

## THE OHIO STATE UNIVERSITY NIOSH AGRICULTURAL HEALTH AND SAFETY PROMOTION PROGRAM

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Surveys conducted in the state of Ohio in 1982 and again in 1990 indicate the rate of farm accidents remains very high. The 1982 survey showed that nearly one-third (30.2 percent) of all farms surveyed (n=918) experienced a farm-related accident during the 3-year period from 1980 to 1982. The 1990 survey revealed that 15 percent of all farms surveyed (n=574) experienced at least one farm accident during 1989. These data demonstrate that farming in Ohio follows the national trend as being one of the most hazardous occupational pursuits. In an effort to reduce the rate of farm accidents, the Ohio State University is participating in a NIOSH Agricultural Health and Safety Promotion Program. The goal of the project is to improve the health and safety record of the Ohio farming community through a comprehensive educational program. Carefully selected faculty members from the departments of Agricultural Engineering, Family Resources, and Preventive Medicine will work with the Cooperative Extension Service to accomplish this objective. The long-term goal of this program will be to establish an up-to-date information source and a network of individuals to teach farm health, safety, and rescue. The first phase of the program is to assess the Extension agricultural safety and health training, education and informational program needs. This will be accomplished through surveys, accessing additional farm accident data, personal knowledge of the professional faculty and a review of available literature. Current Extension literature will be reviewed and updated. New comprehensive teaching modules will be developed in areas of specific concern in the state of Ohio. These modules will cover such areas as tractor, implement and pesticide safety, and will be targeted to satisfy the needs of vocational education teachers. Working with the Ohio Fire Academy, the program will establish a continuing "Train the Trainer" program for Fire and E.M.S. personnel on farm accident rescue. The Department of Agricultural Engineering will develop a "capstone" course for all students to increase their overall understanding of health and safety issues. This program will develop a solid basis for improving the state of Ohio's agricultural health and safety environment on a continuous basis for years to come. This poster session will focus on the current Ohio agricultural health and safety issues, the methods the Ohio State University will employ to mitigate the problem, and the expected long-term effect of the NIOSH program in Ohio.

## CHEMICAL HAZARDS TO THE NEUROBEHAVIORAL HEALTH OF AGRICULTURAL WORKERS

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An estimated 3.2 million agricultural workers in the United States may be at risk of multiple exposures to known or suspected neurotoxic chemicals (e.g., pesticides, fumigants, solvents, metals and gases). These chemicals can produce immediate, delayed or chronic impairments of behavior and neurologic function, including sensory, cognitive and motor abilities. Neuroanatomic or neurochemical damage may accompany behavioral deficits, but often such damage is undetectable before the onset of functional impairment. Current knowledge of the impact of neurotoxicants on agricultural workers is largely derived from controlled laboratory and field studies intended to assess the acute effects of single compounds or compound classes (e.g., organophosphate pesticides). Few studies address the neurobehavioral health of agricultural workers after repeated exposures to multiple chemicals. This presentation describes advances in selected neurobehavioral test methods, proposes a strategy for application in field studies, and suggests a research agenda for the surveillance and assessment of neurobehavioral health among agricultural workers.

## EXPOSURE OF COMMERCIAL PESTICIDE APPLICATORS TO THE HERBICIDE ALACHLOR



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(2-chloro-2',6'-diethyl-N-[methoxymethyl] acetanilide), one of the most common pre-emergent herbicides used on corn and soybean crops, is considered to be carcinogenic in rodents. However, exposure and health information on humans is lacking. A study of commercial pesticide applicators, who apply a variety of herbicides and insecticides to agricultural cropland, was conducted to characterize their exposure and estimate internal dose to alachlor. Surveys were conducted at 5 application companies in Illinois and 7 in Ohio. A total of 20 applicators, 7 hauler/mixers, and 18 controls participated in the study. Participants in the study wore air samplers to measure inhalation exposure and clothing patches to estimate skin deposition. Hand and glove washes, and surface wipe samples were collected to evaluate hand exposures to alachlor. To estimate the absorbed dose of alachlor, urine samples were collected at the beginning and end of the shift, and the morning after the exposure survey. Inhalation exposures ranged from 0.28 to 6.4  $\mu\text{g}/\text{m}^3$  with a mean of 2.1  $\mu\text{g}/\text{m}^3$ . The deposition of alachlor on the skin ranged from 0.03 to 4.0  $\mu\text{g}/\text{cm}^2$  with a mean of 0.63  $\mu\text{g}/\text{cm}^2$ . The legs generally received more deposition of alachlor than any other part of the body. Hand wash and glove rinse samples indicated that the hands were also an area of heavy alachlor exposure; post-shift hand wash samples and rinses of the inside of the gloves ranged from 0.11 to 281  $\mu\text{g}$ . The concentrations of alachlor metabolites in the urine ranged from <1 to 25 ppm with a mean of 5.9 ppm. Those workers with higher inhalation and hand exposures tended to have greater concentrations of urinary metabolites. Alachlor exposures were found to be higher for this group of commercial pesticide applicators than have previously been reported for other applicators and mixers. Individual work practices had a direct impact on the variability of exposure and dose concentrations. Practical steps can be taken to reduce exposure and internal dose, such as proper use of pesticide resistant gloves and aprons.

## A FARM FAMILY AND HAZARD SURVEILLANCE PROGRAM FOR CASH GRAIN FARMERS IN OHIO

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A multiple-phase, population-based health and hazard study of Ohio cash grain farmers and eligible family members is described. The project was designed as a five-year collaborative effort between Ohio State University, CDC/NIOSH, and the State of Ohio. In Phase 1 of the project period, which is now underway, a stratified random sample of 6,480 cash grain farms will be selected from a comprehensive statewide roster, with stratification by size of farm (in acres). A mixed-mode survey (i.e., a self-administered, mailed questionnaire, with telephone follow-up of mail non-respondents) will then be conducted to obtain relevant health and hazard data. The content of the questionnaire and its design will be modeled to a great extent after NCHS' National Health Interview Survey, a national health survey of the civilian non-institutionalized population of the United States. In Phase 2, a subsample of eligible Phase 1 respondents whose farms are located in the 20-county central Ohio area will be invited to participate in a program of nurse-conducted, in-home physical examinations and on-farm hazard assessments. Procedures employed for collection of the Phase 2 health data will be modeled after NCHS' Third National Health and Nutrition Examination Survey (NEANES III). To the extent possible, the collection of the Phase 2 hazard data will be modeled after NIOSH's National Occupational Exposure Survey. With respect to the collection of the Phase 2 health data, attempts will be made to recruit 624 farm families. For each eligible and participating household member, the following procedures will be performed by a specially trained public health nurse according to a standardized protocol: spirometry, audiometry, and measurement of height, weight and blood pressure. With respect to the (concurrent) collection of Phase 2 hazard data from the same subsample of farms, a specially trained, two-person Hazard Technician team will conduct on-farm hazard assessments to obtain (qualitative and quantitative) information on work-related risk factors. In Phase 3, a sample of farm operators will be asked to participate in a program of personal exposure monitoring, with a focus on noise and airborne exposure to dust and selected pesticides. One data collection effort in Phase 3 will involve attempts to collect pesticide exposure data from all residents in the participating domiciles by monitoring levels of selected urinary metabolites. In addition to the urinary metabolite analyses, airborne levels of exposure experienced by the operator/applicator will be monitored by air sampling pumps as in Phase 2, and, in addition, by application of passive dosimetry techniques.

## NOISE AND HEARING LOSS IN THE AGRICULTURAL SETTING

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Nearly 10 percent of the 3.6 million United States farmers and an unknown portion of the additional 11.8 million farm family members, part-time farmers, and hired workers are exposed to average daily noise levels in excess of 85 dB(A), the level at which industrial workers are mandated by OSHA to be protected by a hearing conservation program. Numerous studies have documented a high incidence of hearing loss among farm workers, a finding generally attributed to these high noise levels. Although it is fairly apparent that farmers are at risk for and often develop noise-induced hearing loss, there is little information on actual exposure levels. Most investigations have focused on noise levels produced by tractors; there is virtually no information on levels produced by other farm equipment, livestock or processes. There is also little information on changes in sound levels over time as equipment ages or is modified by the farmer. A more basic problem is adequate characterization of noise exposure in this setting. The OSHA dosage calculations and damage-risk criteria for industry do not take into account farmers' highly seasonal exposure patterns, which are typified by 12-15 hour exposures during peak seasons, preventing adequate recovery prior to re-exposure. Noise-induced hearing loss results from the gradual destruction of sensory hair cells within the cochlea. It is a subtle process which eludes notice until sufficient cells have been damaged so as to produce a decrease in auditory sensitivity. Once damaged, however, the hair cells cannot be repaired or replaced, even through medical intervention. Therefore, the key is prevention through education as to the hazards of noise and the protective measures which may guard against it. Farmers *want* health and safety information made available to them, and initial hearing conservation efforts in this population have been well received. This presentation will summarize the available literature on noise-exposure levels in the agricultural setting, their apparent effects on the hearing of farmers, research questions which need to be addressed, and how the Farm Family Health and Hazard Survey and other projects through NIOSH's Agricultural Initiative are beginning to address these problems.

## **REDUCING STRESS, ACCIDENTS AND DEATHS IN OKLAHOMA AGRICULTURE**



*By Pat Lewis*

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The safety specialist at Oklahoma State University has cooperated with several departments and agencies to promote farm safety in Oklahoma. In 1988, the vital statistics section of the Oklahoma Department of Health furnished nameless agriculture death certificates to the safety specialist to establish new safety educational programs. At that time, suicides proved the leading cause of preventable deaths among the agriculture sector in Oklahoma. The Governor appointed a task force of eight agencies to collectively look into suicide and stress-related problems in rural areas. Various public hearings were held throughout the state enabling farmers/agriculture-related businesses to inform the task force of their concerns/problems. One of the major problems among farmers was the stress they contended with daily. This also may account for various accidents on a farm. An AG-LINK Coalition was formed in 1985 to offer direct communication to farmers in a crisis situation. The crisis may include severe depression, loneliness, family problems, financial, health, or suicidal. AG-LINK is accessible 24 hours a day, and all calls are returned within 15 minutes. Crisis intervention has saved the lives of 234 farmers and 5 lending institute officers. In 1989, the AG-LINK averaged 1,035 phone calls per month. The OSU family life specialist has developed several publications, in-service training and workshops pertaining to stress in the rural areas. His cooperation and assistance with the AGLINK Coalition has been an asset. An Oklahoma Injury Prevention Advisory Board, appointed by the Commissioner of Health, is working with several agencies to determine safety programs in Oklahoma to reduce any type of accidents. The OSU safety specialist is a member of this board and represents the farm and rural safety expertise. In 1989, it was determined by the safety specialist and the Director of Epidemiology that farm pond drowning was the leading cause of preventable deaths in Oklahoma. Farm Bureau and Oklahoma 4-H are working together to implement an ATV safety program for 4-H and Youth. The OSU safety specialist is a member of the National 4-H ATV Safety Committee which is sponsored by American Honda Corporation.

## **COMPILING, CORRELATING AND COMBATING AGRICULTURAL ACCIDENTS IN TENNESSEE**



*By Joel Lown, M.S.A.E.*  
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Agriculture brings industry to the homestead and powerful tools to the untrained - often a deadly mix. Accidents are typically outside of the realm of conventional industrial monitoring, and so widespread that cooperative effort is necessary even to detect and report them. Gathering appropriate accident data allows careful correlation of parameters that can reveal trends and critical areas of focus. Finally, a unique coalition must be drawn together to provide integrated safety programs for a particular state or region.

## **OBTAINING RELIABLE DATA ON FATAL INJURIES INVOLVING VIRGINIA FARM WORKERS**



*By Glen H. Hetzel, Ph.D.*  
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National farm accident and fatality data show that children are at high risk when working on farms. Death certificate data from the Virginia Bureau of Vital Statistics do not show this to be true for the state. Data from 1980-1989 for farm accident victims were reviewed. The analysis showed patterns by age, activity, county and other factors. More than 60 percent of the fatalities involved tractors or machinery. Grouping of deaths by counties did not show the incidences to be consistently high in those counties having the highest agricultural activity. During the 10-year period, only one child under age 14 was reported to have died from a farming accident. This is a significant difference from the situation in many other states. Risk factors associated with the farm-related fatalities were identified. Risk factors are being used to identify areas needing emphasis on current agricultural health and safety programs. The data were also compared with farm-related fatal injury data obtained from the Chief Medical Examiner's Office of the Commonwealth of Virginia. Significant differences were observed in the number of fatalities, place death occurred and when the death occurred. More consistent definitions and better use of E-Codes are needed to increase the reliability of data from agricultural accidents. Reliable data are needed prior to developing effective preventive counter measures.



## ***SURVEILLANCE TO SOLUTION***

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This health promotion system provides the advantage of linking health and safety data with applied research and farm worker training. It is the first time that elements within and outside our university converge upon identified worker hazards from different directions. By concentrating efforts toward known in-state worker hazards, program credibility and speed of program reaction to identified hazards increases. Farm worker populations are being trained that have not been previously reached. Timely workplace-related training that is hands on in nature will reduce worker exposure to job site hazards. The educational effort is strongly supported by small-scale research efforts and a surveillance system. The applied research effort is currently focusing upon reducing the level of pesticide exposure to orchard workers through the adoption of smart sprayers that reduce off-target sprayer applications. The surveillance system consists of a data gathering operation that attempts to corroborate information from various sources within the state of Washington. Its sole purpose is to identify where other efforts within the project should be directed. This applies to both applied research and farm worker training.

## ANALYSIS OF BEDDING AND RAFTER DUST FROM NORTH CAROLINA CHICKEN COOPS

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Respiratory problems documented among poultry farmers include airway irritation, cough, chest tightness and phlegm. In the present study, bedding and rafter dust from 16 different chicken coops were examined. The bedding ranged in age from 2 weeks to 3 years old. Each bedding and dust was examined for bacteria (total, gram negative and thermophilic), fungi, endotoxin, histamine and ammonia. The presence of chicken sera, sera albumin, IgG and egg albumin were also documented. The rafter dust was aerosolized, the respirable fraction collected and evaluated for endotoxin, histamine, and ammonia. Only ammonia correlated with the age of the bedding (up to 1.5 years old  $r=0.9488$ ). The 2-week-old bedding contained an unusually high amount of endotoxin (13570 EU/mg). In the other beddings, rafter and respirable dusts endotoxin levels ranged from 15.2 to 814 EU/mg, 50.9 to 865.2 EU/mg, and 0.1 to 512.8 EU/mg, respectively. Histamine was found in all samples tested ranging from 0.33 to 6.6 ng/mg bedding or dust. Chicken coop bedding and dust contains a variety of substances and organisms that may present a potential respiratory risk to farmers.

## **MUSCULOSKETAL INJURIES IN AGRICULTURE—AN ERGONOMICS PERSPECTIVE**

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The National Institute for Occupational Safety and Health has begun a major research initiative addressing mortality and morbidity in the agricultural workforce. Review of data from the Supplementary Data System (SDS), maintained by the Bureau of Labor Statistics, indicates that upper extremity sprains and strains, including back injuries, account for more than 30 percent of the agriculture-related workers' compensation claims. SDS data were examined for 1985 from 25 states that provided records. A total of 9,970 sprain/strain injury claims were filed. Of these, 3,138 (31.5 percent) occurred in landscaping/horticultural services and horticultural specialties. Also, 2,268 (22.7 percent) sprain/strain injuries occurred in the production of fruits, nuts, vegetables and melons. Typical work activities from these two agricultural sectors will be observed and recorded on videotape for study using a motion measurement system to identify biomechanical stresses in this workforce. The ultimate goal of this study is to identify potential intervention strategies (work place modifications or development of specialized mechanical-assist devices) to reduce musculoskeletal injuries in these agricultural industry sectors.

## ENDOTOXIN IN COTTON DUST: A RESPIRATORY HAZARD WITH IMPLICATIONS FOR WORKER HEALTH IN BOTH AGRICULTURE AND MANUFACTURING



By Robert M. Castellan, M.D., M.P.H., Stephen A. Olenchock, Ph.D.

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The Public Health Service's *Year 2000 Objectives for the Nation* call for the elimination of exposures that cause byssinosis ("brown lung disease"), an occupational lung disorder which affects cotton workers. Recent research on the etiology of byssinosis has contributed substantially to the body of knowledge necessary to achieve this goal. Although byssinosis is usually considered in the context of the textile manufacturing industry, results of this recent research have implications for both agricultural worker health and agricultural practices which may prevent downstream risk in manufacturing. Recent experimental evidence has clearly demonstrated that the acute airway response of humans exposed to cotton dust is associated with airborne endotoxin concentration. Cotton is contaminated by endotoxin-containing gram-negative bacteria while in the field before harvest. Local cotton growing conditions appear to substantially affect the level of colonization by gram-negative bacteria, resulting in wide variation in the potency of cotton dust with respect to endotoxin. A survey of commercial cotton gins has revealed substantial regional differences in endotoxin contamination of airborne cotton dust. In addition to regional effects, year-to-year variability within the same growing location has been observed in the level of endotoxin contamination of experimentally-generated cardroom dust. Subsequent environmental sampling of cardroom work areas in selected commercial cotton textile mills has shown that area of growth differences are also reflected in yarn manufacturing processes. Airborne endotoxin concentrations in work areas of both agriculture and manufacturing range widely, from relatively low levels to levels which may represent a substantial respiratory hazard. Byssinosis prevention may be enhanced by appropriately applying knowledge of how to limit the natural tendency for gram-negative bacteria to colonize cotton. Therefore, defining the factors which influence the level of gram-negative bacterial contamination of cotton is a prime objective of ongoing research. Furthermore, because of the relationship between endotoxin exposure and byssinosis, a pilot surveillance system to monitor endotoxin in cotton is currently under development.

## **AN ANIMAL MODEL TO PREDICT THE PULMONARY RESPONSE TO INHALATION OF AGRICULTURAL DUSTS**

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Agricultural dusts are associated with many farm operations such as grain unloading, hay handling, chicken or pig confinement, etc. Such dusts are often contaminated with bacteria, fungi and molds as well as endotoxins, mycotoxins and spores associated with these microbes. Several farm operations are known to generate high levels of dust and have been reported to cause adverse physical reactions in farm workers. Symptoms often include fever, headache, malaise and respiratory difficulty. The present report describes an animal model which characterizes the pulmonary responses to inhalation of selected agricultural dusts. Bulk samples collected at the farm site can be placed in a container and dust aerosols of respirable size generated by acoustical energy. Guinea pigs can be exposed to these aerosols and their pulmonary responses, such as airway constriction and inflammation, can be monitored as a function of exposure dose and time. This animal model may have the capability to predict the potential biological reactivity of various agricultural materials. In addition, this system could be used to determine the agent(s) associated with agricultural dust which causes disease and to determine the mechanisms by which disease develops.

## **ROLLOVER PROTECTION STRUCTURE (ROPS) FOR FARM TRACTORS: THE STAGE IS SET FOR LOCAL ACTION**

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Between 1980 and 1985, nearly 800 people were killed in the United States in farm tractor rollovers. Current data show that farm tractor rollover fatalities have been a factor in 17 percent of all deaths to workers in the Agriculture, Forestry, and Fishing Industry. A 30 percent reduction in the fatality rate for this industry is a *Year 2000* goal for the nation. To address this problem of farm tractor rollovers, a workshop was held to develop strategies for research and safety promotion in preventing fatalities to farm tractor operators. A widely recognized engineering intervention to prevent rollover fatalities is the use of rollover protective structures (ROPS) and seat belts on all tractors. Proposed strategies fell into two categories: (1) retrofitting tractors built between 1970 and 1985, for which ROPS have already been designed; and (2) retrofitting tractors built before 1970, for most of which there are no ROPS designs. Workshop attendees felt that local action groups should begin educational campaigns to encourage owners of tractors built since 1970 to have lifesaving ROPS and seat belts installed.

**ASSESSMENT OF INHALED AGRICULTURAL DUST HAZARD  
AND MECHANISMS OF DISEASE USING AN ANIMAL  
INHALATION MODEL IN COMBINATION WITH STUDIES OF  
ISOLATED AIRWAYS**



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It is becoming increasingly clear that inhalation of some agricultural dusts in the workplace may cause pulmonary obstruction. We have been conducting biological experiments designed to both assess the potential hazard of agricultural dusts and to determine the mechanism(s) of the pulmonary response. This has been accomplished through the use of a computer-operated dust generation and animal inhalation exposure system (designed by David G. Frazer), which provides dust-exposed animals from which airways are then removed for additional study of the mechanisms of inhaled dust toxicity. Studies on isolated airways involve the isolated perfused guinea pig trachea. The perfused trachea is used because it contains respiratory smooth muscle, which is involved in narrowing of the airways in response to inhaled substances, and other cell types such as epithelium, which lines the airways and is known to be a target of the toxic effects of some agents. The isolated trachea also permits a detailed evaluation of the mechanisms of effect of suspected etiologic agents under carefully controlled laboratory conditions. We are able to ascertain the effect(s) of inhaled substances on respiratory smooth muscle and epithelium. The protocol used to examine dust effect(s) is to apply the bronchoconstricting drug, methacholine, to the fluid surrounding the trachea in order to establish the dose-response relationship for the diameter decrease caused by contraction of the smooth muscle. The methacholine easily reaches the muscle, which is situated on the outer surface of the trachea. These results are compared with the dose-response relationship obtained after the trachea is challenged with methacholine perfused through the lumen. The muscle contracts to luminal methacholine only after the drug has crossed the epithelium. The epithelium is a diffusion barrier and a metabolic site, and also releases modulatory factors which affect the responsiveness of the muscle. We have examined the effects of respirable cotton and barn dusts. A six-hour exposure to cotton dust caused pulmonary obstruction, the degree and duration of which depended on the level of dust in the air. The perfused trachea preparation revealed that a complex set of changes had occurred in the release of modulatory factors from the epithelium, which altered in a dust level- and post-exposure, time-dependent manner responsiveness of the muscle. Inhaled barn dust did not affect pulmonary function or tracheal reactivity. The use of these laboratory methods will continue to assist in the identification of inhaled dust hazards and disease mechanisms.

## **BUILDING STATE-BASED AGRICULTURE SAFETY AND HEALTH INFRASTRUCTURES: A MODEL AGRICULTURE HEALTH PROMOTIONS SYSTEM PROGRAM**



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Based on data from the National Traumatic Occupational Fatalities (NTOF) database maintained by the National Institute for Occupational Safety and Health (NIOSH), Agriculture, Forestry, and Fishing is one of the most hazardous industrial divisions in the U.S. While only 2 percent of the U.S. workers are employed in this sector, it has the fourth highest injury fatality rate (20.4 deaths/100,000 workers) in the U.S. Farming as an occupation has the second highest rate of work-related injury deaths (21.4/100,000 workers). In addition, during 1988 the agriculture industry ranked third among the 10 industrial sectors for occupational injury rates (10.4 injuries/100 workers). Because of the hazardous nature of agricultural employment, the NIOSH, Division of Safety Research (DSR), has instituted an intervention program with the goal of reducing the incidence of fatal and nonfatal traumatic injury, chronic injury, and occupational diseases among the 3.4 million agricultural workers in the U.S. This program, the Agricultural Health Promotion Systems (AHPS), is administered through cooperative agreements to Land-Grant Universities and the Cooperative Extension Service within the States. Through the AHPS, the land-grant universities will disseminate information and conduct programs to prevent illness and injury among agricultural workers and their families. Currently, 15 states are conducting programs in this area for FY 1991, with eight more states to be added by FY 1992. Examples of some of the emphasis areas include, but are not limited to, youth training, bilingual work-site safety packets for farm workers, and programs targeted to older farmers. Also included are programs in forestry, logging and fishing.

## WORKER FATALITIES IDENTIFIED BY IRRIGATION KEY-WORD SEARCHES OF THE DATABASE

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This analysis describes fatal occupational injuries involving irrigation operations or mechanisms in the United States. Cases were identified by examining data from the National Traumatic Occupational Fatality (NTOF) database, which is maintained by the Division of Safety Research (DSR), National Institute for Occupational Safety and Health (NIOSH). NTOF includes data from death certificates, obtained from all 50 States, New York City and the District of Columbia, that indicated the decedent was 16 years or older, died from an external (injury) cause and was injured at work. A key-word search of injury descriptions and cause of death narratives from NTOF identified cases described as involving "irrigation." This analysis includes cases from 1980 to 1989, although data for 1987-89 are incomplete. From 1980 through 1989, 60 workers died in the U.S. from work-related injuries involving irrigation. Twenty-two percent of these deaths occurred in California and 12 percent were in Texas. Most fatalities were among men (97 percent). More deaths occurred to Whites (65 percent) than to Hispanics (30 percent), Blacks (3 percent), or other races (2 percent), although Hispanics may be over-represented relative to their proportion of the labor force. Workers between the ages of 20 and 34 accounted for 43 percent of the deaths. Farmers (32 percent) and farmworkers (37 percent) were the most frequent occupations of the victims. Seventy percent of the fatalities were in the Agriculture, Forestry and Fishing Industry. From 1980 through 1986, the leading causes of death involving irrigation operations or mechanisms were electrocution (67 percent), drowning/suffocation (11 percent), and machines (9 percent). The ability to identify specific occupational fatalities are possible through computer keyword searches of injury descriptions and cause-of-death narratives from the NTOF data base.



## AGRICULTURAL LUNG DISEASE: A NATIONAL PROGRAM

By Gregory Kullman, M.S., Richard D. Kennedy, Michael Lyman, William G. Jones  
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Occupational exposures to dust of agricultural origin are known to cause respiratory illness among farm workers. Several pulmonary responses have been described in different agricultural settings. The National Institute for Occupational Safety and Health (NIOSH), Division of Respiratory Disease Studies (DRDS), in Morgantown, West Virginia is involved in a nationwide agricultural program, emphasizing the study of respiratory illness among farm workers, as a foundation for preventing occupational lung disease through the development and dissemination of appropriate prevention strategies. Surveillance, research, and intervention are key elements of this research program. Our program involves many separate projects that are part of an integrated, multi-disciplined approach to the study of agricultural respiratory disease involving clinical evaluations, environmental exposure assessments, laboratory research evaluating biological disease mechanisms, microbiological characterizations of agricultural materials, animal exposure studies and epidemiological surveillance. NIOSH scientists at DRDS have been actively involved in the study of respiratory illness in a variety of agricultural settings including Dairy Farming (Silo Unloading and Bedding Chopping), Cotton Processing, Recycling, Mushroom Farming, Poultry Growing, Grain Harvesting and Storage, and others. NIOSH scientists are interested in learning about instances of respiratory illness among farm workers and have a Respiratory Disease Health Hazard Evaluation Program available, at no cost as a resource for farm workers. To request assistance or to provide information on the occurrence of respiratory illness among agricultural workers, call (304) 291-4203.

## ORGANIC DUST EXPOSURE FROM COMPOST HANDLING OPERATIONS



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Environmental measurements were made during hand loading of compost in a small scale recycling project. The compost consisted of chopped leaves and branches stored outdoors during a spring and summer of record rainfall. Exposures to organic dust from this material resulted in the hospitalization of one individual experiencing severe respiratory illness. Measurements included inspirable and respirable dust, particle size distribution, endotoxins, spore counts and viable microorganisms. Visible clouds of fine particulate were easily generated during handling activities; impactor measurement of this aerosol indicated a mass median aerodynamic diameter of approximately 3 micrometers. Worse case dust concentrations of inspirable and respirable particulate were 150 and 83 milligrams per cubic meter ( $\text{mg}/\text{m}^3$ ) respectively; however, routine dust exposures from compost handling were below  $1 \text{ mg}/\text{m}^3$  for all size fractions. Microscopic examination (both light and SEM) of these dusts indicated a predominance of spores. Airborne spore counts, made directly from cellulose ester filters cleared with acetone, ranged from 106 to 109 spores/ $\text{m}^3$ . Mesophilic fungi and bacteria, collected using the AGI 30 impinger with distilled water, ranged from 105 to 108 colonies/ $\text{m}^3$ . Airborne thermophilic bacterial concentrations were lower, 103 to 104 colonies/ $\text{m}^3$ . Spore counts made from filter samples collected downstream from the impinger showed high spore penetration, with break-through weighted toward smaller diameter spores,  $< 3 \mu\text{m}$ . Endotoxin concentrations from inspirable, thoracic and respirable dust samples ranged from 636 to 16,300 endotoxin units/ $\text{m}^3$ . Levels of contaminants found here are consistent with those associated with respiratory illness in other agricultural settings.

## **HYPERSENSITIVITY PNEUMONITIS (HP) IN RATS CAUSED BY *Aspergillus Umbrosus* AND *Thermoactinomyces Vulgaris***

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HP is an allergic lung disease in the terminal bronchioles, interstitium and alveoli resulting from repeated exposure to inhaled organic dusts. Thermophilic actinomycetes and fungal spores have been implicated as causes of HP in man. To evaluate the inflammatory potential of the two microorganisms, we exposed rats (Sprague-Dawley, VAF) to extracts of *Aspergillus umbrosus* (AU) and *Thermoactinomyces vulgaris* (TV) six times by intratracheal injection. We made a pathologic evaluation of the changes in the lungs and in the cellular influx in bronchoalveolar lavage fluids (BALF) of exposed and control animals. Initial installations of AU and TV caused an intense inflammatory reaction in and around respiratory bronchioles and blood vessels. The cellular infiltrate (CI) predominantly was lymphocytes, but the number of macrophages was also increased. Lymphatoid granulomas were seen as well as thickening of alveolar walls with type II cell hyperplasia. The number of the total cells in BALF increased dramatically, two-and-one-half to fivefold, compared to the controls. Differential estimates of CI showed 71 percent lymphocytes and 27 percent macrophages. Eight and 28 days after the final exposure, the lung appeared normal. These results indicate that these agents can cause an intense pulmonary inflammation, and that the inflammation subsides rapidly when the exposure ends, leaving no apparent permanent pulmonary injury.

## HYPERSENSITIVITY PNEUMONITIS ANTIGENS ACTIVATE ALVEOLAR MACROPHAGES IN VITRO

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The gaseous phase cultures of alveolar macrophages (AMs) of guinea pigs were exposed to the saline extracts of the dust-borne bacteria *Micropolyspora faeni* (syn. *Faenia rectivirgula*) and *Erwinia herbicola* (syn. *Enterobacter agglomerans*) which have been added at the concentration of 1  $\mu\text{g/ml}$  to culture medium with or without complement. The effects of exposure on superoxide anion ( $\text{O}_2^-$ ) production by AMs were assessed by the lucigenin-dependent chemiluminescence method. Both extracts caused significant ( $p < 0.01$ ) increase in  $\text{O}_2^-$  generation by AMs, as assessed by the 161-254 percent enhancement of chemiluminescence release comparing to control values. The presence of complement augmented the production  $\text{O}_2^-$ , which reached a peak at 3 hours after initial exposure. The possible significance of the generation of oxygen radicals in pathogenesis of the diseases due to exposure to agricultural dusts loaded with bacterial antigens is discussed.

## RESPIRATORY DISEASE MORTALITY IN AGRICULTURAL WORKERS

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Agricultural workers have been shown to be at increased risk of developing respiratory diseases (RDs). Most mortality studies of agricultural workers to date have considered only crude mortality using underlying cause of death and may underestimate the public health importance of contributing causes of death. Furthermore, crude mortality data is a poor measure of premature mortality in the working-age population. Decedents noted as having worked in an agricultural industry were selected from national multiple cause of death data tapes for 14 states that had industry and occupation information for each of the years 1985-1987. To estimate the relative public health importance of specific RDs for these decedents, crude "cause of death" ratios (deaths due to a specified RD/total deaths from all RDs), years of working life lost (15-64 years) and years of potential life lost (age 15-life expectancy) were estimated for deaths where specific RDs were mentioned either as an underlying or contributing cause of death. Of the 81,317 decedents, 11,046 (14 percent) had a RD listed as an underlying cause of death while an additional 8,948 (11 percent) had a RD listed as a contributing cause. Of all RDs, respiratory neoplasms contributed most to the total years of working life lost (38 percent or 7,000 years), while pneumonia and influenza contributed the most to the total years of potential life lost (33 percent or 81,340 years). Calculations of premature mortality are useful in determining the relative public health importance of specific RDs on the working-age population in agriculture. Use of multiple causes of death data allows for an analysis of the maximum diagnostic information listed on death certificates.

## MICROBIAL CONTAMINATION AND IMMUNOLOGIC REACTIVITY OF STORED OATS

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Bulk samples of oats were obtained from Alabama where a cluster of cases of organic dust toxic syndrome occurred in workers who shoveled approximately 800 bushels of oats from a poorly ventilated storage bin. Airborne dusts were obtained from the samples by acoustical vibration in a laboratory dust generator. Microbial contamination of the airborne dusts, as measured by standard dilution plating techniques, revealed  $1.4 \times 10^5$  colony forming units per cubic meter of air (CFU/m<sup>3</sup>) of total viable bacteria,  $1.5 \times 10^3$  CFU/m<sup>3</sup> of gram-negative bacteria,  $1.8 \times 10^5$  CFU/m<sup>3</sup> of thermophilic bacteria, and  $8.3 \times 10^4$  CFU/m<sup>3</sup> of fungi. The most common fungi isolated from the dust included *Alternaria*, *Aspergillus*, *Cladosporium*, *Penicillium*, and *Scopulariopsis* species. Analysis of the generated airborne dust for gram-negative bacterial endotoxins resulted in the detection of 325.71 Endotoxin Units per milligram of dust (EU/mg). The endotoxin contamination of the bulk oats was 122.66 EU/mg. An extract of the bulk sample consumed human serum complement *in vitro* in a dose-dependent fashion, indicating the inflammatory potential of the material. Sera from the exposed workers were examined for antibodies against the extract, against antigens from the predominant fungi, and against standard antigens associated with hypersensitivity pneumonitis. Evidence of exposure (specific antibodies) was determined, although symptomatic and asymptomatic workers could not be differentiated. Stored oats provided a source of respiratory exposure to microbial antigens and to immunoreactive materials.

**DEATHS WITH FARMERS LUNG DISEASE AND DAIRY  
FARMING PRODUCTION: A CORRELATION USING NATIONAL  
CENTER FOR HEALTH STATISTICS MULTIPLE CAUSE OF  
DEATH TAPES**



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Farmer's Lung Disease (FLD) is a form of hypersensitivity pneumonitis (HP) prevalent in agricultural workers. We hypothesize that extensive prolonged work in closed spaces exposes the dairy farm worker to various sensitizing agents associated with HP and FLD more than other types of farm workers. This report looks at data available from the National Center for Health Statistics (NCHS) multiple cause of death data tapes from 1979 through 1986 concerning deaths with FLD. During this time period, 73 death certificates listed FLD as being present. Data from these death certificates were correlated with farming data from the 1982 agricultural survey and the 1986 *Statistical Abstract of the United States*, by state, using Spearman correlations.

**TABLE OF CORRELATIONS**

**Variables by State**

Whole Milk Sold	0.53*
Dairy Farms	0.54*
Farms with Cows	0.54*
Farmers	0.35*
Deaths	0.11*

$P < 0.05 - *$

In this ecological study, deaths with FLD were more related to dairy farming than farming in general, supporting our hypothesis. The NCHS multiple cause of death data tapes have thus provided a new way to evaluate the demographics of an occupational pulmonary disease, and help generate a hypothesis as to its occupational origin.

## **HYPERSENSITIVITY PNEUMONITIS (HP) OR ORGANIC DUST TOXIC SYNDROME (ODTS)?: THE CLINICAL DILEMMA IN ORGANIC DUST EXPOSURES**



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Twelve hours after shovelling composed wood chips and leaves, a healthy 52-year-old male presented to the emergency room with fever ( $T\ 38.8^{\circ}\text{C}$ ), myalgia, and marked dyspnea. Inspiratory crackles, hypoxemia (room air arterial  $\text{PO}_2\ 53\text{mm Hg}$ ), and bilateral patchy pulmonary infiltrates were seen. Systemic steroids were given, and he improved over 3 days. No antibodies were found to 10 common HP antigens. Using respiratory protection, we repeated the exposure setting and made extensive environmental measurements. General area samples for respirable particulate were  $< 1\text{ mg}/\text{m}^3$ . Peak exposures were  $> 80\text{ mg}/\text{m}^3$ . Mass median aerodynamic diameter of the aerosol was approximately 3 micrometers. Microscopic analysis of the dust indicated a predominance of spores, with counts ranging from 106 to 109 spores/ $\text{m}^3$ . Airborne endotoxin concentrations ranged from 244 to 16,300 endotoxin units/ $\text{m}^3$ , levels previously associated with illness in similar settings. Cultures of air samples yielded high levels of mesophilic fungi and lower levels of thermophilic bacteria. Serum from the patient showed precipitation with extracts of bulk samples of the compost material. Inhalation of dust from contaminated organic materials may result in acute respiratory tract illness. Possible mechanisms include toxic and cellular reactions from microbial and other organic products or immunologic responses after prior sensitization to an antigen. Differentiation is based on clinical and epidemiologic clues. Our data suggest that, in a clinical setting even with extensive environmental measurements, separation of ODTS and HP may not be possible.



## **MICROBIOLOGICAL ANALYSES AND INFLAMMATORY EFFECTS OF SETTLED DUSTS FROM RICE AND HAY**

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Fourteen samples of settled dust from two factories processing rice and wheat straw near Shanghai, China, were examined by dilution plating for total bacteria, gram-negative bacteria, thermophilic actinomycetes and fungi. They were also examined for aflatoxin, endotoxin and potential to stimulate production of human interleukin 1B (IL-1B) and to consume complement. The concentrations of total microorganisms were consistently greater than 10<sup>7</sup> CFU/g and ranged from 10<sup>7</sup> to 10<sup>9</sup> CFU/g. In general, the level of microbial contamination was greater in the hay dust samples than in the rice dust samples, with bacteria being the most numerous microorganisms observed followed by molds, thermophilic actinomycetes and yeasts. The predominant fungi were species of *Aspergillus*, *Cladosporium*, *Penicillium*, *Trichosporon*, and *Cryptococcus*. No significant levels of aflatoxin were observed and the isolate of *A. flavum* examined lack significant aflatoxigenic potential. The levels of microorganisms in these samples, the types of organisms found, and the inflammatory mediators such as endotoxin suggest that workers exposed to these dusts may be at risk for respiratory illness.