite resources and opportunities” (p.135). The more resources and opportunities individuals think they possess and the fewer obstacles or impediments they anticipate, the greater their perceived control over the behavior in question. These beliefs
were termed control beliefs (Ajzen, 1988) and may include internal control factors (information, personal deficiencies, skills, abilities, emotions) and external controls factors (opportunities, dependence on others, barriers). This construct takes care of self-efficacy that was introduced in recent versions of the HBM and TRA.

The introduction of perceived behavioral control was not the only amendment to the TRA. In the original theory the influence of beliefs and attitudes on behavior was always mediated by behavioral intention. Ajzen (1985) parallels this view by stating that in certain circumstances perceived behavioral control may influence behavior directly, i.e., it can be seen as a measure of people’s confidence in the ability to carry out their intentions successfully.

A number of similarities and differences between HBM and TPB were identified in a review by Conner and Norman (1994). Some differences were also reviewed by Quine, Rutter, and Arnold (2000) in a study that compared the TPB and HBM in predicting safety helmet use among schoolboy cyclists. These include 1) HBM measures individuals’ perceptions of vulnerability to the health threat as separate from perceptions of severity with which the threat may affect lives. The TPB does not include measures of susceptibility and severity, and it is assumed that these factors influence behavior via effects on behavioral and normative beliefs. Thus, the TPB does not address emotional, fear, and arousal variables. This has led some researchers, for example Oliver and Berger (1979), to suggest that the TPB is limited to the rational part of human decision-making. 2) TPB measures the degree of control a person believes he or she has over performing the behavior. This factor, according to Ajzen (1988), is “assumed to reflect past experience as well as anticipated impediments and obstacles” (p.132). The greater the
perceived behavioral control, the stronger should be the individual’s intention to perform the behavior under consideration. The HBM does not directly measure control beliefs. These are often included by researchers in the barrier construct. 3) The TPB does not include cues to action, the component originators of the HBM believed to be important for triggering the decision-making process. In the TPB these are assumed to influence behavior via their effects on behavioral and normative beliefs.

Protection Motivation Theory (PMT):

This model features two cognitive processes: threat appraisal and coping appraisal, combined to form protection motivation. Protection motivation (typically measured as behavioral intention) is conceptualized as an intervening variable that activates coping behavior. Threat appraisal evaluates the intrinsic (e.g., pleasure) and the extrinsic (e.g., social approval) rewards that increase the probability of making a maladaptive response against perceptions of vulnerability and outcome severity that decrease the probability. Threat appraisal is an expression of the algebraic sum of these variables. Coping appraisal consists of judgments about the efficacy of a preventive response (response efficacy) plus the assessment of the individual’s ability to successfully perform the needed responses or behaviors (self-efficacy) minus the costs associated with the response.

Protection motivation is assumed to be greater when (a) the perceived threat is severe, (b) the individual feels vulnerable, (c) the adaptive response is believed to be effective (d) the individual is confident of his or her abilities to complete the adaptive response, (e) the perceived rewards of the maladaptive behavior are small, and (f) the perceived costs of the adaptive behavior is low. Even though the model is considered as
an algebraic sum (additive), within each of the two appraisal processes, interactive
effects can occur between threat and coping appraisal processes (e.g., self-efficacy and
severity). Presumably, this allows the model to predict outcomes that are contrary to
totally rational decision making (Prentice-Dunn & Rogers, 1986). Although less
extensively researched than the HBM, TRA and TPB the major components of the PMT
have been supported (Prentice-Dunn & Rogers, 1986; Rogers, 1983; Melamed et al.,
1996; Boer & Seydel, 1996). Much of the research reviewed using this model has
involved fear-arousing communication and attitude change.

Applications to Workplace Safety Self-Protective Behavior

From the review of the four expectancy-value models, common belief constructs
emerge that could be relevant to workplace self-protective behavior. These constructs are
(a) threat-related beliefs, (b) self-efficacy beliefs, (c) response efficacy beliefs, (d) barrier
beliefs, and (e) normative expectation beliefs. The rationale for their consideration in
workplace self-protective research is summarized below.

Threat-related beliefs

Beliefs related to susceptibility and the severity of a hazard is featured in the
expectancy-value models. The interrelationship of susceptibility and severity tends to be
treated differently in the belief models that used these constructs. According to Dejoy
(1996), considering a multiplicative relationship might appear the most appropriate with
the expectancy-value tradition. For example, a high level of perceived susceptibility may
not necessarily lead to self-protective behavior if the severity of the treat is minimal.
However, a highly risky outcome could make perceived susceptibility a major factor to
consider.
**Self-efficacy**

Self-efficacy has been incorporated into each of the expectancy-value models. Because most instances of workers’ self-protection involve the performance of a set of prescribed actions on a long-term basis, self-efficacy should be an important factor in determining workers’ self-protective safety behaviors. The worker needs to feel confident about his/her ability to perform required behaviors on a regular and long-term basis.

**Response Efficacy**

Beliefs about the consequences or effectiveness of preventive action can also play a role in each of the models. Response efficacy beliefs are treated as benefits in the health belief model, as part of attitude in the theory of reasoned action, and introduced into the theory of planned behavior as part of control beliefs, and as response efficacy in the protection motivation theory. In most workplace applications, response efficacy involves perceptions about the effectiveness of prescribed work practices or protective equipment in preventing hazardous exposures.

**Barriers**

These have been explicitly considered in both the HBM and PMT and indirectly in the TRA. The HBM literature (Janz & Becker, 1984) suggests that barriers or costs are the single best predictor of health behavior. Relevant to the workplace, research on the use of personal protective equipment shows that job-related barriers are often a major factor in non-compliance (Acton, 1977; Cleveland, 1984; Terrell, 1984).
Normative Expectations (Beliefs)

The TRA and TPB are models that considered the effects of social environment most directly. Social influences are also considered somewhat tangentially, in the intrinsic-extrinsic rewards of portions of the PMT. Research on safety program effectiveness (Planek & Fearn, 1993) and safety climate (Dedobbeleer & Beland, 1991; Niskanen, 1994) highlight the importance of social-organizational factors in supporting good safety performance. The safety literature also contains studies indicating that performance and the types of feedback received from supervisors and coworkers could play an important role in shaping work-related safety behaviors (McAfee & Winn, 1989).

Respiratory Diseases in Production Agriculture

Clinical and epidemiological studies continue to show high prevalence of respiratory disease exposures in work related to animal production and in other agricultural related industries. In 1989, the National Coalition for Agricultural Health and Safety identified respiratory diseases as an important problem in modern agriculture. Kullman (1995) stated that “the magnitude of respiratory health problems in agriculture are evidenced in estimates that 20% of all U.S. farmers suffer breathing problems; agricultural respiratory diseases present an even greater risk for farmers in certain high risk groups, e.g., confinement animal farming where over 40% are affected by respiratory disease” (p.2). Currently, respiratory diseases in agriculture have been a major concern believed to have resulted in one of the highest levels of mortality among occupational groups in the United States (AgrAbility Quarterly, 2004; NIOSH, 2007), and a leading priority for epidemiologists, occupational health and safety professionals, rural health
Purschwitz (1997) presented an overview of the various illnesses and chronic conditions attributed to farm work. The overview identified numerous farm respiratory hazards. These include molds and dusts from grains, hay, and silage; animal dander; toxic gases and particulate matter for livestock wastes; toxic gases, dust, or oxygen deprivation in crop storage structures; vapors from fuels and solvents; pesticide vapors; and welding fumes (pp. 220-221). According to Purschwitz (1997) some of these hazards can lead to acute toxic exposures from respiratory poisoning or asphyxiation, while others result in illnesses.

Von Essen (1992) provided an overview of illnesses due to airborne dusts on the farm. These include hypersensitivity pneumonitis, organic dust toxic syndrome (ODTS), chronic bronchitis, asthma, and mucous membrane inflammation. Brackbill, Cameron and Behrens (1994) combined 5 years of National Health Interview Survey Data and found, for chronic respiratory disease, farmers had an age-adjusted prevalence risk ratio (PRR) of 1.3 versus other currently employed workers.

Zedja et al. (1993) summarized eight representative cross-sectional studies of chronic respiratory symptoms in farmers and found that in some studies 5 to 21% of farmers had chronic bronchitis, over 20% had chest wheeze, 0.4% to 1.5% had hypersensitivity pneumonitis, and 6 to 15% had ODTS.

Among swine producers, Donham (1990) reviewed 14 studies from U.S., Sweden, Canada, and the Netherlands and found the prevalence of respiratory symptoms to be 2 to 4 times that of comparison groups. Donham et al. (1990) found that confinement swine
workers had significantly higher rates of cough, phlegm, chest tightness, shortness of breath, and eye/nose/throat irritation associated with work than did non-confinement swine workers.

Iverson et al. (1990) reported 28.3% of Danish swine farmers had symptoms of shortness of breath, wheezing, and dry cough, and 10.9% had asthma. These figures were observed to be higher than for dairy farmers (7.4% shortness of breath, wheezing, and dry cough; 5.5% asthma). Age was found to be an important factor; 3.6% of farmers aged 31-50 had asthma and 17.9% had chronic bronchitis, while 11.8% of farmers aged 51-70 had asthma and 33% had chronic bronchitis.

Dairy producers are also at risk. Dalphin et al. (1994) found French dairy farmers who used barn drying systems on their forage, resulting in fewer microorganisms in the barn air, clearly had better respiratory function than those who used traditional storage methods. This cross-sectional study was performed to see whether barn drying provides protection against respiratory problems in dairy farmers. The respiratory symptoms and function of a group of 123 farmers with daily exposure to cattle foddering from farms which had had a barn drying system for at least three years were compared with those of a representative sample of 274 farmers working in farms with traditional storage in five districts in the Doubs region of France. The results of this cross-sectional study suggest that barn drying of fodder may protect respiratory function in dairy farmers. Dalphin et al. (1993) found an excess of chronic bronchitis in dairy farmers, and indicated it occurs more frequently in farmers with previous episodes of acute lung reactions.

Husman, Terho, Notkola, and Nuutinen (1990) found that 13.6% of 2,866 Finnish farmers had one or more acute incidents of ODTS related to work, excluding 23 farmers
who had symptoms of hypersensitivity pneumonitis (farmer’s lung). Fifty-two percent of the farmers acquired symptoms less than 4 hours after exposure. Cattle tending was significantly more associated with ODTS than swine (Purschwitz, 1997). Holness and Nethercott (1989) reported a prevalence rate of allergic rhinitis of 21% among workers on primarily dairy and beef farms in Ontario.

Hoppin, Umbach, London, Alavanja, and Sandler (2003) investigated the role of animal exposures and wheeze to assess whether their impact differed among subgroups including atotics, asthmatics and smokers. Using the Agricultural Health Study, a cohort of pesticide applicators in Iowa and North Carolina enrolled in 1994-97. Wheeze associated with animal production was evaluated and interactions among susceptible subgroups were assessed. Logistic regression models were used to examine risk factors for wheeze in the past year among the 20,468 farmers. Results indicate that individuals raising animals requiring direct contact had the highest odds ratio (OR) for wheeze (OR_{dairy} = 1.26; OR_{eggs} = 1.70). A significant dose-response was observed for both the number of poultry and the number of livestock on the farm. In addition, farmers who performed veterinary procedures on a daily basis had an OR of 1.51. The odds of wheeze associated with poultry production was greater among atopic than non-atopic individuals. Furthermore, milking cows daily increased the odds of wheeze in all individuals, with the largest association observed among atopic asthmatic individuals. The impact of dairy, poultry, and egg production varied among smoking groups. It was found that past smokers had the highest odds ratio, followed by never smokers, and then current smokers. The OR_{eggs} (farmers in egg production units) was 2.88 among past smokers but only 1.46 for never smokers. The OR_{eggs} for current smokers was suggestive of reflecting
self selection to exposure among smokers. The study concluded that results were consistent with animal production and respiratory symptoms, and suggests that subgroups may respond differently to exposures.

Radon et al. (2001) conducted a European study to determine which airway symptoms predominate in different types of animal farmers (cattle, pigs, poultry, sheep) and compared the prevalence of symptoms to the general population. A total of 6,156 randomly selected animal farmers in Denmark, Germany (Schleswig-Holstein, Niedersachsen), Switzerland, and Spain completed a questionnaire on respiratory symptoms and farming characteristics in 1995-1997. The prevalence of general respiratory symptoms was compared to the results of the European Community Respiratory Health Survey (ECRHS) obtained in the same region. The results found that pig farmers were at highest risks for the development of work-related symptoms. A significant dose-response relationship between daily hours worked inside animal houses and symptoms was established for pig and poultry farmers. In addition, self-reported nasal allergies {odd ratio 95% confidence interval: 3.92 (3.26 – 4.71)} and nasal irritation during work {3.98 (3.35 – 4.73)} were shown to be associated with the development of chronic phlegm. Furthermore, the prevalence of wheezing, shortness of breadth, asthma and nasal allergies was significantly lower among all farmers in the age group 20-44 years than among the general population. However, the prevalence of usually bringing up phlegm in winter among farmers was significantly higher than in the general population {9.4 (8.3 – 10.5%) versus 7.5 (6.5 – 8.5%)}. Individual factors have been shown to be related to the prevalence of chronic phlegm among farmers.
Grain dust is also a respiratory hazard. Bernhardt and Langley (1993) stated that grain dust can cause acute respiratory inflammation response – nasal stiffness, rhinorrhea, sore throat, acute bronchitis, occupational asthma – as well as ODTS, hypersensitivity pneumonitis, and eye and skin irritation.

Hurst and Dosman (1990) found that grain handlers had a dose-dependent relationship between total dust exposure and decrease lung function, particularly lower flow rates and more chronic bronchitis, and that grain handlers had an annual decline in lung function greater than that of control groups. It was also found that 6 to 30% of grain farmers get grain fever, which resembles influenza, during or shortly after exposure to grain dust. Thus, according to Hurst and Dosman (1990), “Grain dust should be regarded as a dust with toxic properties and not just a nuisance dust” (p.27).

Rublaitus et al. (1994) found that 16.5% of Ohio grain farmers experienced flu-like symptoms in connection with dusty work in the previous year; 10.5% experienced chest tightness associated with work, and 63.6% had experienced some form of respiratory symptoms attributed to dusty work environment.

**Applications in Agricultural Safety and Health**

Petrea (1996) applied the theory of planned behavior to respiratory protection utilization and behaviors of east-central Illinois pork producers. The study was conducted in two phases. A population of 342 pork producers was targeted through mailed questionnaires out of which 184 responded. A sample of 80 was drawn to attend an educational session on respiratory protection. One-half of those producers attending the educational session and one-half of those who did not attend the session were randomly assigned to receive two-strap toxic dust/mist respirators through the mail.
Phase one of the study elicited salient beliefs from the producers that two-strap toxic
dust/mist respirators are hot and uncomfortable; help to keep dust out of the lungs, and
are difficult to keep where needed, and health professional and spouses are motivating
influences.

Findings in the second phase of the study indicated that current use of two-strap
toxic dust/mist respirators nearly doubled. The study found a significant difference
between intentions and self-reported behaviors of pork producers wearing two-strap
dust/mist respirators in confinement facilities for at least 15 minutes after attending the
educational session on respiratory protection. Intentions to use respirators and self-
reported behaviors was found to correlate substantially \((r = .52)\) for producers who
received respirators and attended the educational session. Attitude and subjective norm
contributed equally in the multiple correlation with intention \((Beta = .38)\).

Levin (1994) used the theory of planned behavior in a study on predictors of
glove use by healthcare workers. Intention, attitude and perceived risks were
significantly related to the behavior of wearing gloves every time there was an
occupational risk. Perceived control and attitude were significant contributors to
intention with perceived control contributing the most. The study found that
geographical region (i.e. urban, suburban, and rural) was predictive of glove use.

Aherin and Westaby (1994) and Petrea and Aherin (1994) used the theory of
planned behavior in studies of protective concepts related to agricultural chemicals.
Aherin and Westaby (1994) studied the wearing of protective gloves and availability of
fresh water among a random sample of commercial pesticide applicators in Illinois. The
study found that the behavior of wearing protective gloves every time the chemical
applicators handled herbicides was equally influenced by attitudinal, normative and perceived control factors. Intention to perform the behavior was largely influenced by behavioral beliefs. The behavior of having fresh water available always to wash hands immediately after handling herbicides was found to be influenced mostly by perceived control. The intention to perform the behavior was influenced by behavioral and perceived control beliefs.

Petrea and Aherin (1994) utilized the TPB to study the use of chemical protective eyewear among farmers in Moultrie County in Illinois who self-applied crop pesticides. This study employed salient beliefs in an experimental manipulation to influence behavior. The experiment involved the use of four groups: a control group, those who received goggles through mail, those who received a persuasive message through mail, and those who received both goggles and persuasive message. It was found that farmers’ behavior of “wearing chemical protective eyewear every time they handled crop pesticides during the next six-months” was influenced largely by attitudinal factors. The experimental manipulation found no significant differences among the four treatment groups on self-reported frequency of wearing protective eyewear during the previous six-month.

Perry, Marbella and Layde (2000) studied the association of pesticide safety knowledge with beliefs and intentions among farm pesticide applicators. The study used telephone interviews of 164 randomly selected dairy farmers who were pesticide applicators residing in Wisconsin. A response rate of 77.4% was obtained. Knowledge levels concerning pesticide safety and precautionary handling among the applicators were measured. The relationships between knowledge scores and intention to use handling
precautions, perceptions of pesticide safety peer norms, and perceived self-efficacy to prevent personal exposure were examined. The percent of correct responses to 18 knowledge items ranged from 100% to 45.7%. The study found that knowledge levels were positively related to intentions, beliefs and self-efficacy regarding use of protective gear, but were not significantly related to risk perceptions and peer norms concerning pesticide safety.

Wadud, Kreuter and Clarkson (1998) studied the risk perception, beliefs about prevention and preventive behaviors of central Missouri farmers. A total of 300 farmers were surveyed to identify their beliefs and practices regarding the prevention of respiratory diseases, noise-induced hearing loss, and skin cancer. For each of these problems, farmers who expressed concern about the problem and also believed it was preventable were more likely to report taking preventive measures than were those who did not believe the disease was preventable, those who were not concerned about the problem or both. The study concluded that understanding the beliefs, values, and concerns of a population was one of the most important steps in assessing the health needs and a fundamental precursor to planning health and safety programs for farm workers.

Recommendations for the study include addressing fatalistic beliefs related to causes of disease and injury; identifying and addressing barriers that kept farmers from using safety equipment; and working through existing and frequently used channels of communication to reach farmers with health and safety messages.

Green (1999) reported on nine Saskatchewan farming couple’s perceptions of farm health and safety risks, the measures the couples took to reduce these risks, and
factors influencing their practices. The research participants were part of a purposive sample, aged 30-50 years, engaged in grain and/or livestock farming. Data were collected through three interviews, one time with the couple and twice as individuals. The interviews covered a wide range of topics and lasted two to three hours each. The results indicated that all participants, especially the women, agreed that farmers generally fail to work as safely as they should. However, farmers were almost always aware of the risk they took. Farmers do not consider themselves careless; rather they take calculated risks, after considering the costs and benefits of particular ways of working. This intuitive decision-making process is complex and influenced by diverse factors. The results also found that many aspects of farming work against awareness being translated into action. These include time pressures, the need to rely on personal protective equipment that is uncomfortable and inconvenient, and the absence of any external imposition of safety regulations. The farmer’s familiarity with his daily farm tasks, along with the need to feel competent, to be in control, and present-oriented tended to diminish his/her perception of risk. The extent to which farmers’ actions are congruent with knowledge varies considerably, depending upon personal experiences, such as upbringing, perceived health and fitness, and feelings of vulnerability, as well as social influences, such as the presence of children, whom the farmers wish to protect and set good examples as behavioral norms. The study concluded that farmers considered themselves to be more safety-conscious than their fathers and certain recommended practices were becoming the norm. However, the larger forces in society that shape farmers’ working environments do not support the expansion of this trend.
A special survey conducted by the Bureau of Labor Statistics, U. S. Department of Labor in 2001 on behalf of the National Institute Occupational Safety and Health (NIOSH) and Center for Disease Control and Prevention (CDC) found that 9.4 percent of the establishments using respirators was in agriculture, forestry and fisheries. The survey also included industries in mining; construction; manufacturing; transportation and public utilities; wholesale trade; retail trade; finance, insurance and real estate; and services. For the establishments in agriculture, forestry and fisheries it was found that 5.8 percent of employees used respirators. The results also showed that, in nearly half of the 619,400 establishments where respirators were used, employees used them on voluntary basis only, and in about 12 percent, they were used only when required because of emergencies. The survey excluded farms with fewer than 11 employees, and found that 44.7 percent of the establishments in agricultural and related industries used respirators on voluntary basis only, 19.6 percent used them on both voluntary and required basis, 44.9 percent on required non-emergency basis, and 5.7 percent on a required emergency basis.

The use of respirators by employees in the 12 months prior to taking the survey showed that, 25.1 percent of employees were assessed for medical fitness to wear the respirators, while 59.2 were not assessed. The remaining 15.7 percent did not know of any assessment. With regards to training to use respirators, no training was required in 13 percent of the establishments, 27.7 percent followed manufacturers’ instructions, and 59.3 percent were trained to understand the use and limitations of the respirators used. For fit testing for employees wearing tight-fitting respirators, 52.8 were fit-tested, 30.8
percent were not fit-tested, while 8.8 percent indicated it was not needed, and 7.7 percent don’t know about fit testing for tight-fitting respirators.

Practices in the 12 months prior to the survey by the establishments in agriculture, forestry and fisheries to determine respirator usage showed that 51.5 percent of the establishments used respirators on supervisors’ decisions based on employees’ input and job characteristics. In 16.8 percent of these establishments, employees decide the use based on job characteristics, 13.9 percent adopted written programs instituted by management, and 15.4 percent followed respirator manufacturers’ written instructions.

The extent to which these establishments determined which respirator was appropriate for substances (contaminants) faced by employees in the industries, 8.9 percent was based on employee’s suggestion, 8.7 percent on local store products/sales person, 1.8 percent on air sampling results of the establishments, 23.8 percent on respirator manufacturers’ representative, 39.7 percent on respirator manufacturers’ literature, 5.5 percent was based on assigned protection factor (APF), 5.1 percent was based on hazard ratio, 53.8 percent was from material safety data sheets and 27.3 percent were based on other sources not mentioned.

The above results demonstrate that standards and rules have been followed to keep agricultural workers protected from harmful effects of respiratory contaminants. However, it is interesting to know that even though protective steps are being taken to curb the prevalence of occupational respiratory diseases in agriculture, forestry and fisheries, more efforts are required to provide effective and efficient programs for agricultural workers in these industries.
From the review of the literature, the researcher developed a conceptual framework for the proposed study (Figure 2).

![Conceptual framework and identification of study variables]

Figure 2: Conceptual framework and identification of study variables

The framework shows that beliefs held by people will interact with enabling factors to form an attitude. Attitude will then lead to intention after risk and protective factors have been identified and evaluated by the person to adopt the desired behavior. This behavior is likely to be influenced by modifying factors such as demographic variables.

The Curriculum Guide

The topics that guided the development of the educational program were based on extension publications designed for extension work in the agricultural production and related industries. These include swine, poultry, hay, silage-making and green house industries. Donham (1993), in his agricultural respiratory hazard education series,
provided topics on dusts resulting from decayed grains, grain dusts, livestock confinement dusts and gases, and applied agricultural chemicals. In addition, the National Institute of Occupational Safety and Health and the Occupational Safety and Health Administration have established standards and provided database of resources where employers can access to develop respiratory protection programs for their employees. Furthermore, Grisso, Gay, Hetzel, and Stone (2005) listed some working conditions as risk factors that could expose farmers to respiratory hazards. These include, but are not limited to, working in dusty fields; handling hay; working in silos; feeding or working with feedstuffs; working with corn silage; uncapping silos; cleaning silos and grain bins; working around animal feathers, hair, fur or droppings; working around fish meal; applying agricultural chemicals (e.g. fertilizers and pesticides); and working with toxic paints or solvents. Thus, it is essential to include this information in respiratory safety program to create awareness and also serve as resource or reference guide to agricultural workers.

Monsó et al. (2003) identified type of farming as a risk factor for rhinitis, asthma, chronic bronchitis and toxic pneumonitis. Donham and Thelin (2006) have also reported on special at-risk populations such as children, the elderly, migrant and seasonal workers, and anabaptist and religious groups. Hence, it would be beneficial to include topics related to respiratory diseases to enable farmers or agricultural to be well informed about the causes and symptoms and what steps to take to prevent respiratory illnesses.

Summary

This chapter reviewed belief models relative to the expectancy-value theories that could be applied to workplace safety self-protective behaviors. A review of the
application of these belief models in agriculture and related industries identified variables such as threat-related (vulnerability and severity), barriers, response efficacy, self-efficacy, and normative beliefs found to be relevant for this study. Studies on respiratory diseases prevalent in agricultural and related industries, their associations with type of farming, the farm tasks and farmer characteristics were reviewed as well. The literature cited indicates that agricultural activities present health hazards to agricultural workers; therefore every effort must be made to follow recommended procedures so as to minimize these health threats. The farming population identified to be at risk of exposures to respiratory problems; the symptoms of diseases associated with particular farming activities, and the likelihood of agricultural workers being affected when appropriate precautions are not taken whilst performing these activities were discussed in this review of the literature. Finally, the respirator usage among employees in agricultural and related industries was reviewed.

Based on the review, beliefs constructs that have been predictive of preventive behavior in the safety research literature were selected to develop the conceptual framework of the study.
Chapter 3

METHODOLOGY

The focus of this study was to adopt the conceptual model recommended by the NIOSH to develop a respiratory safety program based on perceived beliefs of agricultural and related workers regarding respiratory hazards and respiratory protection procedures that are followed at the Pennsylvania State University. The primary purpose of the study was to develop a respiratory safety program based upon perceived beliefs of agricultural workers about respirator usage and the adoption of respiratory protective behaviors to prevent respiratory problems.

The following research questions guided the study:

1. What educational needs/topics should be included in a respiratory safety program?
2. What are current beliefs about the risks of respiratory diseases and the use of protective procedures among agricultural workers?
3. What are the perceived barriers to the use of respirators and/or following protective behaviors to prevent respiratory problems?
4. What factors influence the choice of behavior among the agricultural workers?
5. What are the program outcomes on the beliefs and behaviors of program participants after participating in a respiratory protection program?

In addition, the following research hypotheses were tested:

H_{01}: There is a positive correlation between respondents’ perceived beliefs (e.g. perceived susceptibility to respiratory disease) and ratings of topics to be included in a respiratory safety program.

H_{02}: Agricultural workers who perceive themselves to be at risk of getting respiratory disease are more likely to follow precautions for respiratory protection than those who do not perceive themselves to be at risk of getting respiratory disease.
$H_{03}$: There is no significant difference in perceived beliefs and/or preventive behaviors among agricultural workers who participated in the respiratory safety program and those who did not participate.

$H_{04}$: Agricultural workers receiving the program intervention are likely to adopt recommendations provided in the respiratory safety program.

**Research Approach**

The conceptual model has three research phases that were addressed in this study. The first phase involved developing a theoretical framework for the intervention based upon an extensive literature search on the problem. In this phase, behavioral models based upon expectancy-value theories were reviewed and relevant constructs that addressed workplace safety and self-protective behaviors were identified and selected to conduct a needs assessment of the study population. A descriptive correlational research design was used to identify the variables of interest to the study objectives. The variables were analyzed for their significant contribution to the belief constructs and dependent variables.

The second phase of the study was completed based upon the outcomes of the needs assessment. Respondents who participated in the first phase were invited to sign-up to attend a respiratory safety program at the Centre County/ Penn State Visitor Center on April 25, 2007. Workers who attended watched two video presentations - a documentary on respiratory hazards on the farm and an educational seminar series on respiratory hazards on the farm. These videos were obtained from the New York Center for Agricultural Medicine and Health (NYCAMH). The preliminary findings of the survey were also presented to participants.

The third phase involved an assessment of the respiratory safety program by program participants. The overall goal of the respiratory safety program was to create
awareness of respiratory hazards on the farm and identify factors to minimize the risks of respiratory hazards among agricultural workers.

The two-hour respiratory safety program highlighted most of the topics identified earlier by respondents in the needs assessment as “important and relevant” for inclusion in the program. Also, to reinforce the information provided in the two videos, fact sheets/handouts on selected topics (see Appendix F) were provided as supplementary reading materials with further information source on respiratory protection.

The following objectives were formulated to guide the program implementation and/or process evaluation phase:

1. After watching the documentary and reading the supplementary information covering respiratory hazards in the farm, 80 percent of program participants will change their beliefs and behavior about using respiratory protection on the farm.

2. After participating in the respiratory safety program, 60 percent of the participants will demonstrate intention of using respirators and/or following recommendations in respiratory safety program.

A logic model (Appendix D) was developed to serve as guide to the program evaluation process.

**Population and Sample**

**Phase One**

The population for the study included farm workers in agriculture and its related activities. Farm work and/or agricultural related jobs performed in the fields or in confined buildings requiring use of respiratory protection were targeted. A criterion-based sample of participants in agricultural and related facilities was drawn from the Pennsylvania State University farm operations. The population frame included workers
in animal production facilities, farm operations, and greenhouse facilities. In addition, workers engaged in silage and hay making, feed mills, and silos were also included.

Names of the study participants were obtained from the Human Resource Office of the College of Agriculture Sciences. One-hundred and sixty-six workers who met this criterion were asked to participate in this phase of the study.

**Phase Two**

Selection of participants for this phase was based upon respondents who participated in the needs assessment. Electronic mails were sent to all participants who took part in phase one of the study inviting them to sign-up for the respiratory safety program which was developed based upon results of the needs assessment. The invitation was open to all, but limited to only the first 35 workers who signed-up. A detailed program agenda (Appendix F) was sent to those who signed-up to attend the program. A total of 31 workers responded to the email invitation, and 16 of these workers signed-up to attend. Fourteen participants, including one person from the University Environmental Health Service, attended the program. Fifteen workers declined the invitation to participate among which five sent emails to the researcher stating reasons for not being able to attend. The 14 program participants took a survey at the conclusion of the program to suggest improvement of the program quality, content and delivery. Program participants were issued with certificates of participation for attending the program.

**Instrumentation**

A five-part questionnaire (see Appendix B) was developed to collect data. Each section had questions that addressed the objectives of the study. Section A contained
questions pertaining to respirator-use beliefs based upon the following belief constructs: threat-related (perceived severity and perceived susceptibility), self-efficacy, response efficacy, barriers, and normative expectations. The questions for each belief construct were identified and included based upon the review of related literature highlighting the relevance of these constructs to conceptualize self-protective behaviors in workplace safety and health. Questions soliciting respirator-use beliefs were measured on a seven-point semantic distant scale.

Section B contained questions about precautions taken against respiratory hazards. This section contained two parts: statements that sought the opinion of workers about their personal protection against respiratory hazards and statements soliciting information about preventive procedures that were followed in the past 12 months. Statements about personal protection were measured on a four-point Likert-type response scale, 1 = strongly disagree to 4 = strongly agree. On the other hand, statements regarding preventive procedures followed during the past 12 months were assessed using a Likert-type response scale of one (1) = never to five (5) = always.

Section C sought information on education and monitoring of agricultural health and safety. Questions solicited information about the type of training received in the past 12 months and monitoring of airborne substances to meet workplace safety and health standards.

Section D required respondents to rate four main topics based upon their importance and relevance for inclusion in a respiratory safety program. Rating scales for importance and relevance ranged from one (1) = not important/relevant at all to five (5) =
extremely important/relevant. Section E obtained demographic information of the workers.

The program evaluation instrument (see Appendix C) was an adaptation of the Texas Cooperative Extension survey instrument. The instrument was modified to suit the overall goal of this program with appropriate questions asked to evaluate the respiratory safety program. Close- and open-ended questions were included in the evaluation instrument. Questions included items that measured program input, activities, participant reactions to the overall program quality, content of information received, and facilities (physical setting) used for the program.

Question one solicited ratings of program content, quality of audiovisuals aids, the presenter, and contribution of the physical setting to ease of listening and participation. Statements in this category were measured on a five-point Likert-type response scale of 1 = very poor to 5 = very good. Questions two, three, four, and 12 were open-ended which sought information about participants’ reactions – what was liked most about the program; what was liked least about the program; would additional information on the subject area be useful; and any additional comments for program improvement. Question 10 measured awareness/knowledge by program participants in six topics that were covered in the videos. Participants were asked to indicate their awareness or knowledge before and after participating in the program. The awareness or knowledge before and after participation were measured on a five-point Likert-type scale of 1 = not at all aware to 5 = very much aware. Question 11 requested program participants to list any two important pieces of information learned as a result of participation and also indicate if they have already adopted, intend to adopt safer
attitudes/behaviors, or whether the information received was not applicable to their situation.

Review of the Instrument

All instruments used for data collection were reviewed by a panel of 10 experts consisting of faculty members of the Departments of Agricultural and Extension Education and Agricultural and Biological Engineering at the Pennsylvania State University, fellows and mentors of the Great Lakes Center for Agricultural Safety and Health (GLCASH) program for content and face validity. The panel of experts was selected based upon recommendations of the researcher’s doctoral committee, knowledge on agricultural safety and health with regards to respiratory diseases exposure, and research methodology. The Office of Regulatory Compliance at The Pennsylvania State University also reviewed and approved the instrument and cover letter (see Appendix A) to ensure compliance with University policies.

Pilot-testing

For accuracy in measuring content as well as estimating the reliability of the instrument, the instrument was pilot-tested using graduate students and student farm workers in the departments of Agricultural and Extension Education, Soil and Crop Sciences, Veterinary Science in the College of Agricultural Sciences. Thirty questionnaires were sent, however, only 22 questionnaires were returned. Data from the pilot test were checked for consistency of entry, cleaned and entered and analyzed using the Statistical Package for Social Sciences (SPSS version 15.0).

The evaluation instrument was not pilot-tested since it was adapted for the study. However, content and face validity were established by two faculty members and five
graduate students in the department of Agricultural and Extension Education at the Pennsylvania State University.

**Data Collection**

Data for phase one were collected using both mail and electronic survey methods. The design of the electronic version followed the recommendations of Dillman (2000). The questionnaires along with cover letters (see Appendix A) and return addressed envelopes were mailed to 166 research participants in December 2006 through the Office of Human Resource (OHR) for confidentiality reasons. In addition to handling the mailing of questionnaires, confidentiality of the responses were maintained by assigning all respondents a code number so that no names appeared on questionnaires that were returned to the researcher. Follow-up contacts were accomplished by supplying identification codes of those respondents who did not returned their completed questionnaires through the OHR. Reminder letters were mailed after two weeks.

However, due to the holidays, many questionnaires were not returned before the first due date, December 22, 2006. Follow-up contacts were made after the fourth week, and reminder letters and/or replacement questionnaires were sent through the OHR to non-respondents who requested one. Because of the low response rate after the sixth week coupled with the volume of work at the OHR, the researcher requested and received the names of research participants to follow-up non-respondents with an electronic version of the survey. Non-respondents without email addresses were mailed the paper version; whereas those with email addresses were sent electronic version of the survey.

After the first mailing of questionnaires and the first contact made by electronic version of the survey, the researcher received uncompleted returned questionnaires,
emails and phone calls from respondents indicating that they were unqualified for the study. A few others declined participation and were followed with emails to the researcher stating their reasons for not qualifying to participate. This resulted in a total of 53 workers excluded from the sample. Also, the email addresses of three workers could not be verified, and no return mail questionnaires were received from them. These were also excluded to minimize the selection error. Hence, the accessible sample was reduced to 110. Among the returned questionnaires, two paper versions and six electronic versions of the questionnaires were not properly completed. These were discarded and not included in the number of returns received.

Table 3-1 shows the response rate for the data collection process.

<table>
<thead>
<tr>
<th>Time and Date of Mailing/Sending out Survey</th>
<th>n</th>
<th>Percent Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First Mailing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>December 11, 2006 – December 22, 2006</td>
<td>22</td>
<td>20.0</td>
</tr>
<tr>
<td><strong>Second Mailing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January 11, 2007 – January 26, 2007</td>
<td>12</td>
<td>10.9</td>
</tr>
<tr>
<td><strong>Third Mailing and First Electronic Survey</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January 29, 2007 – February 12, 2007</td>
<td>37</td>
<td>33.6</td>
</tr>
<tr>
<td><strong>Second Electronic Survey</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>February 13, 2007 – February 22, 2007</td>
<td>2</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>73</td>
<td>66.3</td>
</tr>
</tbody>
</table>

*Note: 66.3 % = 73/110*

The problem of non-response bias was addressed by comparing early respondents to late respondents (Miller and Smith, 1983) on all selected belief constructs and the overall scores for preventive procedures followed in the past 12 months. Early respondents were classified as those responding before January 11, 2007 and late respondents were those
responding after January 11, 2007. There were no significant differences on the mean scores of belief constructs and for preventive procedures followed.

To address the issue of non-respondents based upon recommendations by Miller and Smith (1983) and Lindner, Murphy, and Briers (2001), a random sample of 20 non-respondents were contacted by telephone and asked to respond to nine survey questions (three in section A, three in section B, and one each from sections C, D and E).

Furthermore, a comparison was made between mailed and electronic survey returns to examine any bias due to type of survey material used to collect information. No statistically ($p > .05$) significant differences were found between mailed and electronic survey returns on all the selected belief constructs and/or variables that were considered for data analyses. Thus, results of this study could be generalized to Penn State University agricultural workers.

**Data Analysis**

Data were coded and analyzed using SPSS version 15.0. Descriptive and inferential statistics were reported. The inferential statistics were used to generalize findings to the Penn State agricultural workers. Descriptive statistics included frequency distributions, means and percentages. Independent t-test, analysis of variance, analysis of covariance and appropriate correlational techniques were used to differentiate between groups based upon respirator usage, belief constructs, and preventive behaviors adopted by the workers. A Chi-square was used to analyze the relationship between respirator use beliefs and ratings of importance and relevance of topics to include in a respiratory protection training module. Multiple regression analysis was conducted to examine
which variables explained the variance in the choice of behavior among the agricultural workers.

The variables for data analyses are presented in Table 3.2.

Table 3.2

Variables in Questionnaire

<table>
<thead>
<tr>
<th>Latent Variable</th>
<th>Item</th>
<th>Type</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section A: Respirator Use Beliefs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Threat-Related Beliefs (perceived susceptibility and severity)</td>
<td>2, 11</td>
<td>Ordinal</td>
<td>7-pt Scale</td>
</tr>
<tr>
<td>Self-efficacy (control beliefs)</td>
<td>7(a)-7(d)</td>
<td>Ordinal</td>
<td>5-pt Scale</td>
</tr>
<tr>
<td>Perceived Barrier</td>
<td>5, 6, 8, 10</td>
<td>Ordinal</td>
<td>7-pt Scale</td>
</tr>
<tr>
<td>Perceived Benefit (response efficacy)</td>
<td>4, 12, 3, 9</td>
<td>Ordinal</td>
<td>7-pt Scale</td>
</tr>
<tr>
<td>Normative Expectation Beliefs (Normative and Subjective norm beliefs)</td>
<td>14(a)-14(d), 15(a)-15(d)</td>
<td>Ordinal</td>
<td>7-pt Scale</td>
</tr>
<tr>
<td>Perceived availability of respirators use</td>
<td>13</td>
<td>Ordinal</td>
<td>7-pt Scale</td>
</tr>
<tr>
<td>Organizational support</td>
<td>16</td>
<td>Ordinal</td>
<td>7-pt Scale</td>
</tr>
<tr>
<td>Respirator User groups</td>
<td>17</td>
<td>Categorical</td>
<td>5 groups</td>
</tr>
<tr>
<td>Type of Jobs</td>
<td>18</td>
<td>Categorical</td>
<td>Yes / No</td>
</tr>
<tr>
<td>Type of Respirator Used</td>
<td>21</td>
<td>Categorical</td>
<td>Yes / No</td>
</tr>
<tr>
<td><strong>Section B: Precautions Against Respiratory Hazards</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal Protection</td>
<td>all 4 items in I</td>
<td>Ordinal</td>
<td>4-pt Scale</td>
</tr>
<tr>
<td>Preventive Procedures Followed</td>
<td>all 8 items in II</td>
<td>Ordinal</td>
<td>5-pt Scale</td>
</tr>
<tr>
<td><strong>Section C: Education and Monitoring of Agricultural Safety and Health</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Section D: Topics for Respiratory Protection Program</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory Diseases Related to Farming</td>
<td>topic A1-A3</td>
<td>Ordinal</td>
<td>5-pt Scale</td>
</tr>
<tr>
<td>Engineering Practices</td>
<td>topic B1-B4</td>
<td>Ordinal</td>
<td>5-pt Scale</td>
</tr>
<tr>
<td>Pesticide Education</td>
<td>topic C1-C2</td>
<td>Ordinal</td>
<td>5-pt Scale</td>
</tr>
<tr>
<td>Agricultural Respirators and How to Use Them</td>
<td>topic D1-D3</td>
<td>Ordinal</td>
<td>5-pt Scale</td>
</tr>
<tr>
<td><strong>Section E: Information About You</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personal Information: Gender</td>
<td>1</td>
<td>Categorical</td>
<td>2 groups</td>
</tr>
<tr>
<td>Age</td>
<td>2</td>
<td>Continuous</td>
<td>years</td>
</tr>
<tr>
<td>Marital status</td>
<td>3</td>
<td>Categorical</td>
<td>5 groups</td>
</tr>
<tr>
<td>Farming experience</td>
<td>4</td>
<td>Continuous</td>
<td>years</td>
</tr>
<tr>
<td>Farm unit/department</td>
<td>5</td>
<td>Categorical</td>
<td>7 groups</td>
</tr>
</tbody>
</table>
The reliability of scales for the belief constructs and representative items for each scale are presented in Table 3.3. The scaling/scoring of the items in each scale are explained as well. These scales represent summated Likert values/scores, and are frequently treated as “approaching” interval type data (Blaikie, 2003, pp.23-27). Blaikie further clarifies that ordinal data may be transformed to nominal/categorical variables for data analysis purposes if the researcher desires.

Table 3.3
Reliability of Scales for Belief Constructs and Representative Items from each Scale

<table>
<thead>
<tr>
<th>Belief construct</th>
<th>Items</th>
<th>Alpha</th>
<th>Items in questionnaire</th>
<th>Scale/scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severity (n=72)</td>
<td>4</td>
<td>.93</td>
<td>Sec. A, 7 (a –d)</td>
<td>1= very little 7=very much</td>
</tr>
<tr>
<td>Susceptibility (n=71)</td>
<td>2</td>
<td>.62</td>
<td>Sec. A, 2 &amp; 11</td>
<td>1=strongly disagree 7=strongly agree</td>
</tr>
<tr>
<td>Self-efficacy - perceived control (n=72)</td>
<td>4</td>
<td>.64</td>
<td>Sec. A, 5,6,8, 10</td>
<td>1=extremely unlikely 7=extremely likely</td>
</tr>
<tr>
<td>Perceived barrier (n=71)</td>
<td>2</td>
<td>.70</td>
<td>Sec. A, 4,12</td>
<td>1=extremely unlikely 7=extremely likely</td>
</tr>
<tr>
<td>Perceived benefit (n=72)</td>
<td>2</td>
<td>.68</td>
<td>Sec. A, 3, 9</td>
<td>1=extremely unlikely 7=extremely likely</td>
</tr>
<tr>
<td>Subjective norm -Normative expectations - (n=58)</td>
<td>8</td>
<td>.86</td>
<td>Q14 (a –d) Q15 (a –d)</td>
<td>1=strongly disagree 7=strongly agree</td>
</tr>
</tbody>
</table>

Table 3.4 also depicts the reliability of scales for preventive procedures followed and the importance and relevance of the educational topics.
Table 3.4
Reliability of Scales for Preventive Procedures and Educational Topics for Respiratory Safety Program

<table>
<thead>
<tr>
<th>Belief construct</th>
<th>Items</th>
<th>Alpha</th>
<th>Items in questionnaire</th>
<th>Scale/scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preventive Procedures followed (n=55)</td>
<td>8</td>
<td>.86</td>
<td>Sec. B, II</td>
<td>1= never; 5= always</td>
</tr>
<tr>
<td>Respiratory diseases related to farming (importance) (n=66)</td>
<td>3</td>
<td>.91</td>
<td>Sec. D</td>
<td>1= not important at all; 5= extremely important</td>
</tr>
<tr>
<td>Respiratory diseases related to farming (relevance) (n=67)</td>
<td>3</td>
<td>.90</td>
<td>Sec. D</td>
<td>1= not relevant at all; 5= extremely relevant</td>
</tr>
<tr>
<td>Engineering practices (importance) (n=65)</td>
<td>4</td>
<td>.90</td>
<td>Sec. D</td>
<td>1= not important at all; 5= extremely important</td>
</tr>
<tr>
<td>Engineering practices (relevance) (n=66)</td>
<td>4</td>
<td>.91</td>
<td>Sec. D</td>
<td>1= not important at all; 5= extremely relevant</td>
</tr>
<tr>
<td>Pesticide education (importance) (n=64)</td>
<td>2</td>
<td>.92</td>
<td>Sec. D</td>
<td>1= not important at all; 5= extremely important</td>
</tr>
<tr>
<td>Pesticide education (relevance) (n=65)</td>
<td>2</td>
<td>.94</td>
<td>Sec. D</td>
<td>1= not relevant at all; 5= extremely relevant</td>
</tr>
<tr>
<td>Ag respirators and how to use them (importance) (n=65)</td>
<td>3</td>
<td>.92</td>
<td>Sec. D</td>
<td>1= not important at all; 5= extremely important</td>
</tr>
<tr>
<td>Ag respirators and how to use them (relevance) (n=65)</td>
<td>3</td>
<td>.92</td>
<td>Sec. D</td>
<td>1= not relevant at all; 5= extremely relevant</td>
</tr>
</tbody>
</table>

Coding of Independent and Dependent Variables for Data Analysis

To facilitate analysis of data, some items in the questionnaire were grouped and recoded. For instance the variables “job type performed” and “respirator type used” by workers were transformed using SPSS syntax command. Also, the variable respirator user group was generated and transformed to three levels: non users, occasional users, and regular users.

Classification of “job-type performed” into three levels was as follows:

- **Group one**: Applying agricultural chemicals; working with paints or solvents
- **Group two**: Working in fields; handling hay; handling manure; and working on corn silage.
Group three: Working in silos; uncapping silos; feeding or working with feedstuff; cleaning grain bins; and working around fish meal.

Department of Agricultural worker was recoded in two groups:

Group One: Agricultural and biological engineering, farm operations, horticulture, and crop and soil science (non-animal-related)

Group Two: Animal diagnostic lab, dairy and animal science, poultry science, veterinary and biomedical science (animal-related)

Similarly, respirator type used was classified into two groups. Group one users comprise workers who used single-strap and two-strap dust masks. Group two users include workers who indicated using half-face cartridge respirators and power air-purifying with helmet. Some workers also indicated using other respirators, such as self-contained breathing apparatus (SCBA) and full-face respirators. Users of these respirators were classified as group two as well.

The variable “preventive behavior” was generated using the mean sum of scores of the eight statements in section B (II) of the questionnaire. Thus, a worker could theoretically have a low of one (1) indicating non performance of task mentioned or a high of five (5) representing performing or following all the procedures described for protection against respiratory disease exposure. Since some of the behaviors described were not applicable to certain group of workers, the variable “protective behavior” was later transformed into level of protection in part of the analysis process. Responses to the eight statements indicating performance of the behaviors (never to always) were transformed to “not performed” (zero) and “performed” (one). The summed value of these statements ranging from zero (0) to eight (8) was also used for the multivariate analysis.
Chapter 4

FINDINGS

This study focused on the use of a conceptual model to develop, implement and evaluate a respiratory protection program (training module) based upon perceived beliefs of farm workers at The Pennsylvania State University regarding the use of respiratory protection in agricultural related activities. The primary purpose of the study was to identify what educational topics were important and relevant for inclusion in a training module for farm workers at the university. The study also sought to identify current beliefs of workers regarding the use of respirators and/or adopting protective behaviors against respiratory hazards, barriers perceived to hinder the use of respirators, and factors perceived to influence the adoption of protective behaviors against respiratory hazards on the farm.

The findings are reported according to the phases of the study and the research questions the study sought to address. First, the demographic profile of the research participants are reported followed by the topics rated to be important and relevant to the respiratory safety program. Next, the belief constructs and their associations with the mean ratings of the topics are reported. The findings of the study as addressed by the research questions are presented, and finally, the outcome of the evaluation of the respiratory safety program based upon the program goals and objectives are reported.
Findings of Phase One

The demographic profile is presented in Table 4.1.

Table 4.1  
Demographic Profile of Respondents

<table>
<thead>
<tr>
<th>Subject Characteristic</th>
<th>f</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>48</td>
<td>65.8</td>
</tr>
<tr>
<td>Female</td>
<td>25</td>
<td>34.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>73</strong></td>
<td><strong>100.0</strong></td>
</tr>
<tr>
<td>Marital Status:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>55</td>
<td>78.6</td>
</tr>
<tr>
<td>Divorced</td>
<td>4</td>
<td>5.7</td>
</tr>
<tr>
<td>Separated</td>
<td>1</td>
<td>1.4</td>
</tr>
<tr>
<td>Single, never married</td>
<td>10</td>
<td>14.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
<td><strong>100.0</strong></td>
</tr>
<tr>
<td>Age:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 – 35 years</td>
<td>16</td>
<td>23.9</td>
</tr>
<tr>
<td>36 – 49 years</td>
<td>30</td>
<td>44.8</td>
</tr>
<tr>
<td>50 – 61 years</td>
<td>21</td>
<td>31.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>67</strong></td>
<td><strong>100.0</strong></td>
</tr>
<tr>
<td>Mean age: 43.25 years SD = 10.33 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range: 39 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farming Experience (since age 16):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 – 1 years</td>
<td>15</td>
<td>23.1</td>
</tr>
<tr>
<td>2 – 10 years</td>
<td>6</td>
<td>9.2</td>
</tr>
<tr>
<td>11 – 20 years</td>
<td>17</td>
<td>26.2</td>
</tr>
<tr>
<td>21 – 45 years</td>
<td>27</td>
<td>41.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>65</strong></td>
<td><strong>100.0</strong></td>
</tr>
<tr>
<td>Mean: 17.54 years SD = 13.33 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range: 45 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm worker (full-time)</td>
<td>18</td>
<td>24.7</td>
</tr>
<tr>
<td>Farm worker (part-time)</td>
<td>2</td>
<td>4.5</td>
</tr>
<tr>
<td>Farm supervisor</td>
<td>9</td>
<td>13.6</td>
</tr>
<tr>
<td>Farm administrator</td>
<td>4</td>
<td>6.1</td>
</tr>
<tr>
<td>Other</td>
<td>32</td>
<td>48.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>66</strong></td>
<td><strong>100.0</strong></td>
</tr>
<tr>
<td>Department/Unit:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ag &amp; Biological Engineering</td>
<td>2</td>
<td>2.8</td>
</tr>
<tr>
<td>Animal Diagnostic Lab</td>
<td>4</td>
<td>5.5</td>
</tr>
<tr>
<td>Crop &amp; Soil Science</td>
<td>15</td>
<td>20.5</td>
</tr>
<tr>
<td>Dairy &amp; Animal Science</td>
<td>14</td>
<td>19.2</td>
</tr>
<tr>
<td>Farm operations</td>
<td>10</td>
<td>13.7</td>
</tr>
<tr>
<td>Horticulture</td>
<td>8</td>
<td>11.0</td>
</tr>
<tr>
<td>Plant Pathology</td>
<td>4</td>
<td>5.5</td>
</tr>
<tr>
<td>Poultry Science</td>
<td>1</td>
<td>1.4</td>
</tr>
<tr>
<td>Veterinary and Biomedical Science</td>
<td>15</td>
<td>20.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>73</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

*Note. Age and farming experience (since age 16) were collected as continuous variables and recoded as categorical variables.*
A total of 73 workers responded to and returned usable questionnaires. A majority of the respondents were male (65.8%). A large percentage (78.6%) of the workers reported being married. The age of the workers ranged from 22-61 years, with almost one-half between ages 36 and 49. The average age of the agricultural workers was 43.25 ($SD = 10.33$) years. Farming experience since the age of 16 ranged from no experience (zero) to 45 years. A majority (76.9%) of the workers have had at least two years of farming experience since age 16. Almost one-half (48.5%) representing the other positions of agricultural workers in the College of Agricultural Sciences were researchers with varied job designations. Some of these designations were laboratory technicians/assistant, research support assistant/associate, research assistant/associate, extension associate and farm advisor.

**Topics to include in Respiratory Safety Program**

Table 4.2 depicts the educational topics which were rated as “important and relevant” to be included in a respiratory safety program. The mean rankings in descending order of magnitude are shown in Table 4.3.

All topics were rated “important and relevant” for protection against respiratory diseases exposures. The mean rankings for these topics (see Table 4.3) show that topics in pesticide education were rated high in “importance and relevance” for the respiratory safety program. Next were topics under respiratory diseases related to farming activities; engineering practices; and agricultural respirators and how they are used.
Table 4.2

Descriptive Statistics of Educational Topics for Respiratory Safety Program

<table>
<thead>
<tr>
<th>Educational Topics</th>
<th>Importance</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>*Mean</td>
</tr>
<tr>
<td><strong>Educational Topics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Respiratory Diseases related to farming activities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge about types of respiratory hazards relative to</td>
<td>67</td>
<td>4.19</td>
</tr>
<tr>
<td>farming activities</td>
<td></td>
<td>.86</td>
</tr>
<tr>
<td>Symptoms of respiratory hazards</td>
<td>66</td>
<td>4.26</td>
</tr>
<tr>
<td>Protecting lungs from farm dust</td>
<td>66</td>
<td>4.18</td>
</tr>
<tr>
<td><strong>Engineering Practices</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practices to reduce risks of respiratory hazards</td>
<td>65</td>
<td>4.09</td>
</tr>
<tr>
<td>Farm gases prevalent in confined environments</td>
<td>65</td>
<td>4.11</td>
</tr>
<tr>
<td>Acceptable/ permissible gas levels in confined environments</td>
<td>65</td>
<td>3.91</td>
</tr>
<tr>
<td>Work practices or habits to minimize respiratory disease exposure</td>
<td>65</td>
<td>4.28</td>
</tr>
<tr>
<td><strong>Pesticide Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Types, causes and prevention of pesticide exposures</td>
<td>66</td>
<td>4.27</td>
</tr>
<tr>
<td>Safe handling chemicals</td>
<td>64</td>
<td>4.42</td>
</tr>
<tr>
<td><strong>Respirators and how to use them</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Types of respirators use in agriculture</td>
<td>66</td>
<td>4.07</td>
</tr>
<tr>
<td>What to look for in respirators</td>
<td>65</td>
<td>4.06</td>
</tr>
<tr>
<td>How respirators work</td>
<td>65</td>
<td>3.94</td>
</tr>
</tbody>
</table>

Note. *Scale: Importance - 1=not important at all; 2=somewhat important; 3=moderately important; 4=very important; 5= extremely important. Relevance - 1=not relevant at all; 2=somewhat relevant; 3=moderately relevant; 4=very relevant; 5=extremely relevant. There were missing data reported on some items, hence the reduction in the sample size.
Table 4.3
Mean Rankings of Topics for Respiratory Safety Program

<table>
<thead>
<tr>
<th>Educational Topics</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Importance of pesticide education</td>
<td>66</td>
<td>4.34</td>
<td>.71</td>
<td>1</td>
</tr>
<tr>
<td>Relevance of pesticide education</td>
<td>66</td>
<td>4.30</td>
<td>.77</td>
<td>2</td>
</tr>
<tr>
<td>Importance of respiratory disease in farming</td>
<td>67</td>
<td>4.20</td>
<td>.81</td>
<td>3</td>
</tr>
<tr>
<td>Relevance of respiratory disease in farming</td>
<td>67</td>
<td>4.14</td>
<td>.83</td>
<td>4</td>
</tr>
<tr>
<td>Importance of engineering practices</td>
<td>65</td>
<td>4.10</td>
<td>.78</td>
<td>5</td>
</tr>
<tr>
<td>Relevance of engineering practices</td>
<td>66</td>
<td>4.03</td>
<td>.81</td>
<td>6</td>
</tr>
<tr>
<td>Importance of Ag respirators</td>
<td>66</td>
<td>4.02</td>
<td>.88</td>
<td>7</td>
</tr>
<tr>
<td>Relevance of Ag respirators topic</td>
<td>66</td>
<td>3.97</td>
<td>.85</td>
<td>8</td>
</tr>
</tbody>
</table>

Note. Scale for importance: 1=not important at all; 2=somewhat important; 3=moderately important; 4=very important; 5=extremely important. Relevance: 1=not relevant at all; 2=somewhat relevant; 3=moderately relevant; 4=very relevant; 5=extremely relevant. There were missing data reported on some items, hence the reduction in sample size.

Precautions against Respiratory Disease Hazards

The study solicited information about what respondents perceived to influence their personal protection action to prevent respiratory disease exposures. Four statements were asked to address this issue. Table 4.4 highlights results of workers’ perceptions regarding personal protection use against respiratory disease hazards.

Two of the statements soliciting opinion of workers towards personal protection against respiratory hazards were positively associated. A Pearson correlation coefficient was calculated for the association between respondents who agreed or disagreed with the statement that: “The work/job I perform generally requires using a respirator/dust mask,” and those that agreed or disagreed with the statement that: “It is part of work policy to
wear a respirator/dust mask against respiratory hazards.” A positive low association was found ($r_{(69)} = .29, p < .01$), indicating a significant linear relationship between the respondents. Job performed on the farm requiring the use of respirators tended to be guided by work policy against respiratory hazards.

Table 4.4

<table>
<thead>
<tr>
<th>Statement</th>
<th>$n$</th>
<th>$M$</th>
<th>$SD$</th>
<th>D/SD</th>
<th>A/SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>I need better instructions to properly wear a respirator/dust mask during farm work.</td>
<td>71</td>
<td>1.94</td>
<td>.74</td>
<td>78.9</td>
<td>21.1</td>
</tr>
<tr>
<td>The work/job I perform generally requires using a respirator/dust mask.</td>
<td>72</td>
<td>2.03</td>
<td>.77</td>
<td>72.2</td>
<td>27.8</td>
</tr>
<tr>
<td>It is part of work policy to wear a respirator/dust mask against respiratory hazards.</td>
<td>71</td>
<td>2.76</td>
<td>.87</td>
<td>26.8</td>
<td>73.2</td>
</tr>
<tr>
<td>There are times I should wear respirators/dust masks but I don’t.</td>
<td>71</td>
<td>2.34</td>
<td>.83</td>
<td>52.1</td>
<td>47.9</td>
</tr>
</tbody>
</table>

*Scale: 1=strongly disagree (SD) 2=disagree (D) 3=agree (A) 4=strongly agree (SA)*

Table 4.5 shows the means, standard deviations, and Pearson correlations among perceived beliefs of respondents relative to using respirators and/or following preventive behavior against respiratory hazards. Results indicate that the typical agricultural worker at Penn State University perceives him or herself to be vulnerable to respiratory hazards ($M = 4.54, SD = 1.30$), and is likely to be affected by a threat of respiratory disease exposure ($M = 5.33, SD = 1.43$). In addition, the worker believes she/he is capable and has control over using protection against respiratory hazards ($M = 5.70, SD = .90$). Furthermore, there is encouragement from management ($M = 4.77, SD = 1.89$) to use respiratory protection.
Table 4.5  
**Means, Standard Deviations, and Pearson Correlations among Belief Constructs and Preventive Behavior**

<table>
<thead>
<tr>
<th>Construct</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-Vulnerability (n = 72)</td>
<td>.432**</td>
<td>.060</td>
<td>-.221</td>
<td>-.125</td>
<td>.181</td>
<td>.511**</td>
<td>.507**</td>
<td>.271*</td>
<td>4.54a</td>
<td>1.30</td>
</tr>
<tr>
<td>2-Severity (n = 72)</td>
<td>-</td>
<td>.092</td>
<td>-.156</td>
<td>-.019</td>
<td>.032</td>
<td>.198</td>
<td>.354**</td>
<td>-.029</td>
<td>5.33b</td>
<td>1.43</td>
</tr>
<tr>
<td>3-Control (Self-efficacy) (n = 72)</td>
<td>-</td>
<td>-.502**</td>
<td>-.018</td>
<td>.342**</td>
<td>.154</td>
<td>.348**</td>
<td>.132</td>
<td>5.70c</td>
<td>.90</td>
<td></td>
</tr>
<tr>
<td>4-Barrier (n = 72)</td>
<td>-</td>
<td>.213</td>
<td>-.367**</td>
<td>-.200</td>
<td>-.266*</td>
<td>-.155</td>
<td>2.83d</td>
<td>1.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-Availability of respirators (n = 72)</td>
<td>-</td>
<td>-.359**</td>
<td>-.187</td>
<td>-.051</td>
<td>-.243*</td>
<td>4.40d</td>
<td>1.62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-Organizational support (n = 71)</td>
<td>-</td>
<td>.113</td>
<td>.283*</td>
<td>.385**</td>
<td>4.77e</td>
<td>1.89</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-Subjective norm (n = 59)</td>
<td>-</td>
<td>.361**</td>
<td>.210</td>
<td>10.76f</td>
<td>12.90</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8-Benefit (response efficacy) (n = 72)</td>
<td>-</td>
<td>.111</td>
<td>5.62g</td>
<td>1.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9-Preventive behavior (n = 69)</td>
<td>-</td>
<td>3.62c</td>
<td>.82</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.**  
** Correlation is significant at the 0.01 level (2-tailed)  
* Correlation is significant at the 0.05 level (2-tailed)  

a Means were computed on a scale of 1 = extremely unlikely/strongly disagree to 7 = extremely likely/strongly agreed  
b Subjective norm was computed based on two variables (normative beliefs and motivation to comply). Normative belief was recoded (-3 to +3) while motivation to comply was coded as 1 = strongly disagree to 7 = strongly agree. The mean values for subjective norm could theoretically range from a low of -36 to a high of +36.  
c Preventive behavior was computed on the scale of 1 = never 2 = rarely 3 = sometimes 4 = often 5 = always.
The agricultural worker at the Pennsylvania State University farm facilities believes that the difficulty in breathing when using a respirator/dust mask and the absence of respirators near confined buildings or facilities are not barriers to using respiratory protection \((M = 2.83, SD = 1.39; M = 4.40, SD = 1.62)\).

Significant associations were found between some belief constructs. The Pearson correlation coefficients for these belief constructs ranged from \(r = .266\) to \(r = .511\). The correlation coefficient values represent a low to moderate association between the belief variables (Davis, 1971). Perceived vulnerability to respiratory disease hazards was found to be positively correlated with perceived severity \((r_{(70)} = .432, p < .001)\); subjective norm \((r_{(57)} = .511, p < .001)\), and response efficacy \((r_{(70)} = .507, p < .001)\), and preventive behavior \((r_{(66)} = .271, p < .05)\), indicating a significant low to moderate association between these variables. Workers who perceived themselves as vulnerable tended to believe they could be affected when exposed to respiratory hazards and tended to believe using respiratory protection would be beneficial to their health.

Similarly, perceived severity positively associated with response efficacy \((r_{(70)} = .354, p < .001)\). Self-efficacy (control beliefs) positively associated with organizational support \((r_{(68)} = .342, p < .001)\) and response efficacy \((r_{(68)} = .348, p < .001)\). On the other hand, self-efficacy belief negatively associated with perceived barriers \((r_{(70)} = -.502, p < .001)\) indicating a significant inverse association between the two variables. Perceived barrier belief negatively correlated with organizational support \((r_{(68)} = -.367, p < .001)\) and response efficacy \((r_{(70)} = -.266, p < .01)\). The availability of respirators or dust masks negatively correlated with organizational support \((r_{(68)} = -.359, p < .001)\) and preventive behavior \((r_{(66)} = -.243, p < .05)\). While there was a positive association
between organizational support belief and self-efficacy belief \((r_{68} = .342, p < .001)\), response efficacy \((r_{68} = .283, p < .01)\), and preventive behavior \((r_{66} = .385, p < .001)\), organization support negatively correlated with perceived barrier belief \((r_{68} = -.367, p < .001)\), and perceived availability of respirators/dust masks \((r_{68} = -.359, p < .001)\). The results indicate a significant inversely moderate association between organizational support (i.e. encouragement from management) and preventive behavior that workers reported.

Table 4.6 presents the means, standard deviations, and Pearson correlation coefficients of belief constructs that were selected for the study. Pearson correlation coefficient values ranged between \(r = .22\) and \(r = .47\), indicating a low to moderate association between the belief constructs and ratings of educational topics on importance and relevance for the respiratory protection program. The associations between these variables were significant at .001 alpha levels. Perceived vulnerability and perceived response efficacy beliefs were significantly associated with all topics on importance and relevance. Significant associations were found between severity and self-efficacy beliefs with regards to the topics: “relevance of respiratory disease in farming” and “relevance of agricultural respirators.” Although a low to moderate association was found between perceived barrier and the ratings of some topics on importance and relevance, these associations were inversely correlated.

The study hypothesized that there would be a positive association between respondents’ perceived beliefs and ratings of topics to be included in the respiratory protection program (directional, one-tailed). The results indicated that threat-related beliefs were significantly associated with most topics on importance and relevance.
Table 4.6
Means, Standard Deviation and Pearson Correlations for Educational Topics and Belief Constructs

<table>
<thead>
<tr>
<th>Educational Topic</th>
<th>M</th>
<th>SD</th>
<th>Vulnerability</th>
<th>Severity</th>
<th>Self-efficacy (Control)</th>
<th>Barrier</th>
<th>Response efficacy (Benefit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Importance of respiratory disease in farming (n=67)</td>
<td>4.20</td>
<td>.81</td>
<td>.405(**)</td>
<td>.269(*)</td>
<td>.195</td>
<td>-.286(*)</td>
<td>.345(**)</td>
</tr>
<tr>
<td>Relevance of respiratory disease in farming (n=67)</td>
<td>4.14</td>
<td>.83</td>
<td>.391(**)</td>
<td>.235(*)</td>
<td>.320(**)</td>
<td>-.426(**)</td>
<td>.338(**)</td>
</tr>
<tr>
<td>Importance of engineering practices (n=65)</td>
<td>4.10</td>
<td>.78</td>
<td>.350(**)</td>
<td>.204</td>
<td>.191</td>
<td>-.387(**)</td>
<td>.376(**)</td>
</tr>
<tr>
<td>Relevance of engineering practices (n=66)</td>
<td>4.03</td>
<td>.81</td>
<td>.371(**)</td>
<td>.156</td>
<td>.187</td>
<td>-.467(**)</td>
<td>.304(**)</td>
</tr>
<tr>
<td>Importance of pesticide education (n=66)</td>
<td>4.34</td>
<td>.71</td>
<td>.224(*)</td>
<td>.229(*)</td>
<td>.107</td>
<td>-.199</td>
<td>.379(**)</td>
</tr>
<tr>
<td>Relevance of pesticide education (n=66)</td>
<td>4.30</td>
<td>.77</td>
<td>.276(*)</td>
<td>.201</td>
<td>.090</td>
<td>-.182</td>
<td>.369(**)</td>
</tr>
<tr>
<td>Importance of Agricultural respirators (n=66)</td>
<td>4.02</td>
<td>.88</td>
<td>.453(**)</td>
<td>.269(*)</td>
<td>.201</td>
<td>-.284(*)</td>
<td>.358(**)</td>
</tr>
<tr>
<td>Relevance of Agricultural respirators (n=66)</td>
<td>3.97</td>
<td>.85</td>
<td>.421(**)</td>
<td>.198</td>
<td>.235(*)</td>
<td>-.372(**)</td>
<td>.368(**)</td>
</tr>
</tbody>
</table>

Note. ** Correlation is significant at the 0.01 level (1-tailed).  * Correlation is significant at the 0.05 level (1-tailed).
Means for educational topics were computed using a scale of 1=not at all important/relevant to 5=extremely important/relevant.
Correlation coefficients were interpreted according to Davis (1971): .01-.09 = negligible association; .10-.29 = low association; .30-.49 = moderate association; .50-.69 = substantial association; .70 or higher = very strong association.
A high belief in perceived vulnerability to respiratory hazards tended to be associated with high ratings of topics on importance and relevance ($M \geq 4.0$). Similarly, a worker’s positive belief in response efficacy (perceived benefit) tended to be associated with high ratings of the educational topics on importance and relevance as well.

To remove the effect of covariate on the ratings of the educational topics, analysis of covariance was used to determine which factors influenced the ratings. The following factors (variables) were selected for the examination: previous training received related to respiratory protection; respirator user groups (non-users, occasional users and regular users); job type performed (categorized into three levels); respirator type used (two levels) and farming experience (categorized into four levels – none to less than two years; 2 -10 years, 11- 20 years, 21 years and over).

One of the assumptions for performing the procedure for the ANCOVA model requires the predictor variables to be independent of each other. This implies that there should be no relationship between factors or covariates; otherwise there will be multicollinearity between the predictor variables (Kutner, Nachtsheim, Neter & Li, 2004). These factors, except for “respirator user groups” and “type of respirators used” met the criteria for selection (i.e., no significant association was found between these variables and they are independent of each other). Therefore, only one of these factors “respirator user groups” or “type of respirators used” was selected for the ANCOVA procedure. Also, “farming experience” and “age group” were significant and very strongly associated ($r_{(65)} = .932, p < .01$). Hence, only one of these variables was used in the ANCOVA model. The covariates considered for the analysis met the selection
criteria in terms of being significantly correlated with the dependent variable, measured on an interval/ratio scale as well as satisfied the test for the normality (Cronk, 2006).

The factorial ANCOVA between-subjects effects was calculated to examine the main effects of previous training in occupational respiratory disease, respirator-user groups, job type performed, and age group of the agricultural workers on the mean ratings for topics for inclusion in the respiratory safety program, covarying the effects of perceived vulnerability, perceived severity, perceived response efficacy (benefit) of using respiratory protection. Response efficacy was significantly related to the mean ratings for importance of pesticide education in respiratory safety program $F_{(1, 34)} = 6.202, p < .05)$. However, the main effects for respirator-user groups, job type performed, age group, and previous training in occupational respiratory diseases were not significant. In addition, the worker's perceived vulnerability to respiratory disease hazards was significantly related to the mean ratings for importance of respiratory diseases in farming $F_{(1, 34)} = 5.544, p < .05)$. There were no significant differences in the main effects for job type performed, age group of workers, respirator-user groups, and previous training received in occupational respiratory disease hazards, covarying the effects of perceived severity, perceived barrier and response efficacy (perceived benefit). The ratings for importance of engineering practices and importance of agricultural respirators and how they are used did not show any significant difference after controlling for the main effects and covarying the effects of perceived vulnerability, perceived severity, perceived barrier, and perceived response efficacy (benefits).
From the above results it could be stated that a typical agricultural worker at the Penn State University, who perceives him or herself to be vulnerable to respiratory disease hazard, and is aware of the consequence (perceived severity) of being affected by the hazard, and has positive perception about the benefits (response efficacy) of using respiratory protection tended to rate the educational topics high on importance and relevance for the respiratory safety program.

**Research Question One: What educational needs/topics should be included in a respiratory disease prevention program?**

The mean ratings of the educational topics indicated that respondents rated the topics very important and relevant to be included in a respiratory safety program. Pesticide education was ranked high \((M = 4.34, SD = .71)\), followed by respiratory disease in farming \((M = 4.20, SD = .81)\) in importance. The workers’ belief in respirator use significantly influenced the ratings of these topics. The worker’s perceived vulnerability to respiratory hazards significantly influenced the ratings for importance of respiratory diseases in farming. Similarly, response efficacy significantly influenced the mean ratings of topics in pesticide education (see Table 4.6). All the ratings of the educational topics were significantly associated with perceived vulnerability and perceived benefit (response efficacy). The workers’ perceived vulnerability to respiratory hazards and perceived benefit of using respiratory protection tended to influence the mean ratings of all the educational topics that were listed.

**Research Question Two: What are current beliefs about the risks of respiratory diseases and/or adopting protective procedures among the agricultural workers?**

The question was addressed by employing an independent samples t-test and one-way ANOVA to compare the mean scores of the respirator use beliefs for assigned
groups (respirator user groups; age groups of workers; job type performed) and other variables such as gender, type of respirators used, previous training received in occupational respiratory hazards, and the farm unit (department) of the agricultural worker.

Tables 4.7 and 4.8 provide results of t-test and ANOVA for the independent variables.

Table 4.7

Independent t-Test Results for selected Respirator Use Beliefs by Worker Gender and by Previous Training in Ag Safety and Health

<table>
<thead>
<tr>
<th>Belief Construct</th>
<th>Characteristic</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>p</th>
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<td>.72</td>
<td>3.66</td>
<td>.001**</td>
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<td>.032*</td>
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</tr>
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<td></td>
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</tr>
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<td>1.99</td>
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<td></td>
</tr>
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<td>Gender</td>
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<td>Previous training?</td>
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<td></td>
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<td></td>
</tr>
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<td>1.27</td>
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<td>5.99</td>
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</tbody>
</table>

Note. The reported mean scores ranged from 1= strongly disagree/ extremely unlikely to 7= strongly agree/ extremely likely. *p < .01, two tailed. **p < .001, two tailed.
The dependent variables that were used for the analyses were: perceived vulnerability, perceived severity, perceived control (self-efficacy belief), perceived barrier, perceived availability of respirators, organizational support, subjective norm beliefs and perceived benefit (response efficacy belief).

The independent samples t-test comparing the mean scores for the respirator use beliefs based on gender, previous training received in occupational respiratory diseases, and type of respirator used while working on the farm found significant difference among the groups compared.

Significant differences were found between male and female workers on their belief in self-efficacy (perceived control), ($t(70) = 3.66$, $p < .001$); availability of respirators, ($t(40) = -2.36$, $p < .05$), and organizational support, ($t(69) = 4.41$, $p < .001$). The mean score of male workers for perceived control belief (self-efficacy) was significantly higher ($M = 5.96$, $SD = .72$) than female workers ($M = 5.21$, $SD = 1.00$). In terms of availability of respirators, females tended to agree to the statement that “Not having a respirator/dust mask near confined animal buildings/facilities when needed will prevent me from wearing one” ($M = 5.00$, $SD = 1.26$), while males tended to express “no opinion” ($M = 4.08$, $SD = 1.70$) about the statement. Furthermore, male workers tended to express positive belief that management encouraged the used of respiratory protection ($M = 5.40$, $SD = 1.65$) compared to female workers ($M = 3.54$, $SD = 1.74$).

There were also significant differences found between workers who indicated they have had training in occupationally related diseases due to pesticide poisoning. Workers who indicated having received training were significantly higher in self-efficacy belief ($M = 5.92$, $SD = .84$) compared to those who did not indicate having any training
had significantly higher mean scores in organizational support belief \((M = 5.57, SD = 1.39)\), compared to the organizational support belief expressed by those who did not receive training \((M = 3.94, SD = 1.99)\). Furthermore, those who received previous training had a significantly higher mean score in response efficacy (perceived benefit) \((M = 5.99, SD = .97)\) compared to those who did not receive any previous training \((M = 5.25, SD = 1.27)\).

Workers were classified into two respirator/dusk mask user-groups. Group one were those workers who use single-strap and double-strap dusk mask and group two comprised those who indicated using half-face cartridge respirators and power air-purifying with helmet (including SCBA, and full-face respirators). A significant difference was found in the mean scores of “availability of respirators” for the two groups \((t_{(40)} = 2.431, p < .05)\). The mean for group one users were significantly higher \((M = 4.48, SD = 1.67)\) than group two users \((M = 3.09, SD = 1.51)\). This implies that agricultural workers who indicated using single-strap and double-strap nuisance dust mask tended to either express no opinion or agree to the statement that “not having a respirator or dust mask near the confined building or facility will prevent me from wearing one.” Group two users tend to disagree with this statement. The reason could be that the job type required the use of these respirators which was essential for protecting agricultural workers performing these tasks.

The ANOVA results for the assigned groups also differed significantly.

Agricultural workers performing group one job-type (i.e. applying agricultural chemicals, working with paints or solvents) differed significantly on mean scores for organizational
support to encourage using respiratory protection. A significant difference was found between group one and group two job-types ($F_{(2, 56)} = 5.89, p < .001$). The Scheffe’ post hoc analysis test was used to determine the nature of the differences. Group one job-type performers differed significantly ($M = 5.54, SD = 1.35$) compared to group two job-type performers ($M = 4.00, SD = 1.75$). Workers performing group three job-type ($M = 4.00, SD = 2.68$) were not significantly different from either of the other two groups. In addition, significant differences were found among workers’ belief scores on organization support and respirator-user groups. A significant difference was found among the three respirator-user groups ($F_{(2, 68)} = 12.17, p < .000$). The Scheffe’ post hoc test indicated that non-users self-reported less encouragement ($M = 3.53, SD = 1.90$) to use respiratory protection compared to regular users ($M = 5.96, SD = 1.33$). However they did not differ significantly from occasional users ($M = 4.56, SD = 1.72$). Also, results showed that regular users ($M = 5.96, SD = 1.33$) differed significantly from occasional users ($M = 4.56, SD = 1.72$). Furthermore, significant differences were found among respirator user-groups and perceived control (self-efficacy), perceived barrier, subjective norm, and perceived benefit (response efficacy) beliefs (see Table 4.8).

There were significant differences among workers’ age group and perceived vulnerability to respiratory disease hazards ($F_{(2, 63)} = 3.07, p < .05$). The Scheffe’ post hoc test found differences among age-group 22-35, ($M = 3.97, SD = 1.36$) and age-group 50-61 ($M = 5.03, SD = 1.23$). Workers belonging to age-group 36-49 were not significantly different from either of the two other age groups. This result indicates that young and less experience agricultural workers tend to belief they are less vulnerable to respiratory hazards.
Table 4.8

Means, Standard Deviations and ANOVA Results for Respirator Use Beliefs

<table>
<thead>
<tr>
<th>Belief Construct</th>
<th>Characteristic</th>
<th><em>n</em></th>
<th><em>Mean</em></th>
<th><em>SD</em></th>
<th>Range</th>
<th><em>F</em></th>
<th><em>p</em></th>
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<td>1.33</td>
<td>2.13</td>
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</tr>
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<td></td>
<td></td>
<td>Group 2</td>
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<td>4.78a</td>
<td>1.19</td>
<td>2.50</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Group 3</td>
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<td>6.19a</td>
<td>.69</td>
<td>5.50</td>
<td>7.00</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>5.43</td>
<td>1.30</td>
<td>2.13</td>
<td>7.00</td>
</tr>
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<td>Organizational support</td>
<td>Job type performed</td>
<td>Group 1</td>
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<td>1.00</td>
<td>7.00</td>
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<td></td>
<td>Group 2</td>
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<td></td>
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<td></td>
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<td>1.75</td>
<td>1.00</td>
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<td></td>
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<td></td>
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*Note.* *Means followed by the same letters differ significantly from each other as determined by the Scheffe' post hoc analysis technique. Mean values were computed on a scale of 1= extremely unlikely /strongly disagree to 7=extremely likely /strongly agree.*
The one-way ANOVA comparing the mean score for self-reported subjective norm belief showed significant differences among respirator-user groups ($F_{(2,56)} = 3.98$, $p < .024$). The Scheffe' post hoc test found differences between regular users ($M = 16.05$, $SD = 14.52$) and non users ($M = 4.81$, $SD = 14.09$). The result demonstrates that regular users of respiratory protection believe people who were important to them showed favorable concerns regarding their protection against respiratory hazards.

Research questions three and four were addressed by using multiple regression analysis to select independent variables that influenced preventive behavior (the criterion variable). The backward elimination method of selection was used to assess the relative importance of the predictor variables in their contribution to the variation in the criterion variable (preventive behavior). The model summary, ANOVA and regression coefficients for the selected variables can be found in Appendix E.

The model summary after using the backward elimination method listed the following predictor variables: 1) previous training received in farm-related occupational illness, 2) perceived barrier belief, 3) perceived vulnerability, 4) availability of respirators, 5) organizational support, 6) subjective norm, 7) job-type require respirator use, 8) work policy stipulating respirator use, 9) job type performed, and 10) farm department of agricultural worker. All of these predictor variables with the exception of the variable job category (#1) showed significant $p$-values. The collinearity statistics for these predictor variables, i.e., the tolerance and variance inflation factor (VIF) values, showed an acceptable range. Tolerance is the percentage of variance in a given predictor that cannot be explained by other predictors. Tolerance close to zero (0) implies there is high multicollinearity and the standard error of regression coefficient will be inflated.
For the listed predictor variables of preventive behavior, tolerance values ranged between 31.6-71.6 % implying that about 39-69 % of the variance in these selected predictor variables can be explained by the other predictors in the regression model.

Alternately, using the variance inflation factor, a VIF that is greater than 2 is usually considered problematic. The stepwise regression method addresses this problem by selecting only the most important and significant predictors for the model.

The results of the stepwise regression analyses are presented in Table 4.9. These results were used to answer research questions 3 and 4.

Table 4.9
Summary of Stepwise Regression for Variables Predicting Preventive Behavior (N=67)

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<th>Adjusted R Square</th>
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**ANOVA Results**

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<th>Mean Square</th>
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<td></td>
<td>Total</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Regression Coefficients**

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td>Zero-order</td>
</tr>
<tr>
<td>Step 4</td>
<td>(Constant)</td>
<td>1.767</td>
<td>.686</td>
<td>2.575</td>
<td>.016</td>
</tr>
<tr>
<td></td>
<td>Work policy stipulates a</td>
<td>1.264</td>
<td>.217</td>
<td>.702</td>
<td>5.831</td>
</tr>
<tr>
<td></td>
<td>Availability of respirators b</td>
<td>-.097</td>
<td>.039</td>
<td>-.293</td>
<td>-2.515</td>
</tr>
<tr>
<td></td>
<td>Job requires respirator usage c</td>
<td>-.499</td>
<td>.167</td>
<td>-.398</td>
<td>-2.988</td>
</tr>
<tr>
<td></td>
<td>Perceived control belief d</td>
<td>.254</td>
<td>.115</td>
<td>.288</td>
<td>2.218</td>
</tr>
</tbody>
</table>

Dependent Variable: Preventive behavior (mean) computed 1= never to 5 = always performed behavior.

a Work policy stipulate respiratory use: dummy coded 1 = yes, 0 = no.
b Availability of respirators: mean computed on a scale of 1= strongly disagree to 7 =strongly agree.
c Job requires respirator usage: dummy coded 1 = yes, 0 = no.
d Perceived control belief: This construct was computed based on summated mean scores of 4 items 1= extremely unlikely/no control to 7 =extremely likely/absolute control.
Research Question Three: What are the perceived barriers to the use of respirators and/or following protective behaviors to prevent respiratory problems?

The perceived barriers to using respirators or following protective/preventive behavior were identified in the regression model(s) as “availability of respirators” and “job requires respirator usage.” These two variables have negative coefficients. This means that perceived lack of respirators may negatively influence behavior to use respiratory protection. Also, if a job requires the use of respirators/dust masks and the agricultural worker does not use it for any reason, it will inadvertently affect preventive behavior. Among the variables which predicted preventive behavior were “work policy stipulating or requiring use of respirators/dust masks” and “perceived control/response efficacy belief” – the control the individual worker has over using respirators for protection or following procedures to prevent respiratory hazards. The implication here is that where there should be a respirator/dusk mask available for use, and the type of job being performed by the worker requires the use of respiratory protection, but because there is no awareness of whether to use respirators or not, preventive behavior may not be adopted.

Other potential variables that could serve as barriers to using respiratory protection were identified as organization support, subjective norm belief, and the department to which the agricultural worker belonged. These variables had negative regression coefficients (see Appendix E) and could be examined further to assess their influence or association on preventive behavior.
Research Question four: What factors influence the choice of behavior among the agricultural workers?

The results of the regression analysis enumerated the factors as: 1) work policy stipulating use of respirators 2) availability of respirators, 3) job types that required the use of respirators/dust masks, and 4) perceived control or self-efficacy belief agricultural workers have over using respiratory protection. It is imperative from the results that agricultural workers need adequate knowledge about the type of respirators available and the kind of protection these respirators offer. Thus, it is important that training in the use of the different types of agricultural respirators is essential, in addition to knowing how these respirators work to reduce respiratory disease exposures. By educating the worker about the risk of respiratory diseases exposures and training them to identify the appropriate type of respiratory protection to use while working in a potentially hazardous environment, will help build confidence in the agricultural worker. This, in turn will improve behavior and subsequently minimize the incidence of respiratory hazards.

Previous training that some agricultural workers reported to have received in the prevention of farm-related occupational illnesses was among the variables identified to influence preventive behavior. Since there were significant associations between worker’s belief about respirator use and ratings of educational topics, an educational program based on these topics that were identified as important and relevant to respiratory safety would be beneficial to them because they have a stake in the programming effort.
Findings of Phase Two (Program Evaluation)

Research Question five: What is the program outcome on the beliefs and behaviors of program participants after participating in a respiratory protection program?

Table 4.10 shows descriptive statistics of items rated by program participants to assess the respiratory safety program.

Table 4.10

*Descriptive Statistics of Items Evaluated for Respiratory Safety Program*

<table>
<thead>
<tr>
<th>Variables</th>
<th>n</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information presented</td>
<td>14</td>
<td>3.00</td>
<td>5.00</td>
<td>4.07</td>
<td>.47</td>
</tr>
<tr>
<td>Accuracy of information</td>
<td>14</td>
<td>4.00</td>
<td>5.00</td>
<td>4.43</td>
<td>.51</td>
</tr>
<tr>
<td>Information is easy to understand</td>
<td>13</td>
<td>4.00</td>
<td>5.00</td>
<td>4.15</td>
<td>.38</td>
</tr>
<tr>
<td>Completeness of information</td>
<td>14</td>
<td>3.00</td>
<td>5.00</td>
<td>3.93</td>
<td>.47</td>
</tr>
<tr>
<td>Timeliness of information</td>
<td>13</td>
<td>4.00</td>
<td>5.00</td>
<td>4.31</td>
<td>.48</td>
</tr>
<tr>
<td>Value of information in making decision to your own situation</td>
<td>14</td>
<td>3.00</td>
<td>5.00</td>
<td>4.21</td>
<td>.58</td>
</tr>
<tr>
<td>Relevance of the examples used to your situation</td>
<td>14</td>
<td>3.00</td>
<td>5.00</td>
<td>4.07</td>
<td>.62</td>
</tr>
<tr>
<td>Quality of visual aids</td>
<td>14</td>
<td>3.00</td>
<td>5.00</td>
<td>4.07</td>
<td>.62</td>
</tr>
<tr>
<td>Quality of handouts</td>
<td>14</td>
<td>4.00</td>
<td>5.00</td>
<td>4.64</td>
<td>.50</td>
</tr>
<tr>
<td>Presenter's knowledge of subject matter</td>
<td>14</td>
<td>4.00</td>
<td>5.00</td>
<td>4.50</td>
<td>.52</td>
</tr>
<tr>
<td>Presenter's speaking/presentation skills</td>
<td>14</td>
<td>3.00</td>
<td>5.00</td>
<td>4.00</td>
<td>.55</td>
</tr>
<tr>
<td>Presenter's organization and preparedness</td>
<td>14</td>
<td>4.00</td>
<td>5.00</td>
<td>4.57</td>
<td>.51</td>
</tr>
<tr>
<td>Presenter's response to questions from participants</td>
<td>14</td>
<td>4.00</td>
<td>5.00</td>
<td>4.50</td>
<td>.52</td>
</tr>
<tr>
<td>Physical setting’s contribution to ease of listening and participation</td>
<td>14</td>
<td>4.00</td>
<td>5.00</td>
<td>4.71</td>
<td>.47</td>
</tr>
</tbody>
</table>

*Note.*<sup>a</sup> Mean computed on a scale of 1 = very poor; 2 = poor; 3 = acceptable; 4 = good; 5 = very good.
Items in the table were rated on a five-point Likert-type scale of 1 = very poor to 5 = very good. The overall program quality was rated as well on a five-point Likert-type scale of 1 = poor to 5 = excellent.

The awareness/knowledge of participants on some selected topics which were highlighted in the respiratory safety program was assessed. Participants rated their awareness of these topics before and after participating in the program. The response scale was 1 = Not at all aware; 2 = very little awareness; 3 = somewhat aware; 4 = Aware; 5 = very much aware.

On average, participants rated the overall program quality as good ($M = 3.84$, $SD = .69$) and all 14 participants indicated they would recommend the program to others. It was reported that the information presented in the program was accurate, timely and easy to understand. In addition, the value of the information presented in making decision ($M = 4.21$, $SD = .58$) and the relevance of the examples cited in the two video presentations ($M = 4.07$, $SD = .62$) were good.

The results of the content analysis of the open-ended questions participants responded to in terms of what they liked most about the program confirmed the above observation. The emerging themes of the content analysis were that information was relevant and complete and the presentations were good. Some responses were: variety of presentation method (01); learning about different health effects (02); scope of the material presented was very good (03); relevant examples (09); and friendly, casual - proper amount of information for time allotted (12). The materials needed to be presented to a wider range of people. Some people may not know if they are at risk (14).
Although the quality of the information presented was perceived to be good, there were mixed reactions in terms of the video quality. Themes that emerged after analyzing the content of responses received on what was least liked about the program were: video quality was poor; particularly the sound quality and materials were not as relevant to Pennsylvania as they could be. Some comments from the participants were: *DVD programs – need to be of better sound quality; first DVD more to the point than second one. Maybe you should have a totally new video made here at Penn State!* (05). *Video needs to be improved but information on video was excellent!* (03).

In terms of what additional information was needed in the subject area that would be useful found emerging themes from the open-ended questions as: more specific information on respirators, including the types of respirators needed to effectively prevent respiratory hazards exposures.

To determine program outcome, participants were requested to list any two pieces of information they have learned as a result of attending the program and indicate their intention to adopt any recommendations presented in the program.

Table 4.11 shows the pieces of information workers reported to have learned as a result of participating in the program and their intention to use this information. A content analysis of the information presented revealed the following themes: *associated respiratory diseases, respirator use, and potential respiratory hazards*.

Of the 14 participants who attended the program, three of them indicated they have already adopted information regarding respirator usage and practices to minimize respiratory hazards exposure.
Table 4.11  
Information Learned from Respiratory Safety Program and Intent to Adopt

<table>
<thead>
<tr>
<th>Code</th>
<th>Important information learned</th>
<th>Intent to use/adopt information learned</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Respirators when handling animals</td>
<td>Probably will</td>
</tr>
<tr>
<td>02</td>
<td>Symptoms of respiratory diseases</td>
<td>Probably will</td>
</tr>
<tr>
<td></td>
<td>Two strap mask</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>More information on lung diseases</td>
<td>Definitely will</td>
</tr>
<tr>
<td></td>
<td>Dust sources in agriculture</td>
<td></td>
</tr>
<tr>
<td>04</td>
<td>Types of respiratory hazards</td>
<td>Definitely will</td>
</tr>
<tr>
<td></td>
<td>Need for education for use of respirators</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>Proper use of respirators according to job practices</td>
<td>Already adopted</td>
</tr>
<tr>
<td></td>
<td>Practices to reduce exposure to hazards</td>
<td></td>
</tr>
<tr>
<td>06</td>
<td>Gas hazards on farms</td>
<td>Probably will not</td>
</tr>
<tr>
<td></td>
<td>Gas hazards from welding</td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>Contaminated air in closed animal space</td>
<td>Definitely will</td>
</tr>
<tr>
<td></td>
<td>Respiratory disease associated by dusts etc</td>
<td></td>
</tr>
<tr>
<td>09</td>
<td>Types of diseases</td>
<td>Definitely will</td>
</tr>
<tr>
<td></td>
<td>Symptoms of diseases vary</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Problem of contained gases</td>
<td>Definitely will</td>
</tr>
<tr>
<td>13</td>
<td>Respirator use</td>
<td>Already adopted</td>
</tr>
<tr>
<td></td>
<td>Respirator safety</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Gases produced</td>
<td>Already adopted some gases</td>
</tr>
<tr>
<td></td>
<td>Symptoms</td>
<td>Definitely will</td>
</tr>
</tbody>
</table>

Five of the participants indicated that they will definitively adopt the topics learned in the program. In addition, two participants indicated they probably will adopt the topics learned. However, one participant indicated probably not adopting topics learned with regards to hazardous gases resulting from welding fumes. The reason for this decision was not shared.

To assess the awareness/knowledge of program participants on topics covered in the respiratory safety program, participants were asked to rate their awareness or knowledge of six major topics that were covered in the respiratory safety program before and after participating in the program. Table 4.12 provides information regarding the
topics covered and what participants indicated they knew before and after participating in the respiratory safety program.

Table 4.12

| Awareness of Educational Topics Covered in Respiratory Safety Program (N = 14) |
|---------------------------------|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Topics covered in program       | Awareness/Knowledge a           | Before program  | After program  | Mean change     | t               | p               | d               |                 |                 |
|                                 | M         | SD        | M         | SD        |                 |                 |                 |                 |                 |
| Respiratory hazards on the farm | 3.64      | 1.39      | 4.71      | .47       | -1.07           | -3.16           | .008            | 0.84            |                 |
| Types of respiratory diseases   | 3.29      | 1.20      | 4.42      | .51       | -1.14           | -3.89           | .002            | 1.04            |                 |
| Symptoms of respiratory diseases| 3.21      | 1.19      | 4.43      | .51       | -1.21           | -3.63           | .003            | 0.97            |                 |
| Practices to reduce risk respiratory disease hazards | 3.57 | 1.34 | 4.50 | .52 | -.93 | -3.48 | .004 | 0.93 | |
| Work behavior to minimize respiratory disease exposure | 3.64 | 1.39 | 4.50 | .52 | -1.79 | -6.36 | .001 | 0.77 | |
| Gases prevalent in confined environment | 2.71 | 1.27 | 4.43 | .51 | -1.71 | -5.63 | .001 | 1.51 | |

Note. a Mean was computed on a scale of 1=Not at all aware, 2=very little awareness, 3=somewhat aware, 4=Aware, 5=very much aware. p < .001, two-tailed.

The results in Table 4.12 indicate that participants significantly became more aware of the topics covered in the respiratory safety program after participating in the respiratory safety program. The topics covered in the respiratory safety program which participants indicated very little awareness or some awareness of before attending the program were: gases prevalent in confined environment ($M = 2.71, SD = 1.27$); symptoms of respiratory diseases ($M = 3.21, SD = 1.19$); and types of respiratory diseases ($M = 3.29, SD = 1.20$).

The program significantly increased their awareness in these topics after watching and listening to the video documentary. The effect sizes (Cohen’s $d$) calculated to examine the effect of the program (video documentaries) on the awareness of the topics after participating in the respiratory safety program found a large effect ($0.77 \leq d \leq 1.51$), (Cohen, 1988).
The program received supplementary and complimentary comments from a few participants - *This seminar should be presented to the farmers of PA as well* (11); *I believe further information on tasks done would be necessary to your analysis. Also we do animal work, but mostly outside which sways the answer. Very informative session! Thanks* (02). *Good job! – Program has great potential for use here at PSU* (01). *Think you might want to design a safety video for use at Penn State over using the old videos* (05).

The demographic characteristics of participants who attended the respiratory safety program and those who did not attend were compared, and an independent t-test was performed on key variables to examine any differences between the two groups. The results are presented in Tables 4.13 and 4.14.

Table 4.13

*Comparison of participants who attended respiratory safety program on belief constructs and preventive behavior*

<table>
<thead>
<tr>
<th>Belief Constructs</th>
<th>Attendance at Program</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived vulnerability</td>
<td>Attended</td>
<td>11</td>
<td>5.05</td>
<td>.96</td>
<td>1.404</td>
<td>.165</td>
</tr>
<tr>
<td></td>
<td>Did not attend</td>
<td>61</td>
<td>4.45</td>
<td>1.34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived severity</td>
<td>Attended</td>
<td>11</td>
<td>5.57</td>
<td>1.54</td>
<td>.589</td>
<td>.558</td>
</tr>
<tr>
<td></td>
<td>Did not attend</td>
<td>61</td>
<td>5.29</td>
<td>1.42</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived control</td>
<td>Attended</td>
<td>11</td>
<td>5.32</td>
<td>1.07</td>
<td>-1.550</td>
<td>.126</td>
</tr>
<tr>
<td></td>
<td>Did not attend</td>
<td>61</td>
<td>5.77</td>
<td>.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived barrier</td>
<td>Attended</td>
<td>11</td>
<td>2.77</td>
<td>1.42</td>
<td>-.138</td>
<td>.891</td>
</tr>
<tr>
<td></td>
<td>Did not attend</td>
<td>61</td>
<td>2.84</td>
<td>1.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Availability of respirators</td>
<td>Attended</td>
<td>11</td>
<td>5.55</td>
<td>1.44</td>
<td>2.655</td>
<td>.010</td>
</tr>
<tr>
<td></td>
<td>Did not attend</td>
<td>61</td>
<td>4.20</td>
<td>1.57</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organizational support</td>
<td>Attended</td>
<td>11</td>
<td>4.00</td>
<td>1.91</td>
<td>-1.573</td>
<td>.120</td>
</tr>
<tr>
<td></td>
<td>Did not attend</td>
<td>61</td>
<td>4.93</td>
<td>1.86</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subjective norm beliefs</td>
<td>Attended</td>
<td>11</td>
<td>13.82</td>
<td>12.61</td>
<td>.869</td>
<td>.389</td>
</tr>
<tr>
<td></td>
<td>Did not attend</td>
<td>61</td>
<td>10.06</td>
<td>12.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived benefit</td>
<td>Attended</td>
<td>11</td>
<td>5.77</td>
<td>1.25</td>
<td>.471</td>
<td>.639</td>
</tr>
<tr>
<td></td>
<td>Did not attend</td>
<td>61</td>
<td>5.59</td>
<td>1.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preventive behavior</td>
<td>Attended</td>
<td>11</td>
<td>3.66</td>
<td>.88</td>
<td>.175</td>
<td>.862</td>
</tr>
<tr>
<td></td>
<td>Did not attend</td>
<td>61</td>
<td>3.62</td>
<td>.82</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The Levene’s test for equality of variance was not statistically significant for all the variables compared ($p > .05$), hence, the equal variance assumption was met.

Table 4.14

*Comparison of demographic characteristics of participants who attended and those who did not attend the respiratory safety program*

<table>
<thead>
<tr>
<th>Demographic characteristic</th>
<th>Did not attend Program</th>
<th>Attended Program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$n$</td>
<td>percent</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>44</td>
<td>72.1</td>
</tr>
<tr>
<td>Female</td>
<td>17</td>
<td>27.9</td>
</tr>
<tr>
<td>Total</td>
<td>61</td>
<td>100.0</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M = 43.09$</td>
<td>$SD = 10.70$</td>
<td>$M = 44.33$</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>44</td>
<td>75.9</td>
</tr>
<tr>
<td>Divorced</td>
<td>3</td>
<td>5.2</td>
</tr>
<tr>
<td>Separated</td>
<td>1</td>
<td>1.6</td>
</tr>
<tr>
<td>Single</td>
<td>10</td>
<td>17.2</td>
</tr>
<tr>
<td>Total</td>
<td>58</td>
<td>100.0</td>
</tr>
<tr>
<td>Job position</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm worker (full-time)</td>
<td>15</td>
<td>26.8</td>
</tr>
<tr>
<td>Farm worker (part-time)</td>
<td>2</td>
<td>3.6</td>
</tr>
<tr>
<td>Farm supervisor</td>
<td>9</td>
<td>16.1</td>
</tr>
<tr>
<td>Farm administrator</td>
<td>3</td>
<td>5.4</td>
</tr>
<tr>
<td>Other</td>
<td>27</td>
<td>48.2</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
<td>100.0</td>
</tr>
<tr>
<td>Farming experience (since age 16)</td>
<td>$M = 18.46$</td>
<td>$SD = 13.15$</td>
</tr>
<tr>
<td>Farm Department</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural &amp; biological engineering</td>
<td>2</td>
<td>3.2</td>
</tr>
<tr>
<td>Animal diagnostic laboratory</td>
<td>3</td>
<td>4.9</td>
</tr>
<tr>
<td>Crop and soil science</td>
<td>14</td>
<td>23.0</td>
</tr>
<tr>
<td>Dairy and animal science</td>
<td>13</td>
<td>21.3</td>
</tr>
<tr>
<td>Farm operations</td>
<td>8</td>
<td>13.1</td>
</tr>
<tr>
<td>Horticulture</td>
<td>6</td>
<td>9.8</td>
</tr>
<tr>
<td>Plant pathology</td>
<td>3</td>
<td>4.9</td>
</tr>
<tr>
<td>Poultry science</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Veterinary science</td>
<td>12</td>
<td>19.7</td>
</tr>
<tr>
<td>Total</td>
<td>61</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The independent t-test found no significant differences on the mean scores of those who attended the respiratory safety program and those who did not attend for all belief constructs and preventive behavior (see Table 4.13), with the exception of
perceived availability of respirators ($t_{(70)} = 2.655, p < .05$). The mean of those who attended the program was significantly higher ($M = 5.55, SD = 1.44$) than the mean of those who did not attend the program ($M = 4.20, SD = 1.57$).

The demographic characteristics of the two groups in terms of age, job position and department of the participants did not differ much. However they differed in gender and farming experience.

Comparing those who attended the respiratory safety program to those who did not attend on the key variables used in the independent t-test, it can be concluded that the two groups were similar on respirator use beliefs. They did not differ on their beliefs regarding vulnerability, severity, self-efficacy, barriers, organizational support, subjective norm, response efficacy, and preventive behavior. This result fails to reject the null hypothesis that there is no significant difference in the perceived beliefs and/or preventive behavior among agricultural workers who participated in the respiratory protection program and those who did not participate. Thus the program may as well influence those who did not attend had they participated.

It must be stated that one of the participants who attended the program had earlier declined participation in the initial research study, but responded to the invitation email and attended the program.
Chapter 5
SUMMARY, CONCLUSIONS, IMPLICATIONS AND DISCUSSION, AND RECOMMENDATIONS

The purpose of this study was to explore perceived beliefs of agricultural workers regarding the use of respiratory protection and develop a respiratory safety program based on these perceived beliefs to prevent respiratory hazards. The study adopted the conceptual framework proposed by the Intervention Effectiveness Research team of the National Institute for Occupational Safety and Health (NIOSH) to develop and deliver an intervention respiratory safety training module to be used by agricultural workers at the Pennsylvania State University. In addition, the study sought to determine the relationship between workers’ perceived beliefs about the use of respirators and/or adopting preventive behaviors against respiratory hazards. The factors that explained the variance in preventive behaviors were explored among the identified agricultural workers. Based upon the identified respirator use-beliefs regarding the use of respiratory protection, educational topics were identified and selected to design the respiratory safety training module for the workers.

The following research questions and hypotheses guided the study:

1. What educational needs/topics should be included in a respiratory safety program?
2. What are current beliefs about the risks of respiratory diseases and the use of protective procedures among agricultural workers?
3. What are the perceived barriers to the use of respirators and/or following protective behaviors to prevent respiratory problems?
4. What factors influence the choice of behavior among the agricultural workers?

5. What is the program outcome on the beliefs and behaviors of program participants after participating in a respiratory safety program?

H_{O1}: There is a positive correlation between respondents’ perceived beliefs (e.g. perceived susceptibility to respiratory disease) and ratings of topics to be included in a respiratory safety program.

H_{O2}: Agricultural workers who perceive themselves to be at risk of getting respiratory disease are more likely to follow precautions for respiratory protection than those who do not perceive themselves to be at risk of getting respiratory disease.

H_{O3}: There is no significant difference in perceived beliefs and/or preventive behaviors among agricultural workers who participated in the respiratory safety program and those who did not participate.

H_{O4}: Agricultural workers receiving the program intervention are likely to adopt recommendations provided in the respiratory safety program.

The conceptual model adopted for the identified three research phases were addressed in this study. The first phase involved developing a theoretical framework for the intervention based on literature search on the problem. This phase reviewed behavioral models based on expectancy-value theories to select relevant belief constructs that addressed workplace safety and self-protective behaviors to conduct a needs assessment of the study population. A descriptive correlational approach was used to identify the variables of interest to the study objectives. The variables were analyzed for their significant contribution to the belief constructs and dependent variables.

A criterion-based sample of participants was drawn from The Pennsylvania State University farm. The population frame included workers in animal production facilities, farm operations, and greenhouse facilities. Names of the study participants were obtained through the Human Resource Office of the College of Agriculture Sciences. One-hundred and sixty-six workers who met this criterion were asked to participate in
this phase of the study. The list was reduced to 110 participants after mailing the questionnaires and receiving feedback from respondents.

A five-part questionnaire was developed to collect data. Section A contained questions pertaining to respirator use beliefs based on the following belief constructs: threat-related (perceived severity and perceived susceptibility), self-efficacy, response efficacy, barriers, and normative expectations. Questions soliciting respirator-use beliefs were measured on a seven-point semantic distant scale. Section B contained questions about precautions taken against respiratory hazards. The section contained two parts: statements that sought the opinion of workers about their personal protection against respiratory hazards and statements soliciting information about preventive procedures that were followed in the past 12 months. Statements regarding personal protection were measured on a four-point Likert-type response scale, 1 = strongly disagree to 4 = strongly agree. The statements regarding preventive behaviors in the past 12 months were assessed using a Likert-type response scale of one (1) = never to five (5) = always. Section C assessed information about the type of training received in the past 12 months and monitoring of airborne substances to meet workplace safety and health standards. Section D required respondents to rate four major topics about respiratory safety issues for importance and relevance to be included in a respiratory safety program. The scales ranged from one (1) = not important/relevant at all to five (5) = extremely important/relevant. Section E solicited demographic information of the workers.

The questionnaires were reviewed by a panel of 10 experts at The Pennsylvania State University, and mentors of the Great Lakes Center for Agricultural Safety and Health (GLCASH) fellows program for content and face validity. The instrument was
pilot-tested with 30 student workers including volunteers who met the study sample criterion. The overall reliability coefficient obtained from the pilot test based on 22 returned questionnaires was $\alpha = .72$. The reliability coefficient of some belief constructs were found to range between .62 and .75. After revising and amending some items in the questionnaire, the overall reliability coefficient for the final study was $\alpha = .85$. A total of 73 usable questionnaires were returned, representing 66.3 % response rate.

The second phase of the study focused on delivering the respiratory safety program to a selected group of workers who were requested to sign-up to attend the program. Workers who attended watched two videos - a documentary on respiratory hazards on the farm, and an educational seminar series on respiratory hazards on the farm. The preliminary findings of the survey were also presented to participants.

The third phase involved an assessment of the respiratory safety program by program participants. The overall goal of the respiratory safety program was to create awareness of respiratory hazards on the farm and identify factors to minimize the risks of respiratory problems among agricultural workers.

The two-hour respiratory safety program highlighted topics identified in the needs assessment as important and relevant to include in the program. Information provided in the video documentary was reinforced with fact sheets/ handouts on topics covered to serve as supplementary reading materials for program participants. Fourteen workers attended the program, including a worker, specially invited to attend, and was not part of the research sample.

Data were collected using both mailed and electronic survey. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software for windows,
version 15. Descriptive and inferential statistics were used. Multiple regression analysis was employed to examine the factors influencing preventive behavior. Both the backward and stepwise methods were use to identify the predictor variables. The most important predictor variables (factors) were identified and selected using the stepwise method.

Conclusions

The majority of agricultural workers at the Pennsylvania State University were male (65.8%) with a large percentage (78.6%) being married. The workers’ age ranged from 22-61 years with an average age of 43.25 years. Farming experience since the age of 16 ranged from no experience to 45 years. A majority (76.9%) of the workers reported having had at least two years of farming experience since age 16.

The results of the study showed that the typical agricultural worker who perceives him or herself to be vulnerable to respiratory disease hazard, and is aware of the consequence (perceived severity) of being affected by the hazard, and who has a positive perception about the benefits (response efficacy) of using respiratory protection tended to rate the educational topics high on importance and relevance for the respiratory safety program. This finding confirmed the research hypothesis that there would be a positive association (correlation) between the worker’s threat-related beliefs and the ratings of the educational topics to be included in the respiratory safety program. Pesticide education was ranked the highest ($M = 4.34, SD = .71$), followed by respiratory disease in farming ($M = 4.20, SD = .81$) in importance. The worker’s perceived vulnerability to respiratory hazards significantly influenced the mean ratings for importance ($r = .405, p < .01$) and relevance ($r = .391, p < .01$) of respiratory diseases in farming. Similarly, response
efficacy (perceived benefit) significantly influenced the mean ratings of topics in pesticide education on importance ($r = .379, p < .01$) and relevance ($r = .369, p < .01$) to include in the respiratory safety program.

The current beliefs regarding the use of respiratory protection were influenced by the type of job performed by workers at Penn State University and this tended to influence behavior towards respirator use. In addition, work policy and the type of job performed by the worker had significant influence on the workers’ belief in using respiratory protection. Two of the statements soliciting the opinion of workers towards personal protection against respiratory hazards were positively correlated. The Pearson correlation coefficient was calculated for the association between respondents who agreed or disagreed with the statement that: “The work/job I perform generally requires using a respirator/dust mask,” and those that agreed or disagreed with the statement that: “It is part of work policy to wear a respirator/dust mask against respiratory hazards.” A positive low association was found ($r_{(69)} = .29, p < .01$), indicating a significant linear association (relationship) between the respondents. Job performed on the farm which required the use of respirators tended to be guided by work policy for protection against respiratory problems. A confirmation of this result was found in the ANOVA results when workers were categorized according to the jobs they performed. Agricultural workers performing group one job-type (i.e., applying agricultural chemicals, working with paints or solvents) differed significantly on the mean scores for organizational support to encourage using respiratory protection. A significant difference was found among group one and group two job-types ($F_{(2, 56)} = 5.89, p < .001$). The Scheffe’ post hoc test found significant differences between group one job-type performers ($M = 5.54$,
Workers performing group three job-type ($M = 4.00, SD = 2.68$) were not significantly different from either of the other two groups. In addition, significant differences were found among workers’ belief scores on organization support and respirator-user groups. A significant difference was found among the three respirator-user groups ($F_{(2, 68)} = 12.17, p < .000$). The Scheffe’ post hoc test indicated that non-users self-reported receiving less encouragement ($M = 3.53, SD = 1.90$) from management to use respiratory protection compared to regular users ($M = 5.96, SD = 1.33$). However, non-users did not differ significantly from occasional users ($M = 4.56, SD = 1.72$). These results also indicated that regular users ($M = 5.96, SD = 1.33$) differed significantly from occasional users ($M = 4.56, SD = 1.72$). The above results regarding use of respiratory protection has some implications for the agricultural workers. It appears workers are not receiving the desired organizational encouragement to use respirators. This might be because most workers may not be aware of the type of jobs that require the use of respiratory protection and thus may not feel the need to use respiratory protection. Another speculation could be that they are not encouraged because some of the jobs performed may not appear to present any risk to their health. Workers should understand their job classification in terms of the risks involved so that the risk factors can easily be identified to serve as a priority for the worker to make informed decisions about using respiratory protection. Workers whose jobs required mandatory protection against respiratory hazards use it while performing those jobs. However, the worker must be made aware of the risks involved in all jobs on the farm that could be potentially hazardous, hence, the need to classify the jobs according to the level of risks each job presents.
There were significant differences found among workers’ age group and their perceived vulnerability to respiratory disease hazards ($F_{(2, 63)} = 3.07, p < .05$). The Scheffe’ post hoc test found differences among age-group 22-35 ($M = 3.97, SD = 1.36$), and age-group 50-61 ($M = 5.03, SD = 1.23$). Workers belonging to age-group 36-49 were not significantly different from either of the two other age groups. This result indicates that young and less experience agricultural workers tended to belief they are less vulnerable to respiratory hazards.

Figure 3 shows the variables that were selected using the backward regression model to determine which factors influenced preventive behavior among the agricultural workers.

Figure 3: Identified factors (in italics) likely to influence preventive behavior

The backward elimination method identified 10 potential predictor variables that could be researched.
In the terms of the barriers perceived to using respirators and/or following protective behaviors among the target population, the results indicated that organizational support, subjective norm, and the department to which the agricultural worker belonged, whether or not the job performed required use of respirators, perceived barrier to using respirators, and perceived availability or respirators were potential barriers that tended to hinder the use of respiratory protection.

The factor that influenced the choice of behavior among the target population were selected from the stepwise regression model as: 1) work policy stipulating use of respirators 2) availability of respirators, and 3) job types that required the use of respirators/dust masks, and 4) perceived control or self-efficacy belief agricultural workers had over using respiratory protection.

The stepwise regression analysis calculated to predict factors influencing behavior found a significant regression equation $F_{(4, 27)} = 12.059, p < .0001$, with an $R^2$ of .641. These factors explained 64.1% (Adjusted $R^2 = .588$) of the variance in preventive behavior.

The regression equation is given as:

The agricultural worker’s predicted preventive behavior = 1.767 + 1.264 (work policy stipulating respirator use) - .097 (availability of respirators) - .499 (job requires respirator usage) + .254 (perceived control belief).

Two of the factors were negatively related to preventive behavior – perceived availability of respirators ($\beta = -.293, p < .018$) and job-type requiring respirator usage ($\beta = -.398, p < .006$). The standardized coefficients of these factors (Beta weights) indicated a significant contribution to the variance in preventive behavior model (the dependent
variable). Work policy stipulating the use of respiratory protection contributed 42.3% to the parsimonious model. Perceived control belief significantly contributed to the variance in preventive behavior (i.e. 5.8 %) as well. The results demonstrate the need for agricultural workers to have the requisite knowledge about the type of respirators available and the kind of protection these respirators offer. It is therefore evident that training in the use of the types of agricultural respirators is essential, in addition to acquiring the knowledge of how these respirators work to minimize respiratory hazards. Hence, educating agricultural workers about the risk of respiratory disease exposures and training them in identifying the appropriate type of respiratory protection to adopt while working in potentially hazardous environment will help build confidence in their use. This, in turn, will improve behavior and subsequently minimize the incidence of respiratory hazards exposures.

The respiratory safety training program which was delivered to participants demonstrated a need to have similar sessions for all agricultural workers at The Pennsylvania State University. Participants reported increased awareness of educational topics that were covered in the program. The themes emerging from evaluating the program outcome by the participants revealed additional information on 1) associated respiratory diseases, 2) respirator use, and 3) potential respiratory hazards, all of which appeared to be job-related. These thus emphasize the need to categorize jobs performed by the agricultural workers so that they can be aware of any risks involved and thus develop positive attitudes towards following precautionary measures while at work.
Implications and Discussion

This study has implications for workers at the Pennsylvania State University and other working environments with similar conditions as the study population. The study adds to results found in related studies that sought to understand workers’ safety with regards to using personal protective equipment. As concerted efforts are directed at addressing safety issues at the workplace, especially in agricultural and related industries the factors that have been found to predict behavior among workers in these industries should be taken into account when planning agricultural safety and health programs. The onerous task rests on extension safety specialists and safety officers to explore these factors which have been found to significantly influence the worker’s safety behaviors.

While this study employed components of expectancy-value health belief models with particular reference to belief constructs that tend to influence personal safety at the workplace, some significant findings were found to be consistent with the findings of related studies which used the general belief models. Consistent with the literature, most of the belief constructs were low to moderately correlated \((.26 \leq r \leq .511)\). Most notable is the fairly substantial significant association found between perceived vulnerability (susceptibility) to using respirators and/or respiratory protection and perceived response efficacy or perceived benefit \((r_{(70)} = .502, p < .001)\). This finding is consistent with those reported by Melamed, Rabinowitz, Feiner, Weisberg, and Ribak (1996) who used the protection motivation theory to explain hearing device use among male industrial workers. Another noticeable finding was the relatively substantial inverse association between self-efficacy beliefs and perceived barrier belief \((r_{(70)} = -.502, p < .001)\). This result is consistent with the claim (Weinstein, 1993; Melamed et al., 1996) that it is
difficult to differentiate between the two factors because a worker reporting obstacles to performing a desired health behavior will also report lower self-efficacy beliefs (perceived control beliefs) and vice versa. However, in this study the stepwise regression analysis procedure addressed this problem and found that self-efficacy (perceived control belief) significantly contributed to the variance in preventive behavior. Self-efficacy was part of the predictor variables found to be most significant in related studies (Melamed et al., 1996; Perry, Marbella & Layde, 2000) in addition to perceived barrier perceptions. The low to moderate associations found between the belief constructs should be interpreted with caution. Even though these associations appear to be low to moderate indicate that other variables need to be explored. Thus, the potential variables identified through the backward regression analysis should be explored further. There is the need to understand the workers’ beliefs so as to plan effective safety program that will help meet their needs.

As the findings indicate, there is the need to analyze and categorize the type of jobs agricultural workers perform so that each worker would be well-informed about the risks these jobs present and adopt the appropriate preventive behavior for protection. In addition, management efforts should be directed at facilitating self-efficacy perceptions and attempt to remove the perceptions as to the kind and type of respiratory protection the worker should use.

**Recommendations**

This study has uncovered the need to conduct further research into the target population to understand the worker’s behavior towards using respiratory protection. Further research is highly recommended to target the at-risk groups, specifically the
young and less experienced agricultural workers, whose current beliefs about respiratory protection could be understood better through a focused group interview. Observation of the self-reported behavior is very essential to ascertain the adoption of recommended strategies or procedures to prevent any health hazard. Thus, it is critical to follow-up with those participants attending the program to ensure they are practicing what was learned.

It is recommended that this respiratory training program be incorporated into the annual agricultural safety and health training program for agricultural workers at the College of Agricultural Sciences, and most especially for newly-hired workers to create the needed awareness in the jobs they would be assigned.

There appears to be abundant resource materials at the national agricultural safety database (NASD) from which similar programs could be designed and delivered to program participants. Together with these resources, it is highly recommended that a relevant Pennsylvania video documentary based on the results of the current study be produced for use as resource materials for agricultural safety and health personnel.

Results of the program evaluation by the section of workers who participated suggested the need to make these resources available to everyone. It will be beneficial to design a web training program that agricultural workers or workers who perform duties in related areas may access and complete. Job safety credit, educational credit or a certificate for completing the training should be issued to participants.

Replicating this study in selected counties in Pennsylvania is highly recommended because surveillance data seemed to highlight the risk of respiratory
illnesses among a range of agricultural workers. A major focus could be among migrant workers who may benefit from a translated version of this program.

There is the urgent need to collaborate with other agencies like the health and human services and manufacturers of respiratory protective equipment who work closely with the target population to understand the need of these workers. This collaboration could holistically curtail the problem of respiratory hazards exposures among agricultural and related workers.

Finally, the work policy regarding the use of respiratory protection should be made clear to all workers so that the decision to use or not use respirators (or respiratory protection) should not be left at the discretion of the worker who may not know whether the job being performed presents a health risk.
REFERENCES


Donham, K. J. (1993). *Agricultural respiratory hazard education series.* Revision of units 2 (Dust from decayed grains), 3 (Grain dusts), 4 (Livestock confinement dusts and gases), and 6 (Applied agricultural chemicals). American Lung Association.


Appendix A

Human Subjects Approval Emails and Survey Cover Letters
Hi Prosper,

The Office for Research Protections (ORP) has reviewed the above-referenced study and determined it to be exempt from IRB review. You may begin your research. This study qualifies under the following category(ies):

**Category 2:** Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observations of public behavior unless: (i) information obtained is recorded in such a manner that human participants can be identified, directly or through identifiers linked to the participants; and (ii) any disclosure of the human participants’ responses outside the research could reasonably place the participants at risk of criminal or civil liability or be damaging to the participants’ financial standing, employability, or reputation. [45 CFR 46.101(b)(2)]

**PLEASE NOTE THE FOLLOWING:**
- Include your IRB number in any correspondence to the ORP.
- The principal investigator is responsible for determining and adhering to additional requirements established by any outside sponsors/funding sources.
- **Record Keeping**
  - The principal investigator is expected to maintain the original signed informed consent forms, if applicable, along with the research records for at least three (3) years after termination of the study.
  - This will be the only correspondence you will receive from our office regarding this modification determination. **MAINTAIN A COPY OF THIS EMAIL FOR YOUR RECORDS.**
- **Consent Document(s)**
  - The exempt consent form(s) will no longer be stamped with the approval/expiration dates.
  - The attached informed consent form(s) is the one that you are expected to use.
- **Follow-Up**
  - The Office for Research Protections will contact you in three (3) years to inquire if this study will be on-going.
  - If the study is completed within the three year period, the principal investigator may complete and submit a Project Close-Out Report. ([http://www.research.psu.edu/orp/areas/humans/applications/closeout.rtf](http://www.research.psu.edu/orp/areas/humans/applications/closeout.rtf))
- **Revisions/Modifications**
  - Any changes or modifications to the study must be submitted to the Office for Research Protections on the Exempt Modification Request Form available on our website: [http://www.research.psu.edu/orp/areas/humans/applications/exemptmod.rtf](http://www.research.psu.edu/orp/areas/humans/applications/exemptmod.rtf)

Please do not hesitate to contact me if you have any questions or concerns.

Thank you,

Jodi

Jodi L. Mathieu, BS, CIP
Research Compliance Coordinator
Office for Research Protections
The Pennsylvania State University
201 Kern Graduate Building
University Park, PA 16802
Phone: (814) 865-1775
Fax: (814) 863-8699
[http://www.research.psu.edu/orp/](http://www.research.psu.edu/orp/)

Part of this e-mail is in application/msword format.

#23306 - Doamekpor (5-31-06).doc
Hi Prosper,

The Office for Research Protections (ORP) has reviewed the modification for the above referenced study. This request does not change the exemption status and this study continues to be exempt from IRB review. You may continue with your research.

**MODIFICATION REVIEW CATEGORY:**

Category 2: Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observations of public behavior unless: (i) information obtained is recorded in such a manner that human participants can be identified, directly or through identifiers linked to the participants; and (ii) any disclosure of the human participants' responses outside the research could reasonably place the participants at risk of criminal or civil liability or be damaging to the participants' financial standing, employability, or reputation. [45 CFR 46.101(b)(2)]

**COMMENT:** Approval of the November 20, 2006 email has been granted.

Please note the following:

- Include your IRB number in any correspondence to the ORP.
- The principal investigator is responsible for determining and adhering to additional requirements established by any outside sponsors/funding sources.
- **Record Keeping**
  - The principal investigator is expected to maintain the original signed informed consent forms, if applicable, along with the research records for at least three (3) years after termination of the study.
  - This will be the only correspondence you will receive from our office regarding this modification determination.
    - **MAINTAIN A COPY OF THIS EMAIL FOR YOUR RECORDS.**
- **Consent Document(s)**
  - The exempt consent form(s) will no longer be stamped with the approval/expiration dates.
  - The most recent consent form(s) that you sent in for review is the one that you are expected to use.
- **Follow-Up**
  - The Office for Research Protections will contact you in three (3) years to inquire if this study will be on-going.
  - If the study is completed within the three year period, the principal investigator may complete and submit a Project Close-Out Report. ([http://www.research.psu.edu/orp/areas/humans/applications/closeout.rtf](http://www.research.psu.edu/orp/areas/humans/applications/closeout.rtf))
- **Revisions/Modifications**
  - Any changes or modifications to the study must be submitted to the Office for Research Protections on the **Modification Request Form - Exemption available on our website:** [http://www.research.psu.edu/orp/areas/humans/applications/exemptmod.rtf](http://www.research.psu.edu/orp/areas/humans/applications/exemptmod.rtf)
  - Modifications will not be accepted unless the Modification Request Form is included with the submission.

Please do not hesitate to contact me if you have any questions or concerns.

Thank you,
Jodi
Jodi L. Mathieu, BS, CIP
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Fax: 814-863-8699
[http://www.research.psu.edu/orp/](http://www.research.psu.edu/orp/)

Correspondence with College Human Resource Personnel
I have reviewed the survey you provided that you wish to send to college farm workers regarding the Prevention of Respiratory Diseases in Production Agriculture.

First, I need you to verify for me that this has been reviewed and approved by the Human Subjects office. When written confirmation of that approval is received, I will proceed with processing the request through the Employee Relations Division. Since some employees you wish to survey are technical service employees we want to ensure compliance with the Union/University Teamsters Agreement and give the Union and the Employee Relations Division a heads up. I will also discuss this request with the unit leaders and Environmental Health and Safety.

This office will assist you in the distribution the survey for your thesis research once all clearances have been received. I will wait to hear from you.

Kim
December 11, 2006

Dear __________

Over the years, studies have shown that respiratory illnesses are rising among farm workers and their families. We worry about the implications this might have on the lives and farm businesses of people engaged in agriculture. We are therefore exploring ways to minimize the incidence of respiratory hazards in farming.

To aid us in providing safety education programs for Pennsylvanians, we are conducting a study: “Prevention of Respiratory Diseases in Production Agriculture” to gather information about respiratory hazards among farmers in Pennsylvania.

As a resident of Pennsylvania, you are one of a small number of people who are being asked to give their opinion about the current situation. If you agree to participate, it should take you approximately 20-25 minutes to complete the questionnaire. You must be at least 18 years old to participate in this study. As an adult, the completion and return of the enclosed questionnaire will be considered your implied informed consent. In order for the results of this study to truly represent the current situation in your area of operation, it is important that you complete the questionnaire and return it in the enclosed return-addressed envelope provided by December 22, 2006.

Your participation in this study is voluntary, and you may decline participation at any time. However, when you decide to participate we would appreciate frank and honest responses from you. You can choose not to answer certain questions you feel uncomfortable answering. You are assured of complete confidentiality. The survey has a code number for mailing purposes only. This code will be used to follow-up individuals who do not return the questionnaire. No individual responses will be reported. A summary of the results will be mailed to you when the study is completed.

If you have questions/concerns about this survey, please contact me or any of the undersigned at the telephone number or email address provided.

Thank you very much for your help in this important endeavor

Sincerely,

Prosper Kwesi Doamekpor
Graduate Research Assistant
434 Agricultural Administration Building
The Penn State University
University Park, PA 16802
Phone: 814-865-6551
Email: pkd117@psu.edu

Connie D. Baggett
Associate Professor
319 Agricultural Administration Building
The Penn State University
University Park, PA 16802
Phone: 814-863-7415
Email: bbc@psu.edu
January 11, 2007

Dear __________

Three weeks ago, a questionnaire was mailed to you about the study, “Prevention of Respiratory Diseases in Production Agriculture (and related areas),” we are conducting to collect your views about the prevention of respiratory diseases of people working in production agriculture. We have not yet received your completed questionnaire. The study is very important to all workers in the agricultural industry. It will help us in designing a respiratory education program for agricultural workers in your area of operation. Hence, your participation is urgently needed.

If you need a replacement questionnaire in case the first one was misplaced or you did not receive it, please contact us immediately so we can send you a copy. We understand your concerns about time, the questionnaire will take approximately 20-25 minutes to complete. So, we encourage you to complete the questionnaire we sent you and return it in the return-addressed, envelope no later than January 26, 2007.

Thank you for your participation and please feel free to call or send an e-mail using the information below if you have questions about the questionnaire.

Sincerely,

Prosper Kwesi Doamekpors
Graduate Research Assistant
434 Agricultural Administration Building
The Penn State University
University Park, PA 16802
Phone: 814-865-6551
Email: pkd117@psu.edu

Connie D. Baggett
Associate Professor
319 Agricultural Administration Building
The Penn State University
University Park, PA 16802
Phone: 814-863-7415
Email: bbc@psu.edu
January 30, 2007

Dear ___________

Two weeks ago, a questionnaire was mailed to you about the study, “Prevention of Respiratory Diseases in Production Agriculture (and related areas),” we are conducting to collect your views about the prevention of respiratory diseases of people working in production agriculture. We have not yet received your completed questionnaire. The study is very important to all workers in the agricultural industry. It will help us in designing a respiratory education program for agricultural workers in your area of operation. Hence, your participation is urgently needed.

I have enclosed a replacement questionnaire in case your questionnaire has been misplaced or you did not receive the first one. We understand your concerns about time, the questionnaire will take approximately 20-25 minutes to complete. So, we encourage you to complete the enclosed questionnaire as accurately as possible and return it in the return-addressed envelope no later than February 12, 2007.

Thank you for your participation and please feel free to call or send an e-mail using the information below if you have questions about the questionnaire.

Sincerely,

Prosper Kwesi Doamekpor
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434 Agricultural Administration Building
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Appendix B

Research Instrument (Questionnaire)
Prevention of Respiratory Diseases
In Production Agriculture

The Pennsylvania State University
Department of Agricultural & Extension Education
323Agricultural Administration Building
University Park, PA 16803
SECTION A: RESPIRATOR USE BELIEFS

Please complete the following section even if you DO NOT currently use a respirator of any type. We would like you to express your feelings and beliefs regarding the following statements pertaining to respirator or dust mask use in confined animal housing or facilities.

For the scales that follow, please place a check on the spaces that best reflects the way you feel about the statement.

Example: I think the chances of having cold weather this year in Pennsylvania is

Likely ____:____:____:____:____:____:___ Unlikely

Extremely quite slightly neither slightly quite extremely

CONCEPT: Your beliefs about wearing a respirator/dust mask when in confined animal housing or building for more than fifteen (15) minutes for the next six months.

1. Do you use a respirator/dust mask when working in confined animal housing or confined space on this farm/facility?
   ☐ No
   ☐ Yes
   If yes, how often did you wear a respirator/dust mask every time you were in confined housing or building for more than fifteen (15) minutes during the last 12 months?
   Never ____:____:____:____:____:____:_____ Always

2. My chances of developing respiratory diseases if I should be exposed to respiratory hazards while working in confined animal housing/facility is
   Low ____:____:____:____:____:____:_____ High
   Extremely quite slightly neither slightly quite extremely

3. My knowledge about the causes of respiratory diseases will influence me to use a respirator/dust mask while working in a confined animal housing/facility.
   Unlikely ____:____:____:____:____:____:_____ Likely
   Extremely quite slightly neither slightly quite extremely

4. The difficulty I will have in breathing when I wear a respirator/dust mask will prevent me from wearing one every time I am in a confined animal housing/facility.
   Unlikely ____:____:____:____:____:____:_____ Likely
   Extremely quite slightly neither slightly quite extremely

5. If I wanted to I could wear a respirator/dust mask while in a confined animal housing/ facility for more than fifteen (15) minutes.
   Unlikely ____:____:____:____:____:____:_____ Likely
   Extremely quite slightly neither slightly quite extremely

6. For me to wear a respirator or dust mask while working in a confined animal building/facility for more than fifteen (15) minutes would be
   Difficult ____:____:____:____:____:____:_____ Easy
   Extremely quite slightly neither slightly quite extremely

7. If you had a serious exposure to respiratory hazards while working in a confined animal housing/ building without using respiratory protection and you became ill, to what extent do you think it would affect your….
   d. Mental well-being? Very little ____:____:____:____:____ Very much.
8. To what extent are you capable of wearing a respirator/dust mask when you are in confined animal housings/facilities?
   Not at all capable ____:____:____:____:____:____:____ Capable to a great extent.

9. In your opinion does the regular use of respirators/dust masks in confined animal housings/facilities reduce potential lung damage?
   Not at all ____:____:____:____:____:____:____ Very much

10. How much control do you have over wearing a respirator/dust mask when you are working in confined animal housing/facility?
    Absolutely no control _____: _____:_____:_____:_____:_____:_____ Complete control

---

**To what extent would you disagree or agree to the following statements: (please check your response)**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Tend to disagree</th>
<th>No opinion</th>
<th>Tend to agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>11. If I get exposed to respiratory hazards while working in a confined animal housing without using respiratory protection, I would likely suffer lung damage.</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>12. The inconvenience of taking time to put on and take off a respirator/dust mask will prevent me from wearing one.</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>13. Not having a respirator/dust mask near confined animal housings/facilities when needed will prevent me from wearing one.</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>14. The following people who are important to me think I should wear a respirator/dust mask every time I am in confined animal housing/facility:</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>A. Spouse</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>B. Health professional</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>C. Environmental health and safety specialist</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>D. College safety personnel</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>15. Generally speaking, I want to do what the following people who are important to me think I should do with regards to wearing a respirator/dust mask:</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
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<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>A. Spouse</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
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<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>B. Health professional</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
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<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>C. Environmental health and safety specialist</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
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<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>D. College safety personnel</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
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<td>☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
</tbody>
</table>
16. To what extent do management personnel at your workplace stress the value of wearing a respirator/dust mask?

17. How would you describe your use of respirators/dust masks? (Please select only one)
   - I do not use respirators and I am not thinking about using any.
   - I do not use respirators but I am thinking of using them.
   - I use respirators but not on a regular basis.
   - I use respirators but have only begun to do so within the last six months.
   - I use respirators regularly and have done so for longer than six months.

18. What jobs/tasks do you perform on the farm? (Please check all that apply)
   - Working in the fields
   - Handling hay
   - Working in silos
   - Uncapping silos
   - Feeding or working with feedstuffs
   - Handling manure
   - Working on corn silage
   - Cleaning grain bins
   - Working around fish meal
   - Applying agricultural chemicals (fertilizers and/or pesticides e.g., herbicides, insecticides, rodenticides, fungicides, etc)
   - Working with paints or solvents
   - Other (please specify) ____________________________

19. How many times per week do you estimate working in confined animal housing or confined space while performing your assigned duties? ___________

20. How many hours per week do you estimate spending in confined animal housing/facility or confined space while you are performing your assigned duties? ____________________________

21. Which of the following type(s) of respiratory protection do you use? (Please check all that apply).
   - Single strap dust mask
   - Two strap dust mask – with or without exhale valve, will have the number “TC-21C-(various three-digit numbers)” and the words dust/mist on the straps or filters or exhale valve, if equipped.
   - Half face Cartridge respirator with or without chemical cartridges but with pre-filter in place, and has “TC-23C (various three digits numbers)”on some part of the body of the respirator. It may have an optional holder for using only the dust filter.
   - Power Air-Purifying with helmet respirator – helmet contains a battery powered fan that pulls air through a dust/mist filter, normally located in the top of the helmet and circulates the air over the face. This will have numbers “TC-23C-(various three-digit numbers)”on filters and/or on some part of the helmet.
   - Other (please specify) ____________________________
SECTION B: PRECAUTIONS AGAINST RESPIRATORY HAZARDS

An important part of this study is to learn how you feel about your personal protection and what preventive procedures you follow. Please indicate the extent to which you disagree or agree with the following statements by checking [✓] the box that represents your response.

<table>
<thead>
<tr>
<th>I. Influence on your Personal Protection</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I need better instruction to properly wear a respirator/dust mask during farm work.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The work/job I perform generally requires using a respirator/dust mask.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is a part of work policy to wear a respirator/dust mask against respiratory hazards.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>There are times I should wear a respirators/dust mask but I don’t.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

To what extent have you taken precautionary measures against respiratory hazards by performing the recommended activities listed below? Please check [✓] the box that represents your response on how frequently you have taken precautions to prevent respiratory disease exposure during the past 12 months.

<table>
<thead>
<tr>
<th>II. Preventive Procedures Followed</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limit exposures to respiratory contaminants by restricting re-entry into sprayed fields or areas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operate within a controlled environment whenever possible (e.g. cab, control room, etc).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use mechanical controls to remove air contaminants (e.g. fans, exhaust blowers, filters, etc).</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximize ventilation to reduce dust levels in working areas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Move work outside whenever possible.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limit time of exposures to respiratory contaminants by changing work areas when the need arises.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avoid dusty work in confined areas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wear personal protective equipment when doing jobs that present a risk.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SECTION C: EDUCATION AND MONITORING OF AGRICULTURAL SAFETY AND HEALTH

This section seeks information about your experience with agricultural safety and health training during the past 12 months. Place a check [✓] in the appropriate box.

1. Have you received training in the prevention of farm-related occupational illnesses due to pesticide poisoning?
   - [ ] No
   - [✓] Yes

2. Have you received training in the prevention of farm-related occupational diseases other than from pesticide poisoning (for example, respiratory hazards)?
   - [ ] No
   - [✓] Yes

3. Please indicate the sources from which you have received occupational illness training or information (Select all that apply).
   - [ ] Supervisor
   - [ ] College safety personnel
   - [ ] Environmental health and safety specialist
   - [ ] Other sources (please specify) ______________________________________________

4. Are you aware of any evaluation or monitoring of noise, fumes, dusts, gases, mists, or vapors that has been done in any of your work areas?
   - [ ] No
   - [✓] Yes
   **If you responded yes, identify what was evaluated or monitored? _______________________
   When did this occur? __________________________________________________________

5. Have there been any substitutions of chemicals or changes in equipment or processes in the past 12 months to protect you and other people on this farm/facility?
   - [ ] No
   - [✓] Yes, (please describe) ______________________________________________________
   - [ ] Don’t know.

6. Are you aware of the Occupational Safety and Health Administration (OSHA) regulation regarding respiratory protection?
   - [ ] No
   - [✓] Yes

7. Have you received any training in the past 12 months to meet OSHA standards for respiratory protection?
   - [ ] No
   - [✓] Yes
The information below requires your opinion about how important and relevant it is to include the stated topics in a respiratory safety education program.

Please check [✓] the box that represents your choice for importance and relevance of including topics listed on the left column in a respiratory safety program.

<table>
<thead>
<tr>
<th>Topics for a respiratory protection program (rate the importance and relevance of the topics listed)</th>
<th>Importance</th>
<th>Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory diseases related to farming</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge about types of respiratory hazards relative to farming activities.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symptoms of respiratory hazards.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protecting lungs from farm dust.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other topic(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering practices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practices to reduce risks of respiratory hazards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm gases prevalent in confined environments.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceptable/permissible gases levels in confined environments.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work practices or habits to minimize respiratory disease exposure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other topic(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pesticide education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Types, causes and prevention of pesticide exposure.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safe handling chemicals (e.g. disinfectants, fumigants).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other topic(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agricultural respirators and how to use them</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Types of respirators use in agriculture.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>What to look for in respirators.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How respirators work.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other topic(s)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SECTION E: INFORMATION ABOUT YOU

Finally, we assure you that all information provided will be treated with confidence. Results will be presented in such a way that your identity cannot be connected with the information you provide. You are not obliged to answer any question that you feel uncomfortable answering.

1. Gender: □ Male
   □ Female

2. Age: _____ years

3. Check your current marital status: (Please check one)
   □ Married
   □ Divorced
   □ Widowed
   □ Separated
   □ Single, never married

4. How many years have you worked on a farm since the age of 16? _______ years

5. What best describes your position on this farm in the past 12 months? (Please check one)
   □ Farm worker (full time)
   □ Farm worker (part time)
   □ Farm supervisor
   □ Farm administrator (including book-keeping, record-keeping)
   □ Student working full time
   □ Student working part time
   □ Other (Please specify) ____________________________________________

6. In which farm department do you currently work? _____________________________________

Thank you for completing this questionnaire.

Please return the completed questionnaire in the enclosed envelope and mail to the return address below:

Department of Agricultural & Extension Education
323 Agricultural Administration Building
The Pennsylvania State University
University Park, PA 16803

Code # ______
Appendix C

Program Evaluation Instrument
Respiratory Safety Program Evaluation Form

Your views on the information received in today’s presentation are extremely important. Please take a few minutes to tell us about your experience to help us improve future programs (check the response that applies to you).

1. Please rate the following aspects of the program?

**Content:**

<table>
<thead>
<tr>
<th></th>
<th>Very Poor</th>
<th>Poor</th>
<th>Acceptable</th>
<th>Good</th>
<th>Very Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Information presented</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>b. Accuracy of information</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>c. Information is easy to understand</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>d. Completeness of information</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>e. Timeliness of information received to be useful</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>f. Value of information in making decision to your own situation</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>g. Relevance of the examples used to your situation</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

**Quality of:**

<table>
<thead>
<tr>
<th></th>
<th>Very Poor</th>
<th>Poor</th>
<th>Acceptable</th>
<th>Good</th>
<th>Very Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>h. Visual aids</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>i. Handouts</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

**Presenter(s):**

<table>
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<tr>
<th></th>
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<th>Poor</th>
<th>Acceptable</th>
<th>Good</th>
<th>Very Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>j. Knowledge of subject matter</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>k. Speaking / presentation skills</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>l. Organization / preparedness</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>m. Response to questions from participants</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

**Facilities:**

<table>
<thead>
<tr>
<th></th>
<th>Very Poor</th>
<th>Poor</th>
<th>Acceptable</th>
<th>Good</th>
<th>Very Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>n. Physical setting’s contribution to ease of listening and participation</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

2. What did you like most about this program?

3. What did you like least about this program?

4. Would additional information in this subject area be useful to you?
   O Yes, I would like more information on:
   ______________________________________________________________
   ______________________________________________________________
   ______________________________________________________________
   O No, I have adequate information

5. Please rate the overall quality of the program?
   O Poor   O Fair   O Good   O Very good   O Excellent

*Please continue on the other side*
6. Do you plan to take actions or make changes based on the information from this program? (Check one)  
O Yes  O No  O Not sure

If “no” or “not sure,” which of the following best describes your reason? (Select one only)
O Information was not applicable or relevant to my situation
O Information was relevant to my situation but taking no action is the best or most appropriate decision at this time
O Need more information (or research further) before making decision on action or changes
O Just wanted the information – had no particular plans to implement
O Other (please specify) __________________________________________________________

7. Do you anticipate benefiting (economically) as a direct result of what you learned from this program?  
O Yes  O No

8. In the past 12 months, how many other related safety programs have you participated in? _______
If none (0), was this the first time as a participant in an educational safety program?  
O Yes  O No

9. Would you recommend this particular program to others?  
O Yes  O No

10. For each of the topics listed below mark one number in the left column that best describes your awareness/knowledge BEFORE participating in today’s program; and then mark the ONE number in the right column that best describes your awareness/knowledge AFTER the program.

1=Not at all aware; 2=very little awareness; 3=somewhat aware; 4=Aware; 5=very much aware

<table>
<thead>
<tr>
<th>Topics covered</th>
<th>Awareness/Knowledge BEFORE Program</th>
<th>Awareness/Knowledge AFTER Program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1  2  3  4  5</td>
<td>1  2  3  4  5</td>
</tr>
<tr>
<td>Respiratory hazards on the farm</td>
<td>O O O O O</td>
<td>O O O O O</td>
</tr>
<tr>
<td>Types of respiratory diseases</td>
<td>O O O O O</td>
<td>O O O O O</td>
</tr>
<tr>
<td>Symptoms of respiratory diseases</td>
<td>O O O O O</td>
<td>O O O O O</td>
</tr>
<tr>
<td>Practices to reduce the risks of respiratory hazards</td>
<td>O O O O O</td>
<td>O O O O O</td>
</tr>
<tr>
<td>Work behavior to minimize respiratory disease exposure</td>
<td>O O O O O</td>
<td>O O O O O</td>
</tr>
<tr>
<td>Gases prevalent in confined environment</td>
<td>O O O O O</td>
<td>O O O O O</td>
</tr>
</tbody>
</table>

11. In the spaces provided below, list any TWO (2) important pieces of information you have learned from this program, and indicate if you have already adopted it or intend to adopt it, or not applicable to your situation.

<table>
<thead>
<tr>
<th>Important information learned (write the information below)</th>
<th>Intention to use/adopt information learned</th>
<th>Already adopted</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Definitely will not</td>
<td>Probably will not</td>
<td>Undecided</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

12. Any additional comments: _____________________________________________

THANK YOU!
Appendix D

Program Logic Model
## Logic Model for Respiratory Safety Program

### Problem/Opportunity

A primary chronic health condition affecting farmers is respiratory disease. This results from the inhalation of hazardous chemicals such as fumigants, pesticides and airborne contaminants like dust. The mostly affected group is in the confinement livestock production. Other agricultural worker could be at risk if protective measures are not followed.

### Resources

<table>
<thead>
<tr>
<th>Funding Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSHA and NIOSH data base</td>
</tr>
<tr>
<td>CDC surveillance data on respiratory diseases</td>
</tr>
</tbody>
</table>

### Program Staff

<table>
<thead>
<tr>
<th>Program Staff</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extension Educators and safety specialists</td>
<td>will meet and discuss curriculum for training.</td>
</tr>
<tr>
<td>Farm supervisors</td>
<td>will provide information about respiratory hazards from pesticide education, reported cases of illness.</td>
</tr>
<tr>
<td>Volunteers</td>
<td>will prepare program manual and modules on respiratory diseases for participating groups.</td>
</tr>
<tr>
<td>Time invested</td>
<td>will test program with selected farm supervisors.</td>
</tr>
<tr>
<td>Advertise program</td>
<td>will participate in program activities.</td>
</tr>
</tbody>
</table>

### Immediate Impacts

<table>
<thead>
<tr>
<th>KASI</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm workers will:</td>
<td>Take safety precautions when using or working with fumigants/chemicals</td>
</tr>
<tr>
<td>Farm workers will:</td>
<td>Use the information from Extension to safeguard future working plans in their farm operation.</td>
</tr>
</tbody>
</table>

### Intermediate Impacts

<table>
<thead>
<tr>
<th>KASI</th>
<th>Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm workers will:</td>
<td>Adopt the correct practices learned through seminar.</td>
</tr>
<tr>
<td>Participants will:</td>
<td>Administer the use of the appropriate respirators when working in an unsafe environment.</td>
</tr>
</tbody>
</table>

### Extended Impacts

| Farm workers will: | Be able to continue in production agriculture with reduced risk of respiratory diseases and less expenses on health related issues. |
| Farm workers will: | Reduce rates of reported cases of respiratory diseases from surveillance data. |

### Evaluation

<table>
<thead>
<tr>
<th>Data Sources and Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surveillance data on respiratory hazards from pesticide education, reported cases of illness.</td>
</tr>
<tr>
<td>Knowledge test scores of participants demonstrating increased</td>
</tr>
<tr>
<td>No. of participants intending to adopt recommendations: % adopting what was learned.</td>
</tr>
<tr>
<td>Documentation of annual training Program: % adopting practice</td>
</tr>
</tbody>
</table>

### Planning

| Farm workers will: | Be able to continue in production agriculture with reduced risk of respiratory diseases and less expenses on health related issues. |
| Farm workers will: | Reduce rates of reported cases of respiratory diseases from surveillance data. |

### External Influences

<table>
<thead>
<tr>
<th>On volunteers or coalition:</th>
</tr>
</thead>
<tbody>
<tr>
<td>On clients: willingness to work with agency partners, existing respiratory programs, willing of other staff to participant in the design and implementation of the program,</td>
</tr>
</tbody>
</table>

### Assumptions

Text assumptions of the logic in the program: by making IF THEN statements about components in the model. See if you agree and others agree with the assumption. If not, make changes.
Appendix E

Model Summaries for Backward and Stepwise Regressions
Table 4.9.1
Summary of Back Regression Results for Selecting Predictor Variables of Preventive Behavior

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>.918(i)</td>
<td>.843</td>
<td>.769</td>
<td>.29105</td>
</tr>
</tbody>
</table>

**ANOVA**

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>9.575</td>
<td>10</td>
<td>.958</td>
<td>11.304</td>
<td>.000</td>
</tr>
<tr>
<td>Residual</td>
<td>1.779</td>
<td>21</td>
<td>.085</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>11.354</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Regression Coefficients (a)**

<table>
<thead>
<tr>
<th>Model</th>
<th>Predictor Variables</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
<th>Correlations</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>(Constant)</td>
<td>3.077</td>
<td>.345</td>
<td>8.925</td>
<td>.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Previous training in farm-related occupational illnesses</td>
<td>.873</td>
<td>.221</td>
<td>.606</td>
<td>3.958</td>
<td>.001</td>
<td>.352</td>
</tr>
<tr>
<td></td>
<td>perceived vulnerability</td>
<td>.330</td>
<td>.068</td>
<td>.618</td>
<td>4.826</td>
<td>.000</td>
<td>.315</td>
</tr>
<tr>
<td></td>
<td>Perceived barrier belief</td>
<td>-.177</td>
<td>.050</td>
<td>-.376</td>
<td>-3.523</td>
<td>.002</td>
<td>-.283</td>
</tr>
<tr>
<td></td>
<td>Availability of respirators</td>
<td>-.167</td>
<td>.037</td>
<td>-.503</td>
<td>-4.553</td>
<td>.000</td>
<td>-.334</td>
</tr>
<tr>
<td></td>
<td>Organizational support</td>
<td>-.121</td>
<td>.047</td>
<td>-.300</td>
<td>-2.554</td>
<td>.018</td>
<td>.372</td>
</tr>
<tr>
<td></td>
<td>Subjective norm beliefs</td>
<td>-.014</td>
<td>.006</td>
<td>-.276</td>
<td>-2.390</td>
<td>.026</td>
<td>.245</td>
</tr>
<tr>
<td></td>
<td>Job requires respirator usage</td>
<td>-.565</td>
<td>.128</td>
<td>-.451</td>
<td>-4.415</td>
<td>.000</td>
<td>-.097</td>
</tr>
<tr>
<td></td>
<td>work policy stipulates</td>
<td>1.036</td>
<td>.220</td>
<td>.575</td>
<td>4.711</td>
<td>.000</td>
<td>.650</td>
</tr>
<tr>
<td></td>
<td>Job category #1</td>
<td>.294</td>
<td>.161</td>
<td>.222</td>
<td>1.823</td>
<td>.083</td>
<td>.121</td>
</tr>
<tr>
<td></td>
<td>Farm department belonged</td>
<td>-.665</td>
<td>.204</td>
<td>-.502</td>
<td>-3.267</td>
<td>.004</td>
<td>-.209</td>
</tr>
</tbody>
</table>

(a) Dependent Variable: Preventive behavior (mean) Predictors: (Constant), Availability of respirators, work policy stipulates, Perceived barrier belief, Job requires respirator usage, Organizational support, Farm department belonged, perceived vulnerability, subjective norm beliefs, Previous training received in the prevention of farm-related occupational illnesses, Job category #1 Dummy coding: Farm department belonged: 1 = non animal-related, 0 = animal-related. Previous training received: 1 = training, 0 = no previous training; Job category group: 1 = performed group one type job, 0 = does not perform group one job-type.
### Table 4.9.2

**Summary of Stepwise Regression for Variables Predicting Preventive Behavior (N=67)**

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>.650(a)</td>
<td>.423</td>
<td>.403</td>
<td>.46746</td>
</tr>
<tr>
<td>Step 2</td>
<td>.713(b)</td>
<td>.508</td>
<td>.474</td>
<td>.43887</td>
</tr>
<tr>
<td>Step 3</td>
<td>.759(c)</td>
<td>.576</td>
<td>.530</td>
<td>.41477</td>
</tr>
<tr>
<td>Step 4</td>
<td>.801(d)</td>
<td>.641</td>
<td>.588</td>
<td>.38848</td>
</tr>
</tbody>
</table>

**ANOVA Results**

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>Regression</td>
<td>4.798</td>
<td>1</td>
<td>4.798</td>
<td>21.958</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>6.556</td>
<td>30</td>
<td>.219</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>11.354</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>Regression</td>
<td>5.768</td>
<td>2</td>
<td>2.884</td>
<td>14.974</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>5.586</td>
<td>29</td>
<td>.193</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>11.354</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>Regression</td>
<td>6.537</td>
<td>3</td>
<td>2.179</td>
<td>12.666</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>4.817</td>
<td>28</td>
<td>.172</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>11.354</td>
<td>31</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>Regression</td>
<td>7.279</td>
<td>4</td>
<td>1.820</td>
<td>12.059</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>4.075</td>
<td>27</td>
<td>.151</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>11.354</td>
<td>31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Regression Coefficients**

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td>Zero-order</td>
</tr>
<tr>
<td>Step 1</td>
<td>(Constant)</td>
<td>2.773</td>
<td>.234</td>
<td>11.865</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>work policy stipulates</td>
<td>1.171</td>
<td>.250</td>
<td>.650</td>
<td>4.686</td>
</tr>
<tr>
<td>Step 2</td>
<td>(Constant)</td>
<td>3.211</td>
<td>.294</td>
<td>10.935</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>work policy stipulates</td>
<td>1.136</td>
<td>.235</td>
<td>.631</td>
<td>4.833</td>
</tr>
<tr>
<td></td>
<td>Availability of respirators</td>
<td>-.097</td>
<td>.043</td>
<td>-.293</td>
<td>-2.244</td>
</tr>
<tr>
<td>Step 3</td>
<td>(Constant)</td>
<td>3.175</td>
<td>.278</td>
<td>11.418</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>work policy stipulates</td>
<td>1.273</td>
<td>.231</td>
<td>.707</td>
<td>5.500</td>
</tr>
<tr>
<td></td>
<td>Availability of respirators</td>
<td>-.089</td>
<td>.041</td>
<td>-.269</td>
<td>-2.168</td>
</tr>
<tr>
<td></td>
<td>Job requires respirator usage</td>
<td>-.341</td>
<td>.161</td>
<td>-.272</td>
<td>-2.114</td>
</tr>
<tr>
<td>Step 4</td>
<td>(Constant)</td>
<td>1.767</td>
<td>.686</td>
<td>2.575</td>
<td>.016</td>
</tr>
<tr>
<td></td>
<td>work policy stipulates(^{a})</td>
<td>1.264</td>
<td>.217</td>
<td>.702</td>
<td>5.831</td>
</tr>
<tr>
<td></td>
<td>Availability of respirators(^{b})</td>
<td>-.097</td>
<td>.039</td>
<td>-.293</td>
<td>-2.515</td>
</tr>
<tr>
<td></td>
<td>Job requires respirator usage(^{c})</td>
<td>-.499</td>
<td>.167</td>
<td>-.398</td>
<td>-2.988</td>
</tr>
<tr>
<td></td>
<td>Perceived control belief(^{d})</td>
<td>.254</td>
<td>.115</td>
<td>.288</td>
<td>2.218</td>
</tr>
</tbody>
</table>

Dependent Variable: Preventive behavior (mean) computed 1 = never to 5 = always performed behavior.

\(^{a}\) Work policy stipulate respiratory use: dummy coded 1 = yes, 0 = no.

\(^{b}\) Availability of respirators: mean computed on a scale of 1 = strongly disagree to 7 = strongly agree.

\(^{c}\) Job requires respirator usage: dummy coded 1 = yes, 0 = no.

\(^{d}\) Perceived control belief: mean for construct computed on 1 = no control to 7 = absolute control.
Appendix F

Invitation letters, Program Agenda and Handouts
April 11, 2007

Dear ___________

You have been selected to participate in the Respiratory Safety Programs to be held at the Centre County/Penn State Visitor Center on Wednesday, April 25, 2007 from 9.30 - 11.45 AM. Only a select few are invited.

Based upon the responses we received from survey participants, we put together a respiratory safety seminar during which we will be presenting information to help you to be more knowledgeable about respiratory protection. We will also share data about diseases associated with exposure to dust, pesticides, and gases found in and around agricultural and related areas. You will also review two short video documentaries on respiratory hazards on the farm and related areas.

This seminar has been approved by Mr. Ray Pruss, the college safety officer, and we urge you to sign up to attend. Once you sign up, we will send you the detailed program for the session including parking instructions for the venue.

Thank you.

Prosper Kwesi Doamekpor
Graduate Research Assistant
434 Agricultural Administration Building
The Penn State University
University Park, PA 16802
Phone: 814-865-6551
Email: pkd117@psu.edu
April 11, 2007

Dear ___________

You are invited to attend the Respiratory Safety Program to be held at the Centre County/Penn State Visitor Center on Wednesday, April 25, 2007 from 9.30 - 11.45 AM.

This program is part of an on-going study to seek the views of Penn State farm workers about preventing respiratory diseases in agriculture and related areas. Based on the responses received from workers that were surveyed, we have put together this seminar during which we will present information to help participants (i.e. selected surveyed workers) to be more knowledgeable about respiratory protection. We will also share data about diseases associated with exposure to dust, pesticides, and gases found in and around agricultural and related areas. Participants will also review two short video documentaries on respiratory hazards on the farm and related areas.

Attached is the program agenda.

Please feel free to contact me if you have any questions.

Thank you.

Prosper Kwesi Doamekpor
Graduate Research Assistant
434 Agricultural Administration Building
The Penn State University
University Park, PA 16802
Phone: 814-865-6551
Email: pkd117@psu.edu
Prevention of Respiratory Diseases in Agriculture
Respiratory Safety Program
Wednesday, April 25, 2007
Centre County/ Penn State Visitor Center – Large Conference Room

9:30 a.m. Arrival and welcoming of participants
(Refreshments will be served)

9.45 a.m. Introduction of program organizers and research team

10.00 – 10.30 a.m. DVD/Video – Breathe Easy: Respiratory hazards on the farm
(Duration: 22 minutes)

10.30 – 11.00 a.m. DVD/Video – Respiratory Hazards on the Farm (educational series
seminar by Dr. Charles S. Pratt (M.D.) (Duration: 24 minutes)

11.00 – 11.15 a.m. Break

11.15 – 11.30 a.m. Presentation of survey findings

11.30 – 11.40 a.m. Questions, comments, evaluation of seminar

11.45 a.m. Departure
Alert! Who Me?  
Wear a Respirator?

You use guards to prevent power take-off accidents, you wear a hat to shield the sun, and heavy clothes protect you from cuts and scrapes. But what kind of protection are you giving your lungs?

Routine farm tasks are performed around dirt, grain dust, molds, pollen, animal dander, welding fumes and diesel exhaust. And every day, those particles enter your lungs.

You may not notice the effects now, but over time these conditions can lead to what has been called "farmer's lung," the farming equivalent of the miner's "black lung" disease.

The simplest way to prevent farmer's lung is to wear an air-purifying respirator whenever you work in dusty or vapor-filled conditions. You might notice that you get fewer colds, don't tire as easily, or no longer wheeze, cough or become congested after working in dusty places.

Respirators aren't just for farmers who have breathing problems. They're for farmers who don't want to get them.

Check out what a respirator can do for you. Call your local Extension office today.

Adapted for respiratory safety program
Respiratory Hazards in Agriculture

Farm Safety Association

Instructor:

The following script can be used to deliver a 15- minute training session to employees.

POINTS TO EMPHASIZE

• Minimize exposure to dust and spores.
• Minimize exposure to gases.
• Personal Protective Equipment.

Dust and mold spores are encountered in many agricultural activities, and are often associated with respiratory illnesses, such as Farmers Lung, Q Fever, Toxic Organic Dust Syndrome, and Extrinsic Allergic Alveolitis.

Engineering practices

The prevention of particle release and control of dust is achieved by providing leak proof ducts and enclosed conveyor systems for grains and feeds. Buildings should have local ventilation systems in areas frequented by workers where particulates become airborne. For field operations self-propelled equipment should have enclosed cabs provided with filtered air. Where crushers, grinders and mixers are used, the area should be enclosed to contain the airborne materials.

Work practices

There are several practices that can either help prevent the growth of mold spores or limit the damage they can cause. The following measures are recommended:

Harvested crops such as hay and grains should be dry when stored (14% moisture content) Hay with a high risk of spoilage should be stored in silage instead of being baled. Ventilate areas where bales are being opened and wear respiratory protection when doing so.

Sprinkling one liter of water onto the cut side of the bale immediately before opening or chopping it can reduce airborne molds and dusts. Anti-fungal agents may be applied to fresh material and hypochlorite solution may be used for grain. However a risk of chemical fume inhalation may be created.

Indoor humidity should be maintained below 80% to reduce airborne organisms. Rotating crops will help to decrease fungal growth.

Fungi and dust from grain and animal confinement can be eliminated by using pellet feed rather than dusty chopped feed, or by substituting silage for hay.

When cleaning use a wet process.

Use a fork to spread out open bales rather than doing it manually.

Moisten the top layer of silage before opening it.

In the fields, you can lower the speed of equipment to reduce the release of fine particles.

Organize equipment and work practices so that any prevailing wind can carry the dust away from your face.

Indoor dust minimizing practices include pressure washing with cold water, water with additives and sprinkling with agents such as vegetable oil. Animal feeding should be done just before leaving a room to limit worker exposure. Fast dumping of large amounts of material creates greater amounts of dust.
Gases

A variety of potentially toxic gases are produced during many routine agricultural operations. These gases are commonly produced in areas such as silos and manure pits.

**Nitrogen oxides** - (mainly in silos) loading and distributing the silage should be done by mechanical means if possible. Do not enter a silo until 2-3 weeks after filling, post warning signs, and run the blowers for at least 30 minutes before entering a filled silo. Workers entering a silo should wear an air supplied full face respirator and follow confined space entry procedures.

**Carbon monoxide** - ensure that equipment such as gas heaters, pressure washers and vehicles are functioning properly. When working indoors ensure the building is well ventilated, especially where internal combustion engines may be operating.

**Ammonia** - Ammonia concentration can be reduced in poultry barns by the use of peat for litter. Keep bedding dry to reduce Ammonia levels, low-residue flooring, such as wire mesh or narrow slats, keeps urine and faces from accumulating resulting in less ammonia evaporation and pulverization of feed and fecal material.

To reduce ammonia levels in livestock buildings, prevent air leakage through manure channels. Exhaust as much air as possible through the manure channels. Use tight fitting hatches, water traps or evacuation fans to eliminate air leakage.

To decrease hydrogen sulfide leaks, there should be a gas trap between the confinement building and outside storage, airflow should be directed towards the floor to keep dust and gases from entering the breathing zone of the worker.

Manure should not sit in the pit for more than three weeks. Do not enter manure pits during agitation.

If manure is beneath a slatted floor, plenty of water should be used to keep manure solids submerged and the gases in solution.

**Farm chemicals**

Pesticides, fertilizers, and sanitizers are common farm chemicals which produce harmful fumes.

Always follow label direction when handling these chemicals. Regularly maintain spraying equipment to avoid rupture/leaking valves crossing threading leaking valves and hose that may become disconnected. Spray booms should be on the back of the vehicle thus reducing the worker exposure to chemicals.

**Personal protective equipment.**

The selection of specific types of protective equipment depends on the hazard present and the amount of filtering necessary. There are two general types of air-purifying respirators: the mechanical filter and the chemical cartridge.

Chemical cartridges protect against certain gases and all but the most toxic vapors. Its primary function is to remove organic vapors. Chemical cartridges that work in conjunction with a specific mechanical filer should be used for protection during spray painting or pesticide application.

Do not use chemical cartridge filters when working with gases or vapors that cannot be effectively filtered out by the cartridge, regardless of concentration.

A mechanical filter respirator with toxic dust approval should be used to protect against grain dust and molds. It should be tightly sealed around the nose and mouth. Do not use a mechanical filter for protection from chemicals or toxic gases.

Powered air purifiers can be a mechanical filter, a chemical cartridge or both. They may be preferred for excessively high concentration of dust or pesticides, but they cannot be used in oxygen-limited environments. Gas masks are more effective than chemical cartridge respirators against high concentrations of toxic gases, but should not be used in oxygen-limited environments.

Air supplied respirators- two types of air supplied respirators are approved for use in oxygen deficient areas, such as manure pits, silos containing silo gas, air-tight silos or bins containing high-moisture grain. They are hose mask with blower and emergency air supply and the self-contained breathing apparatus.
These respirators all offer effective protection against toxic dust. The primary differences are the quality of fit, the length of time the protection will be provided and the cost.

Finally, let's take a moment to review some of the Do's and Don'ts of respiratory hazards.

<table>
<thead>
<tr>
<th>DO:</th>
<th>DON'T:</th>
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<tr>
<td>• Dry wet hay, grain or other crops.</td>
<td>• Enter a silo or manure pit without an air-supplied full face respirator.</td>
</tr>
<tr>
<td>• Use a wet process when cleaning.</td>
<td>• Use a mechanical filter for protection from chemicals or toxic gases.</td>
</tr>
<tr>
<td>• Control feed rates.</td>
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<tr>
<td>• Use chemical cartridges for toxic organic vapors.</td>
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NASD Review: 10/2003

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Rodents carry potentially lethal Hanta Virus

*Farm Safety Association*

The disease known as Hanta Virus Pulmonary Syndrome has been identified as a health risk to the general population. Danger of infection is specifically associated with the deer mouse. Other rodents may also be carriers.

Although the risk of infection is slight, the Hanta Virus is potentially lethal. Half of the people infected by the virus have died. At least one death has been attributed to the disease in Ontario. The victim contracted the virus after cleaning out a cottage that had been infested by mice.

Rodent nesting materials, burrows, droppings, and the surrounding environment present the greatest risk of infection. The danger is higher in an enclosed environment -- e.g. granaries, feed rooms, and other storage areas. Rodents may also nest over winter in farm equipment such as combines and balers.

Direct contact with rodents will increase the risk of infection. Disease transmission most commonly occurs when rodent droppings are disturbed and the resulting dust is inhaled.

**Symptoms**

The average time between contact with the virus and the onset of illness is two to three weeks.Unfortunately, the initial symptoms are non-specific. They include fever, muscle ache, cough, headache, nausea, and vomiting -- very much like the flu.

If you develop a fever or respiratory illness that is rapidly worsening and includes shortness of breath, seek immediate medical attention. Inform the doctor that you have been in contact with rodents, and suspect possible Hanta Virus infection.

**Prevention**

To minimize risk of Hanta Virus infection, rodent populations must be controlled.

- General cleanliness is very important.
- Get rid of trash, abandoned machinery, discarded tires, and other items that could serve as rodent nesting sites.
- Use commercial traps, rodenticides, or ultra-sonic devices.
- Seal all openings of more than a quarter-inch diameter. Use metal flashings at the base wooden or earthen structures. Gravel under structures helps prevent burrowing.
- Keep food and garbage in rodent-proof containers. Trash should be disposed of promptly.
- Cut grass, brush and dense shrubbery within 100 feet of buildings.

Even with the most fastidious control program, some contact with rodents and/or their droppings is inevitable on the farm. Infested facilities need to be cleaned up before entry and use. It is critically important to protect your respiratory system and skin when handling dead rodents, droppings, nesting materials, and other areas of contact.

Observe the following precautions:

- Any enclosed area should be aired out for at least 30 minutes before cleanup begins.
- Always wear rubber gloves when cleaning up rodent carcasses and droppings, or when handling traps.
- Wear a respirator that has a HEPA (P100) rating. Ordinary dust masks will not filter the virus!
- If there is evidence of a lot of rodent activity, wear disposable coveralls. Any exposed clothing should be washed separately from the regular family laundry. Handle clothing with gloves. Wash in hot water and detergent, and dry in a hot dryer.
- Before starting cleanup, thoroughly wet down the area with a 10 percent household bleach solution (3 tablespoons of bleach in one quart of water).
- Use only wet cleaning techniques, such as damp mopping. Avoid sweeping, vacuuming and other dry cleanup techniques.
• Double bag rodent carcasses and other solid materials in a 10 percent bleach solution. Dispose of the bagged material by burning or burial.
• After cleanup, disinfect the entire area with a 10 percent bleach solution. Allow the area to dry thoroughly before entry or use.
• All traps should be disinfected in a bleach solution.
• Before removing rubber gloves, wash them in a bleach solution, and then with soap and water. Wash your hands upon removal of the gloves.

Although the Hanta Virus is not particularly hardy, it is potentially lethal. All rodent-contaminated materials should be treated as infected. If you have any reason to suspect that you have been infected by Hanta Virus, seek immediate medical attention. Survival chances are enhanced by early treatment of the disease.

A Quick Guide to dealing with Hanta Virus is available from the Farm Safety Association’s Guelph office. For more information about this dangerous disease, contact your local public health office.

This Hanta Virus Guide, available from the Farm Safety Association, details safe cleanup procedures.

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NASD Review: 11/2003
Respiratory Diseases Related to Work on the Farm

*Nebraska Rural Health and Safety Coalition*

**CHRONIC BRONCHITIS**

Inflammation of the bronchial tubes of the lung leading to cough and production of phlegm. In order for this to be considered chronic bronchitis, it must be present for at least several months of the year. This is more common in farmers than persons who do not work on a farm. In the population as a whole, smoking is the main risk factor for this disorder.

**ACUTE BRONCHITIS**

Inflammation of the bronchial tubes that lasts for several days or weeks. This causes cough and mild chest tightness in some people. Heavy exposure to grain dust is one thing that causes this condition.

**ORGANIC DUST TOXIC SYNDROME**

This syndrome consists of fever, chills and a flu-like feeling which begins 4-6 hours after heavy exposure to organic dust. The most common causes include breathing large amounts of grain dust or being exposed to mold spores when uncapping a silo. Wearing a dust mask helps prevent this.

**FARMER'S LUNG**

This is an allergic reaction in the lung to spores from molds, to some bacteria that grow in spoiled hay or to poultry feathers (rarely). Symptoms include a fever, dry cough and severe fatigue which begin 4-6 hours after the exposure. This problem is uncommon but can cause severe disability if not recognized and treated.

**ASTHMA**

Spasm and inflammation of the bronchial tubes cause cough, wheezing, chest tightness and shortness of breath in asthma. A variety of exposures to dust and fumes can worsen asthma in farmers. Wearing a dust mask and regular use of medications can help prevent symptoms.

**IRRITATION OF THE NOSE AND SINUSES**

These problems are caused by gases such as ammonia (found in animal confinement units) as well as by grain dust. They can be made less severe by good ventilation and use of respiratory protective devices. Some people with nasal and eye symptoms have allergies. They should discuss possible use of medication for the allergy with their physician.

**TIPS ON MASKS**

- Make sure all workers have access to masks when needed.
- Discard disposable masks when they become soiled on the inside or become clogged.
- Disposable masks should have two straps for better fit.
- Disposable masks worn in dusty environments should be NIOSH approved for use in dusts and mists.
- Look for these kinds of respiratory protective devices in your local farm supply store and supply catalogs.
Two strap mask with exhalation valve

Half-face mask with replaceable cartridge

Powered air purifying respirator
Lungs Need Protection from Farm Dust

Denis Zeimet, Charles V. Schwab and Laura Miller
Iowa State University

Protective equipment is important when farmers work with pesticides and toxic products. Protective equipment is equally important when farmers work in dusty conditions common to most farms.

Exposure to grain dust, molds, pollen, animal dander, soil dust, welding fumes, and diesel exhaust can lead to serious respiratory problems. Although they are less toxic than some chemicals, dusts are suspended in the air and can easily enter the lungs and cause damage.

Dust in the lungs has both immediate and long-term effects. It can cause additional physical stress for the person, resulting in fatigue or shortness of breath. Long-term exposure to dust can be accompanied by congestion, coughing or wheezing, sensitivity to dust, and frequent respiratory infections such as colds, bronchitis, and pneumonia. Over time, exposure to dust can result in serious respiratory illnesses, such as farmer's lung, asthma, emphysema, chronic bronchitis, and other irreversible, incurable ailments.

The National Safety Council reported that 300 workers on large farms were incapacitated due to respiratory conditions in 1990, about one-third caused by dust.

To avoid immediate and long-term respiratory problems, farmers are encouraged to wear protective equipment, such as a respirator, whenever they work in dusty conditions. Respirators may be a good choice if workers are:

- congested or have breathing problems;
- generally bothered by dust, or
- concerned about the amount of foreign particles that get into the body.

This publication offers information about respirators used to protect lungs from farm dust. Chemicals such as pesticides, anhydrous ammonia, cleaning solvents, and disinfectants also require the use of protective equipment. Check pesticide applicator training manuals or discuss details with professionals.

HOW RESPIRATORS WORK

Respirators can be one of two types: those that purify existing air, and those that supply air from a tank or other source.

Air-supplied respirators, such as the self-contained breathing apparatus (SCBA) used by firefighters, rarely are used in farming activities. They are relatively expensive and wearers must be trained.

Many dusty conditions on the farm can be improved with the use of an air-purifying respirator. This device fits over the nose and mouth and uses a filter or cartridge to mechanically remove dust particles from the air as the wearer breathes. An air-purifying respirator provides protection from dust and mists.

WHAT TO LOOK FOR

There are many styles of respirators on today's market, however, not all are recommended for farming activities. Whether you're selecting a new respirator or evaluating an existing respirator, always consider several factors.

Testing and approval: All respirators used in farming activities should be approved by the National Institute of Occupational Safety and Health (NIOSH). NIOSH-approved respirators have been tested and meet special federal standards.

Proper use: Many problems result from using an inappropriate respirator. For example, dust masks will not reduce
chemical vapors. A respirator approved for use with chemicals may not filter dust.

Always use a respirator appropriate for the task. The specific contaminant for which the respirator is approved will be written on the cartridge filter or instructions with the respirator.

Proper rating: As part of the testing process, a respirator is assigned a "protection factor," or PF rating, which indicates how well the respirator can perform its job. For farming activities, always use a respirator with a PF rating of 10 or above.

Proper size and fit: The respirator must form a good seal with the wearer's face so that the respirator can function properly. Dust that slips through a poor seal goes directly to the lungs.

Respirators are available in various sizes and designs to fit most faces. Eyeglasses, clothing, and facial hair such as beards or sideburns, can interfere with the seal. All respirators must be "fit tested" by safety professionals, using smoke, saccharin, or banana oil while the device is being worn.

Cost: Respirators can be either disposable or non-disposable. Disposable respirators are inexpensive and can be discarded when dirty or when the job is finished, but they can be relatively expensive if protection is required on a regular basis. A better choice is a durable respirator that can be washed and stored after each use.

The wearer's physical condition: The wearer of an air-purifying respirator must be in good physical condition. Since air is drawn through a filtering mechanism, breathing becomes more difficult, and can cause stress for people with medical problems, such as heart conditions or respiratory ailments. Always get a physician's approval to wear a respirator.

LIMITATIONS OF RESPIRATORS
No respirator can solve all air quality problems. Wearing a respirator incorrectly is as dangerous as not wearing a respirator at all. People have a false sense of security when wearing a faulty respirator or one that is inappropriate for the task.

Respirators should not be worn when concentrations of dust are in the explosive range. In this situation, you may protect your lungs from dust but you're exposing yourself to other dangers. A general rule is that if it's too dusty to see your hand at arm's length, the environment is dusty enough to be explosive.

Another dangerous situation occurs when air-purifying respirators are used in toxic environments. Since air-purifying respirators do not provide oxygen, the air in the working environment must have at least 19.5 percent oxygen. Death can occur in a limited oxygen environment.

Respirators that filter dust cannot protect wearers in toxic chemical environments, such as manure pits, silos, or sludge tanks. Wearing a respirator equipped with a dust filter in these conditions can be fatal.

The use of respirators in day-to-day farm operations may be a new practice for many operators. However, respirators can reduce exposure to farm dust and may prevent serious respiratory problems.

RESPIRATORY SAFETY
How Much Do You Know?
1. How many farm workers in the United States suffer from serious respiratory illnesses each year?
   a. less than 30
   b. at least 300
   c. more than 1,000
2. People who work in agriculture develop immunities to dusty conditions over time. True or false?
   Wearing a respirator, even if it does not fit correctly, is better than wearing none at all. True or false?
3. Most people cannot tell when a respirator fits properly. True or false?
4. Most respirators used in farming activities supply fresh oxygen. True or false?
5. A respirator with a chemical cartridge is appropriate to use when
   a. cultivating in the wind.
   b. removing the chemical for which it has been rated.
   c. cleaning a hog confinement building.
What Can You Do?

You can reduce your exposure to farm dust with these guidelines:

- Make a list of jobs where you might need a respirator.
- Determine proper respirator for the job. Check the label or with a professional if you have questions.
- Compare the cost of disposable and non-disposable respirators.
- Ask a professional to fit-test your respirator.
- Routinely clean and inspect all non-disposable respirators. Discard disposable ones when dirty.

FOR MORE INFORMATION

Respirators are available from the manufacturer, through mail-order catalogs, local implement dealers, or local farm supply stores. For more information, contact your local extension office, insurance representative, physician, or hospital clinic.

These extension publications also may be helpful:

* Take a deep breath and think lung protection, Pm-1334d. 1988.


Answers to quiz: 1-b; 2-False; 3-False; 4-True; 5-False; 6-b.
Using and Selecting Respirators

Dawna L. Cyr and Steven B. Johnson
University of Maine

Respirators protect the lungs from many airborne health hazards on the farm, ranging from deadly silo and manure gases to dust, molds and chemicals. Frequent exposure to airborne health hazards can create long-term health threats. Respirators should be selected based on the air hazards that exist on the particular job. One type of respirator purifies the air breathed and another provides fresh air from a tank strapped to the individual. Farmers working in the areas that may become toxic, oxygen-deficient or smoke-filled need to wear self-contained, oxygen-supplied respirators. Every respirator must be purchased to fit the person wearing it. Test your respirator before entering a hazardous area. If it fails, leave the work area immediately. Even with respirator equipment, keep your time in a hostile atmosphere as short as possible. (See fact sheet Care of Respirators.)

- Select the right respirator for the job.
- Insure a proper fit for the respirator.
- Keep respirators clean and replace them when needed.

Requirements for the Use of Respirators
Anyone going to work wearing a respirator must first have a medical check-up. If people have breathing problems such as asthma, a heart condition, severely high blood pressure, or are extremely sensitive to heat, they may not be able to work wearing a respirator.

Respirators must be initially fit-tested. The test must be repeated at least once a year, and records must be kept of the tests and respirator assignments.

Many things can affect how a respirator fits. Some people have physical features that make it difficult to get a proper fit. Scars, hollow temples, excessively protruding cheekbones, deep creases, or missing teeth can all prevent many kinds of face pieces from sealing properly. Try different sizes of respirators to get the best possible fit. A good fit will not be achieved if anything comes between the skin of the face and the seal of the face piece. This includes hair, a beard, eye glasses, a hat, welding helmet and goggles.

Any time a person experiences a facial physical change, another respirator fit test should be done. Such changes include weight loss or gain, having a tooth pulled or new dentures.

Types of Respirators
Dust masks are simple, low-cost versions of the filter respirators to be used in areas with nuisance dust and chaff. They are disposable and inexpensive. They provide good protection. Mechanical filter respirators provide respiratory protection against particulates such as dusts, mists or metal fumes. These respirators either trap particulates or neutralize or absorb gasses and vapors. They do not protect against both. Select the appropriate one for your job. A respirator with toxic dust approval should be used for protection against grain or wood dusts, and spores during silo filling. A fume-approved respirator should be worn when welding. Never rely on this type of respirator in oxygen-deficient areas because it does not supply oxygen.

Choosing the proper air-purifying respirator depends upon a proper face fit, filter efficiency and length of time worn. Workers with beards cannot use air purifying respirators because their facial hair does not allow for direct contact between the skin and respirator. Have air purifying respirators fitted by a professional, and follow the proper fitting procedures each time it is put on.
Air purifying respirators come in two-strap and adjustable strap models. Each has its own individual procedure for putting on and taking off. When putting on the two-strap respirator, prestretch the straps and cup the respirator in your hand with your fingertips at the metal strip. Place the respirator under your chin and over your nose and put on the top strap over your head, and then the lower strap. Using the fingertips of both hands, mold the metal nosepiece low on the bridge of the nose. When removing, take the lower strap off first, and then the top strap. The adjustable strap respirator is put on and fitted almost the same. The only difference is you put the bottom strap on first then the top strap, and then adjust the straps accordingly. To remove it, release the tension and remove the bottom strap and then the top.

If an air-purifying respirator becomes damaged in any way, it loses its effectiveness and should be discarded. This type of respirator is damaged if it is torn, if you can smell or taste contaminates, irritation occurs, breathing becomes difficult when wearing it, or dizziness or other distress occurs. Should any of these symptoms arise when wearing the respirator, leave the area immediately, and discard the respirator.

Chemical cartridge respirators and gas masks are not effective when oxygen is lacking. These can only protect against contaminants that have good warning properties; specifically, those which can be smelled at concentrations low enough not to be harmful. Don't use them in silos or manure pits where there might be a lack of oxygen. Make sure that they are National institute for Occupational Safety and Health (NIOSH) approved respirators.

Supplied-air respirators are available in demand, pressure-demand and continuous-flow models. Make sure the supplied air is of breathable quality by buying from a reputable dealer and testing before use. This kind of equipment is limited use in agriculture, since the length of the hose line limits the mobility of the wearer. Do not wear supplied-air respirators in areas of oxygen deficiency or atmospheres immediately dangerous to life or health. The wearer cannot escape if the air supply is cut off or if something goes wrong with the respirator.

A self-contained breathing apparatus (SCBA) offers the best protection to agricultural workers entering oxygen-deficient areas or other atmospheres immediately dangerous to life. There are two basic types of SCBA: open circuit and closed circuit. The closed circuit design involves a rebreathing device and the open circuit SCBA expels the exhaled air into the atmosphere instead of recirculating it. SCBAs have the advantage of an independent supply of breathable air, but there are also disadvantages. They are heavy and bulky, can only be used for a short time and require extensive training.

**Jobs Requiring Respirators**

Several jobs around the farm pose respiratory hazards that can lead to permanent lung damage. The following is a list of jobs that require the use of a respirator of some kind.

- Working in heavy dust or chaff (haying, combining, picking corn, milling, welding, or tilling dusty fields)
- Handling moldy hay
- Applying fertilizer or lime, or other materials that raise heavy mineral dusts
- Handling and applying pesticides
- Fumigating
- Working in silos, high moisture grain storage, and other closed areas where there isn't enough oxygen to support life or when poison gases may be present
- Working in or around manure storage facilities where there are poison gases
- Spraying paint
- Using solvents or other chemicals with noxious or toxic vapors

*Working where known allergens are present if the worker suffers from allergies such as hay fever*
Introduction

Who Needs to Know About Respiratory Illnesses?

- those working in dusty fields or buildings
- those handling moldy hay
- those working in silos
- those feeding or working with feedstuffs
- those working in corn silage
- those uncapping silos
- those cleaning grain bins
- those exposed to bird droppings or feather, hair, or fur dust
- those exposed to fish meal

Farmers account for more than 30% of adults disabled by respiratory illness, yet a large percentage of farmers are nonsmokers. If you work in any one of these situations, then you need to be aware of Farmer's Lung as well as other respiratory hazards.

Farmer's Lung is only one of the respiratory hazards for farmers, but it is a serious one. The number of farmers affected has also been increasing in recent years. This results from a growing awareness among farmers and that they have been seeing their physicians more frequently. The larger size of silos accounts for much of the increase.

What is Farmer's Lung?

Farmer's Lung is a noninfectious allergic disease caused by inhaling dust from moldy hay, straw or grain. It is a disease because the body reacts to the invading contaminants (mold spores) which the body's immune system cannot counteract.

The lungs allow oxygen to enter the bloodstream and carbon dioxide to exit the bloodstream. They are the location for a vital process for good health; but they are also the quickest and most direct route for hazardous contaminants to enter the body and the bloodstream. The results from exposure to mold spores can be so debilitating that some farmers are even forced to leave the occupation completely.

What are These Mold Spores and Why are They so Dangerous?

Mold spores are tiny bacteria less than 4 microns in size -- so small that as many as 250,000 spores can fit on a pin head and a farmer can inhale as many as 750,000 of these spores per minute! They are produced by microorganisms which grow in moist hay and stored grain silage where the moisture content is high (30%) and the area is poorly ventilated. When farmers move or work with hay and silage materials in which mold spores have grown, the mold spores attach themselves to airborne dust particles. The farmer not only inhales dust particles which may not be extremely hazardous, but he also inhales mold spores which are a serious hazard. Heavy concentrations of mold spores appear as dry, white or grey powder or clouds.

The body has natural defense filtering systems (such as mucous lining, coughing and sneezing) against dusty air which helps remove some contaminants, BUT most contaminants overpower and pass through
these defenses. Mold spores not only bypass defenses because of their number, but also because they are so small. Very fine particles, like mold spores move into, accumulate, and settle into the lower lungs. There they produce toxins. Remember that the lungs transfer oxygen to the bloodstream, and most of the actual exchange of carbon dioxide and oxygen takes place in the lower lungs. Now the lungs become a roadway for toxic materials to travel through the bloodstream with the oxygen. The body's reaction to the toxins permanently affects the lungs' ability to transfer oxygen into the bloodstream. The lung tissue becomes permanently scared and each exposure to mold spores increases the damage. The body's last defense against these tiny invaders is to develop an allergy producing cold or pneumonia-like symptoms.

**Symptoms of Lung Disease and State of Illness**
The farmer will develop specific symptoms based upon the intensity of dust and spores to which he has been exposed or the intensity of his body's reaction to the dust and spores. He is also likely to develop an increased sensitivity to mold exposure, having more severe reactions with fewer exposures. In all cases, each exposure aggravates the problem.

**Acute State**
This is the most noticeable condition which typically begins 4 - 8 hours after exposure. Most farmers ignore the symptoms because they are so similar to a common summer cold.

Typical Symptoms:
- fatigue
- chills
- shortness of breath
- tightness in the chest

**Subacute State**
This is a more serious condition because symptoms will be stronger and remain longer even with no further exposure to moldy dust particles.

Typical Symptoms:
- severe shortness of breath with any exertion
- headache
- irritating cough

**Chronic State**
This is the most serious condition because of its gradual onset and its long-lasting debilitation. At the chronic state, the disease becomes irreversible.

Typical Symptoms:
- chronic coughing
- progressively increasing and severe shortness of breath with even the slightest exertion
- physical weakness
- occasional fever and sweating at night
- appetite depression
- general aches and pains

Typically farmers develop chronic Farmer's Lung slowly over time after repeated exposure to mold spores because they continue to ignore the symptoms of acute attacks. However, it is possible to develop Chronic Farmer's Lung even after one acute attack.

A delay in seeking medical help damages the farmer most. Often, by the time a farmer sees a physician, there is already serious, permanent damage. And in some cases scar tissue (pulmonary fibrosis) develops, further interfering with the normal functions of the lungs.
How to Tell if You Have Farmer's Lung

Self diagnosis is not recommended. Always check with your physician to confirm your suspicions. However, here are some ways to tentatively diagnose yourself:

- Have you experienced a sudden illness that developed a few hours after you handled moldy crop material?
- Do you have a chronic cough?
- Do you have a general feeling of tiredness or depression?

Medical Treatment

It is not enough to look at the list of symptoms and think that you may have Farmer's Lung. You need to see your family physician. The list only helps you recognize symptoms that might match and it is important not to ignore them.

When you see your doctor, there are several things you can do to help him/her diagnose you correctly. A doctor who is unfamiliar with farmers' illnesses or does not know you are a farmer can mistake the symptoms of Farmer's Lung for a cold, asthma, flu or even pneumonia, and incorrectly diagnose your illness.

Tell your doctor:
- you are a farmer and the type of farming you do
- if you have been exposed to moldy crop material
- what chemicals and/or dusts you work with

Then your doctor can do several things to confirm or disprove a tentative diagnosis.
- take a blood test
- take a chest x-ray
- administer a breathing capacity test
- examine lung tissue
- administer an inhalation challenge
- perform an immunological investigation
- perform lung function testing
- review clinical history

Farmer's Lung can be controlled in many ways. One way for your doctor to help control it is to give you symptomatic relief. But Farmer's Lung cannot be cured. Unfortunately, there is no way to determine in advance if you are immune.

Measures Farmers Can Take

Farmers can control or even minimize the possibility of getting Farmer's Lung by several preventative measures:

Preventative Measures
- identify contaminants and hazards in the work environment
- minimize the amount and type of contaminants in the work environment
- avoid exposure to contaminants and mold spores and dust from decayed grains and forages
- limit exposure to all contaminants
- operate within a controlled environment whenever possible (e.g., cab, control room, etc.)
- depend upon mechanical controls to remove air contaminants (e.g., fans, exhaust blowers, filters, etc.)
- have as much ventilation as possible in dusty areas
- move work outside whenever possible
- avoid dusty work in confined areas
- wear respirators, masks or other protective equipment
Management to Prevent Mold Spore Growth

- use mold inhibitors
- bale hay, ensile crops, harvest and store grain at recommended moisture contents
- dry grain properly before storage
- properly ventilate storage buildings
- crops should be adequately ventilated to cool them down.
- always use a plastic sheet to cap open silos (not plant material) holding down the edges with heavy weight (e.g. tires)

When You Must Work With Moldy Materials

- wet down feed before transferring to minimize dust
- convert to mechanical or automated feeding or feed handling systems
- wet down the top of the silo before uncapping ensiled material
- use some wetting techniques when cleaning out grain bins or other dusty areas
- use respiratory protection when handling moldy or dusty materials

If you decide to use some form of respiratory protection, then make sure you use the appropriate device for the work task. Most farmers wear dust masks to protect themselves from Farmer's Lung. This is the best and most cost-efficient protection unless you know you will be exposed to extremely high levels of moldy dusts or you already have developed Farmer's Lung.

Those who have Farmer's Lung should talk to their doctor about the type of equipment that will offer the most protection because every exposure increases the risk of serious permanent damage. Also, for any device you choose, make sure it fits well and is properly maintained.

For more information about respiratory equipment, see your local extension office or the publication on "Respiratory Protection."

More Information About Farmer's Lung

The chances of acquiring the disease are the greatest in late winter and early spring. This is mainly because farmers feed the hay and grain materials which have had a longer time to develop mold. Also, during those colder months, farmers are likely to feed baled hay inside, and mold spores stay in the air inside a barn much longer. The amounts of mold spores a farmer will breathe in such a confined space are much more concentrated. Unrolling large round hay bales also may release mold spores. Other times to be more careful about dusts that may contain higher levels of mold spores are:

In late summer - while cleaning out grain bins before filling with new grain
In early winter- opening new silos may release mold spores from the top layer of silage.

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More information on topics about respiratory protection can be found at the Center for Disease Control and Prevention website: http://www.cdc.gov/nasd/menu/topic/ppe_respiratory.html
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Education


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October 1985 – November 1989  Bachelor of Science in Agriculture and Diploma in Education (Teacher Certification), University of Cape Coast.


Professional Experience

January 2004 – August 2007  Graduate Research Assistant, Department of Agricultural and Extension Education, The Pennsylvania State University.


August 2001 – May 2002  Project Manager, Participatory Tropical Forest Development by Women in Indigenous Communities (PTFDWIC), Begoro, Ghana. Forestry project sponsored by International Tropical Timber Organization (ITTO) in collaboration with Forestry Commission and DWM.


February 1991 – December 1995  Agricultural science teacher and Head of Department, Ghana National College, Cape Coast, Ghana.

December 1989 - January 1991  Research Associate, Department of Agricultural Engineering, School of Agriculture, University of Cape Coast, Cape Coast.

Professional Organizations

National Scholars Honor Society
Gamma Sigma Delta Honor Society of Agriculture
American Association of Agricultural Education (AAAE)
Association of International Agricultural and Extension Education (AIAEE)
Minorities in Agriculture Natural Resources and Related Sciences (MANRRS)