HIGH PLAINS INTERMOUNTAIN CENTER FOR AGRICULTURAL HEALTH AND SAFETY

2007-2012 CLOSEOUT REPORT

CDC/NIOSH Cooperative Agreement # 5U54OH008085

Table of Contents

Cover 1

Table of Contents 2

List of Terms and Abbreviations 7

Closeout Document 1: The Final Progress Report 8

Abstract 8

HICAHS Administrative/Planning Core 9

Section 1 9

Section 2 13

BACKGROUND 13

Center Mission and Goals (2007-2012) 13

Function 1: Leadership 14

International Accomplishments (other than dairy) 14

National Accomplishments 14

National Tractor Safety Initiative (2005-2007) 15

Regional Accomplishments 15

State Accomplishments 15

HICAHS Dairy Initiatives 16

Evaluation Program Accomplishments 20

Agricultural Center Evaluation (ACE) Project 20

Function 2: Internal Advisory Committee 24

Function 3: External Advisory Board 25

Function 4: Interdisciplinary Coordination Plan 25

Function 5: Outreach 25

Function 6: Feasibility Projects 27

Agricultural Center Evaluation 30

Section 1 30

Significant Findings 30

Translation of Findings 30

Outcomes/Impact 31
Section 2 32
BACKGROUND 32
SPECIFIC AIMS 33
METHODOLOGY 33
Program Monitoring 34
Research Questions 34
Limitations 35
RESULTS AND DISCUSSION 36
CONCLUSION 39
INCLUSION ENROLLMENT REPORT 39
INCLUSION OF CHILDREN 39
MATERIALS AVAILABLE FOR OTHER INVESTIGATORS 39
PUBLICATIONS 39

RESEARCH CORE: Occupational Lung Disease and Endotoxin Exposure in New Dairy Workers 41
Section 1 41
Significant Findings 41
Translation of Findings 42
Outcomes/Impact 42
Section 2 45
BACKGROUND 45
SPECIFIC AIMS 45
METHODOLOGY 46
GC-MS/MS Analyses 48
3-OHFA Analysis 49
Muramic Acid Analysis 49
Ergosterol Analysis 50
RESULTS AND DISCUSSION 52
Worker Exposure to Bioaerosols and Associated Respiratory Outcomes (Specific Aim 1) 55

Worker Exposure to Bioaerosols and Associated Cytokine Response (Specific Aim 1) 59
Respiratory Symptoms 61
Comparison of Exposure and Health Outcomes for Colorado and Californian Dairy Workers (Specific Aim 2) 62
Exposure of Naïve Workers to Bioaerosols (Specific Aim 3) 63
Evaluation of rFC endotoxin assay and GC-MS analysis of 3-OHFA in predicting changes in pulmonary function and biomarkers (Specific Aim 4) 63
Survey of genetic markers relating to lung disease and endotoxin pathway (Specific Aim 5) 63
Identification of high risk jobs within the dairy industry (Specific Aim 6) 63
Exposure Predictors 70
Evaluation of Interventions 70
Education/Training 71
Intervention/Outreach 71
CONCLUSION 72
INCLUSION ENROLLMENT REPORT 73
INCLUSION OF CHILDREN 74
MATERIALS AVAILABLE FOR OTHER INVESTIGATORS 74
PUBLICATIONS 74
Peer Reviewed Journal Articles 74
Conferences /Presentations 76
Seminars/Webinars/CE/Lectures/multimedia 77
Conference Leadership 77
Reports 78
Standards 78
Graduate Students Trained – MS and PhD 78
REFERENCES 79

PREVENTION/INTERVENTION CORE: Injury Risk Analysis in Large-Herd Dairy Parlors 81
Section 1 81
Significant Findings 81
Translation of Findings 82
Outcomes/Impact 82

Section 2 83
BACKGROUND 83
SPECIFIC AIMS 83
METHODOLOGY 84
RESULTS AND DISCUSSION 84
CONCLUSION 85
INCLUSION ENROLLMENT REPORT 87
INCLUSION OF CHILDREN 88
MATERIALS AVAILABLE FOR OTHER INVESTIGATORS 88
PUBLICATIONS 88

EDUCATION/TRANSLATION CORE: Developing and Testing Interactive CD Health and Safety Curricula for 4-H Youth 92
Section 1 92
Significant Findings 92
Translation of Findings 93
Outcomes/Impact 93
Section 2 94
BACKGROUND 94
EPIDEMIOLOGY OF CHILD INJURY AND ILLNESS 94
EDUCATION EFFORTS TARGETING CHILDREN & YOUTH 96
BACKGROUND LITERATURE 97
THEORETICAL FOUNDATION FOR 4-H CDs 98
SPECIFIC AIMS 100
METHODOLOGY 100
RESULTS AND DISCUSSION 111
CONCLUSION 111
INCLUSION ENROLLMENT REPORT 112
INCLUSION OF CHILDREN 113
MATERIALS AVAILABLE FOR OTHER INVESTIGATORS 113
PUBLICATIONS 113

EDUCATION/TRANSLATION CORE: Translation and Dissemination Program 114
Section 1 114
Section 2 117
BACKGROUND 117
Significance of Agriculture in Public Health Service Region 117
Agricultural Extension Model 118
SPECIFIC AIMS 119
METHODOLOGY 120
RESULTS AND DISCUSSION 123
INCLUSION ENROLLMENT REPORT 126
INCLUSION OF CHILDREN 126
MATERIALS AVAILABLE FOR OTHER INVESTIGATORS 126
PUBLICATIONS 126
LITERATURE CITED 127
Closeout Document 2: The Final Financial Status Report 128
Closeout Document 3: The Final Invention Statement and Certification 129
Closeout Document 4: Equipment Inventory Listing 130

Appendices 133
Appendix 1: ACE Reports 134
Appendix 2: HICAHS Products 147
Appendix 3: Selection of minutes from various HICAHS meetings 179
Appendix 3.1: 2008 HICAHS Advisory Board 180
Appendix 3.2: 2009 High Plains & Mountain Region Dairy Health & Safety Workshop 195
Appendix 3.3: 2011 HICAHS Dairy Advisory Board 205
Appendix 3.4: 2011 HICAHS International Dairy Research Consortium (Colorado) 224
Appendix 3.5: 2011 HICAHS International Dairy Research Consortium (Ireland & Sweden) 231
Appendix 4: Advisory Board Responsibilities 234
Appendix 5: 2009 Regional Needs Assessment Results 236
Appendix 6: 2007-2011 Distribution of Projects and PAR Priorities 246

LIST OF TERMS AND ABBREVIATIONS

ACE	Agricultural Center Evaluation
ACGIH	American Conference of Industrial Hygienists
ASHCA	Agricultural Safety and Health Congress of America
ACGIH	American Conference of Industrial Hygienists
ANSI	American National Standards Institute
ASSE	American Society of Safety Engineers
CDC	Centers for Disease Control and Prevention
CSU	Colorado State University
ERC	Education and Research Center
HICAHS	High Plains Intermountain Center for Agricultural Health and Safety
ILO	International Labour Organization
MAP-ERC	Mountains and Plains Education and Research Center
NAS	National Academies of Sciences
NCBA	National Cattlemen's Beef Association
NIEHS	National Institute of Environmental Health Sciences
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health
NORA	National Occupational Research Agenda
NTSI	National Tractor Safety Initiative
ONES	Outstanding New Environmental Scientist Award
OSHA	Occupational Safety and Health Administration
PAR	Program Announcement Received
PHS	Public Health Service
PI	Principal Investigator
ROPS	Roll-Over Protective Structures
WestON	Western States Occupational Network

High Plains Intermountain Center for Agricultural Health and Safety 2007 – 2012
Abstract

Since its inception in 1991, HICAHS has demonstrated adaptability in its responsiveness to stakeholder needs while still maintaining a long-term vision for improving agricultural health and safety. In addition to the various administrative, outreach, program evaluation and feasibility projects under the Administrative Core (page 9), there were 4 major projects conducted during this period: Research Core Project "Occupational Lung Disease and Endotoxin Exposure in New Dairy Workers" (page 41), Prevention/Intervention Core Project "Injury Risk Analysis in Large-Herd Dairy Parlors" (page 81), and Education/Translation Core Projects "Developing and Testing Interactive CD Health and Safety Curricula for 4-H Youth" (page 92) and the "Translation and Dissemination Program" (page 114). These novel, long-term projects were responsive to national and regional agricultural health and safety needs and NIOSH-directed priorities. Sixteen of the 17 priorities in the 2006 NIOSH PAR were addressed, along with the recommendations of the National Program for Occupational Health and Safety in Agriculture, and the National Occupational Research Agenda (Appendix 6).

In addition HICAHS leaders directed two projects that were the first of their kind to involve all of the NIOSH Ag Centers, the National Tractor Safety Initiative (page 15) and the Agricultural Center Evaluation Project (page 30). Both projects were funded through NIOSH Supplemental Funding.

The goals for the 2007-2011 funding period were:

1. To conduct interdisciplinary research related to the prevention of occupational disease and injury among agricultural workers and their families in Federal Region VIII.
2. To develop, implement, and evaluate education, translation, and outreach programs for promoting health and safety for agricultural workers and their families in Federal Region VIII.
3. To develop, implement, and evaluate model programs and tools for intervention and prevention of illness and injury among agricultural workers and their families in Federal Region VIII.
4. To develop linkages and communication with other governmental and non-governmental bodies involved in agricultural health and safety, and especially with other agricultural health and safety programs.

HICAHS met each of these goals for the 2007-2011 funding period through its four primary research projects and other activities (a no-cost extension was received until June 2012). HICAHS readily responded to emerging and unforeseen health concerns, such as the E. Coli outbreak in inmates working at a dairy correctional facility (page 26) or responding to a local concern about exhaust from a tractor cab (page 26). Neither of these concerns were foreseeable at the time of the initial grant submission, but HICAHS maintains an interdisciplinary staff that can readily address these issues (page 24). HICAHS products total 225 including 20 students trained, 67 peer-reviewed publications, and 82 presentations. Notable accomplishments were the formation of strategic partnerships in the dairy industry, creation of HICAHS Dairy Initiatives, and the various national and international leadership positions of HICAHS researchers. HICAHS continues to engage the community to promote agricultural health and safety. Its successful feasibility program is enhancing the sustainability of agricultural health and safety for future generations by training a new generation of researchers.

HICAHS Administrative/Planning Core

Administration Core
Stephen J. Reynolds (970-491-3141, Stephen.Reynolds@colostate.edu)
Victoria V. Buchan (970-491-5211, Victoria.buchan@colostate.edu)
2007-2012

Section 1

The High Plains Intermountain Center for Agricultural Health and Safety is composed of a nationally recognized group of researchers and partners with a wide-range of expertise. Since its inception in 1991, HICAHS has continued to work on sustaining the human resources of the region (Federal Region VIII) and reduce morbidity and mortality in the agricultural population.

Goals

1. To conduct interdisciplinary research related to the prevention of occupational disease and injury among agricultural workers and their families in Federal Region VIII.
2. To develop, implement, and evaluate education, translation, and outreach programs for promoting health and safety for agricultural workers and their families in Federal Region VIII.
3. To develop, implement, and evaluate model programs and tools for intervention and prevention of illness and injury among agricultural workers and their families in Federal Region VIII.
4. To develop linkages and communication with other governmental and non-governmental bodies involved in agricultural health and safety, and especially with other agricultural health and safety programs.

Function 1*: *Leadership

HICAHS met each of its goals for the 2007-2011 funding period through its six core administrative functions and four primary research projects. The Administrative and Planning Core was led by Director Stephen Reynolds and Deputy Director Victoria Buchan. Of particular significance was their leadership in two projects that were the first of their kind for including researchers from all of the NIOSH Ag Centers nationwide. All 10 of the Ag Centers participated in the **National Tractor Safety Initiative** to improve safety by reducing the number of tractor overturns. The initiative addressed several facets of tractor overturns, including the availability of roll-over protective structures (ROPS), social marketing, economic impact and social cost of overturns, and financial incentives for retrofitting tractors. The **Agricultural Center Evaluation** included six Centers and resulted in five annual reports (2006-2010) describing the productivity of the Centers and addressing eleven program evaluation questions. Members of ACE leadership team were instrumental in addressing the data requirements of the 2006 NAS evaluation of the NIOSH AgFF programs.

Evaluation. In addition to internal program evaluation efforts and the Agricultural Center Evaluation project, a paper and telephone survey was created and administered at Cooperative Extension meetings

and with members of the HICAHS Advisory Board to learn of regional concerns for agricultural safety and health.

Organizational Involvement. HICAHS researchers participated and/or became involved in leadership in multiple regional, national, and international organizations including the American Conference of Industrial Hygienists (ACGIH), International Labour Organization, Western States Occupational Network (WestON), Agricultural Safety and Health Congress of America, Robert Woods Johnson Commission to Build a Healthier America hearings, ANSI standard for confined space in agriculture, National Academy of Sciences Review of NIOSH Agriculture Programs, and others.

Dairy Initiatives. HICAHS researchers had two large dairy projects in this funding cycle. Stakeholder involvement from the dairy industry has increased, resulting in the creation of the HICAHS Dairy Board (28 members) and the HICAHS International Dairy Research Consortium (38 members from 11 countries). HICAHS partnered with DeLaval Incorporated, the global leading manufacturer of dairy equipment, to offer a one-day workshop entitled *Worker Safety on Dairy Farms: How Does OSHA Apply?* Strategic partnerships have been formed with DeLaval and Alpha Technology to design milking tools that will enable workers to perform milking tasks more efficiently, productively, and with reduced risk for the development of musculoskeletal disorders. Researchers have visited over 60 large-herd operations in 9 US states and 3 countries. HICAHS partnered with the Southwest Ag Center to host two High Plains and Mountain Region Dairy Health and Safety Workshops 2009 and 2011 in Denver, Colorado. Through NIOSH Supplemental Funding, HICAHS partnered with the I-29 Dairy Consortium to sponsor five health and safety workshops in four states entitled *What You Need to Know About OSHA Before OSHA Needs to Know About You*. Additionally, a HICAHS Translation project enabled a partnership with Utah State University and Utah Dairy Extension to offer a two-day workshop entitled *Agriculture Safety Management Using Lean Six Sigma.*

Function 2*: *Internal Advisory Committee. HICAHS continues to have a dynamic team of people who lead agricultural safety and health projects and organize with outreach and education activities. Notable additions to HICAHS include Dr. Teresa Tellechea, cultural anthropologist and native Spanish speaker, and Allison DeVries, Center Coordinator, former dairy farm manager and NIOSH fellow and contractor. This group was successful in facilitating synergy among the programs and researchers involved with HICAHS.

Function 3: External Advisory Board. The board has assisted HICAHS with connecting to the agricultural industry and dissemination of findings, plus strategic planning and the development of the proposals for the 2011 NIOSH grant proposal. The newly created Dairy Advisory Board Meeting held its first meeting in April 2011 with 12 members representing dairy producers, extension specialists, and equipment manufacturers.

Function 4: Interdisciplinary Coordination Plan

A broad range of interdisciplinary teams was assembled for every project in the 2007-2011 funding cycle. The nationally recognized investigators brought expertise in occupational and pulmonary medicine, exposure assessment, ergonomics, education and evaluation, occupational psychology, microbiology, toxicology, environmental chemistry, epidemiology and biostatistics, agriculture,

veterinary medicine, engineering, and human behavior. Dr. Tellechea provides an example of where a gap in expertise was recognized and addressed.

Function 5: Outreach

Research findings were disseminated through conference and workshop presentations, newsletters, trade publications and peer-reviewed publications, professional presentations, and trainings. The HICAHS website was updated to more effectively communicate Center activities, translate research findings through project summaries, provide educational materials, announce coming events, and solicit pilot projects.

- HICAHS is continuing to reach out to the agricultural community regarding emergency preparedness through collaboration with a USDA funded grant led by Dr. Thomas Johnson.
- HICAHS researchers provided consultation to resolve: 1) Health effects inside a tractor cab from exhaust and 2) Respiratory illness among veterinarians and livestock in a horse barn due to exposure to bioaerosols.
- HICAHS faculty worked with the Colorado Environmental Pesticide Education Program, helping to coordinate and support training programs specially targeting monolingual Spanish speaking workers using narrative story telling as a means to reach low literacy workers.
- HICAHS continues to coordinate with the OSHA Consultation program at CSU to identify needs among agricultural workers.
- Dr. Reynolds provided assistance to the Colorado Department of Public Health and Environment responding to an outbreak of E. coli O111 among inmates (18 cases) in a Colorado correctional facility that was associated with their dairy operation.
- Dr. Reynolds served as backup for Dr. Roy Buchan as AIHA representatives on the NORA Agricultural Health Committee.
- HICAHS faculty worked with Claudia Arrieta and the staff of the Colorado Environmental Pesticide Education Program to deliver training video sessions to Colorado Corn and Potato Growers.

Function 6: Feasibility Projects

During the last cycle HICAHS distributed 12 pilot/feasibility awards, funded between $10,000 to $20,000 each. This program has been highly successful, leading to the generation of federally-funded R01 grants, the development of new educational materials and intervention techniques, the training of student and junior investigators, and publication of peer-reviewed journal articles and conference presentations. Of the twelve awards made from 2006-2011, all but two were made to junior investigators (7 assistant professors, 2 postdoctoral researchers, and one research associate). Six have received academic promotions and are now Assistant or Associate Professors making important contributions to agricultural health and safety at Colorado State University, the University of Nebraska, the University of Texas, and the University of Utah.

Outcomes/Impact

HICAHS projects were successful in meeting the goals of the 2007 grant proposal. Notable accomplishments were the formation of strategic partnerships in the dairy industry, creation of HICAHS Dairy Initiatives, and the various national and international leadership positions of HICAHS researchers. HICAHS continues to engage the community to promote agricultural health and safety. Its successful feasibility program is enhancing the sustainability of agricultural health and safety for future generations by training a new generation of researchers.

Section 2

BACKGROUND

The High Plains Intermountain Center for Agricultural Health and Safety was established in 1991 to promote a healthy and safe working population in agriculture. A nationally recognized group of researchers and partners with a wide-range of expertise were brought together for the 2007-2011 programs funded by the National Institute for Occupational Safety and Health (NIOSH) under the theme of "Health and Safety on Ranches and Farms in the High Plains Rocky Mountain Region." The Administrative Core was organized to facilitate and lead this collaboration with Dr. Stephen Reynolds as Director and Dr. Victoria Buchan as the Deputy Director. The Administrative and Planning Core provided overall vision, administration, and management of the Center. Investigators and Partners were recruited throughout the region (PHS Region VIII) to increase collaboration and leverage resources to address health and safety needs in agriculture. A no-cost extension was received with this report period ending June 15, 2012.

Center Mission and Goals (2007-2012)

The mission of HICAHS is to sustain the human resources of this unique high plains intermountain region, and reduce morbidity and mortality in the agricultural population. Housed in a land grant institution, HICAHS was well positioned to translate research knowledge into community action. The HICAHS projects addressed the most significant needs of the region (Federal Region VIII) and the priorities of the National Program for Occupational Health and Safety in Agriculture. Particular attention was paid to the recommendations of the Kennedy Report (1995), the NIOSH Board of Scientific Counselors Agricultural Review (2000), the NIOSH National Occupational Research Agenda, Healthy People 2010, and the priorities laid out by NIOSH in PAR 06-057.

The goals of HICAHS from 2007-2011 were:

1. To conduct interdisciplinary research related to the prevention of occupational disease and injury among agricultural workers and their families in Federal Region VIII.

2. To develop, implement, and evaluate education, translation, and outreach programs for promoting health and safety for agricultural workers and their families in Federal Region VIII.

3. To develop, implement, and evaluate model programs and tools for intervention and prevention of illness and injury among agricultural workers and their families in Federal Region VIII.

4. To develop linkages and communication with other governmental and non-governmental bodies involved in agricultural health and safety, and especially with other agricultural health and safety programs.

FUNCTIONS

Function 1: Leadership

International Accomplishments (other than dairy)

Dr. Stephen Reynolds was awarded a Fulbright Fellowship to teach and conduct research on environmental, occupational and agricultural health in Armenia in 2007. He was Chair of American Conference of Industrial Hygienists (ACGIH) in 2010 (serving in rotation on the Board of Directors in 2008 – 2011), the scientific organization known for the development of occupational exposure guidelines utilized by more than 70 countries. He represented ACGIH in Australia and Finland, and other meetings of international leaders of Occupational Hygiene associations. He has collaborated closely with colleagues in Sweden (for almost 15 years), Australia, Canada (close to 20 years) and other nations on research regarding agriculture lung disease, organic aerosols, and endotoxin.. He has been an Adjunct Professor at the University of Saskatchewan since 2002, directing the PhD research of Dr. Kirychuk and serving as an international member of the Canadian Centre for Health and Safety in Agriculture.

Dr. Paul Gunderson chaired the panel of experts formulating a "Code of Practice on Safety and Health in Agriculture" that was convened by the International Labour Organization, Geneva, Switzerland across 2009 -2010. The panel consisted of eight members representing the governments of Costa Rica, Kenya, South Africa, Sweden, Thailand, the United Kingdom, Uruguay, and Viet Nam, eight members representing agricultural employers within Ethiopia, Jamaica, Canada, Argentina, New Zealand, the Czechoslovakia Republic, the U.S., and Pakistan, and eight members from agricultural worker groups within South Africa, the U.K., Argentina, Barbados, Australia, the U.S., Sweden, and Burundi. Dr. Gunderson authored two of the twenty chapters (ergonomics and thermal conditions) and Dr. Lorann Stallones authored the machinery and work equipment safety chapter within the proposed code. The code was adopted by the panel and reviewed by the ILO Board of Governors, and within the Secretariat's Office of the United Nations. The Code was approved and formally ushered out at the International Labour Conference scheduled for September, 2011 in Ankara, Turkey. Dr. Stallones is the PI on a Fogarty International Center/NIH project to conduct training in agriculture injury prevention research in China. This project is designed to develop a cadre of scholars studying agriculture injuries.

National Accomplishments

Dr. Stephen Reynolds and Dr. Gunderson participated in the planning and organization of the Agricultural Safety and Health Congress of America. Dr. Reynolds also served as PI on the National Tractor Safety Initiative, as well as providing expert testimony representing the NIOSH Ag Centers at the Robert Woods Johnson Commission to Build a Healthier America hearings. Dr. Reynolds was a co-author of the ANSI standard for confined space in agriculture (ANSI/ASSE Z117.1-2009). Dr. Gunderson chaired the National Academy of Sciences Review of NIOSH Agriculture Programs and Dr. Stallones served on the review committee. Dr. Stallones served as President of the American College of Epidemiology (2009-2010) and delivered her Presidential Address entitled “Food Matters” which linked the agro-ecosystem

to human health. Dr. Vicky Buchan provided vital leadership and organization to the National Ag Centers Initiative Evaluation (ACE). Dr. Reynolds and other staff members also participate in the multi-Center coordinating committee that was led by Marc Schenker during the 2007-2011 funding cycle.

National Tractor Safety Initiative (2005-2007)

The National Tractor Safety Initiative was one of two projects of national significance to the Ag Centers, and to agricultural safety and health in the United States. The National Agricultural Tractor Safety Initiative involved collaboration of investigators from all ten of the NIOSH Agricultural Centers (including the Children's Center). An important result was the creation of a multidisciplinary, multicenter team or network. The Agricultural Center Evaluation project and the National Tractor Safety Initiative were the first project to involve investigators from all of the Centers. Both of these efforts were spearheaded by HICAHS.

HICAHS Director Stephen Reynolds led the National Tractor Safety Initiative, which was partially built upon the results of a HICAHS projects from the previous funding cycle conducted by work at other Ag Centers and the work of HICAHS Researchers Juhua Liu and Paul Ayers. The project was funded for 24 months (2005-2007) with the goal of improving safety practices, increasing the accessibility of safety equipment, and changing ideas, behaviors, and policy regarding tractor safety. Recommendations for follow up work included the need for region-specific interventions. The initiative website is available at http://depts.washington.edu/trsafety/. Among the projects that grew out of this initiative, the New York Center for Agricultural Medicine and Health's New York ROPS Retrofit Rebates program has been notably successful getting ROPS on tractors. http://ropsr4u.com/

HICAHS has continued to address tractor safety in its 20011-2016 research efforts. One project by Dr. Paul Ayers of the University of Tennessee will contribute to ROPS availability by developing a computer program that will facilitate the production of diverse and reliable systems to match all post-ROPS tractors.

Regional Accomplishments

Dr. Reynolds and Dr. David Douphrate participated in the development of the Western States Occupational Network (WestON), spearheaded by the NIOSH Western States Office and partnered with the Mountain and Plains ERC. The purpose of WestON is to build capacity among 22 Western states to conduct surveillance of work-related injuries and illnesses, and increase epidemiological capacity in occupational health and safety at the state level.

State Accomplishments

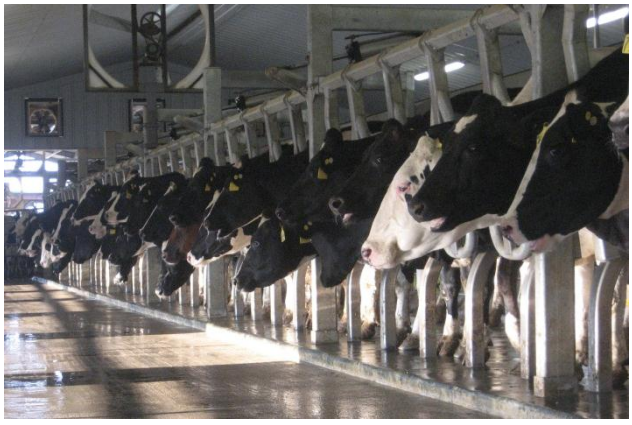
Drs. Reynolds and Stallones provided vital expertise and leadership in the development of the Colorado Occupational Health Surveillance Program/Worksafe Colorado. The Colorado Department of Public Health and the Environment is the recipient of a NIOSH grant to build capacity in occupational safety and health.

HICAHS Dairy Initiatives

Background

In the past three decades the US Dairy industry has moved to a large-herd, mass production model with a goal of increased milk production at lower cost. Expanding production capacity has required a larger workforce, primarily comprised of non-English speaking Latino workers (> 90%) with minimal experience in agriculture. Dairy farming is among the most dangerous occupations and accounts for a disproportionately large percentage of all injuries in livestock-related agriculture. Dairy workers also experience relatively high rates of respiratory disease associated with inhalation of dusts during milking, feeding, and other tasks. High employee turnover and lost work time are significant concerns for dairy owners and managers. A new challenge to dairy entrepreneurs, who are seeking to ensure safe working environments and to comply with state or federal occupational safety and health regulations, is the increased employee numbers. Many dairy owners and managers now responsible for managing human resources and safety programs have not had formal training in employee management or occupational health and safety. Complying with a large number of health and safety regulatory standards while simultaneously training a predominantly non-English speaking workforce is a daunting challenge. In a highly competitive global market it is critical that dairy owners and managers have the knowledge, tools, and support needed to effectively address these challenges and sustain a healthy, productive workforce.

Approach



Photograph courtesy of Evelyn teVelde

Over the past decade and particularly in the last five years, HICAHS has worked closely with the dairy industry to understand the causes and impact of work-related injuries and illnesses, develop and evaluate effective education and engineering interventions, and build a network of partners with capacity to address the global health and safety needs of the dairy industry. At the core of all of our projects and interventions has been a focus on stakeholder engagement and partnership building. The HICAHS approach to address health and safety on dairy farms is to ***LISTEN*** to dairy stakeholders, and ***RESPOND*** to expressed needs and concerns with *sound and relevant* research and outreach efforts.

Network Capacity Building - HICAHS researchers have increased stakeholder involvement in the dairy industry by forming partnerships for research, outreach, and translation/dissemination efforts.

- *Serving Dairy Owners and Employees.* To date, researchers have visited over 60 large-herd operations in 9 US states and 3 countries. Strategic partnerships have been formed with representatives of US dairies and producer organizations. Producers and other industry

stakeholders now view HICAHS researchers as trustworthy and capable partners to address the occupational health and safety needs on large-herd dairy operations.

- *Working with Dairy Industry.* In addition to dairy producers, HICAHS researchers have engaged industry-leading service and equipment companies to address health and safety on the dairy farm. HICAHS and DeLaval (the global market leader in dairy equipment and supplies) have formed a collaborative partnership to address the health and safety needs in the US as well as internationally. HICAHS has also formed a collaborative partnership with Alpha Technology, Inc., manufacturer of a new milking tool. We are working closely with DeLaval and Alpha Technology to design milking tools that will enable workers to perform milking tasks more efficiently, productively, and with reduced risk for the development of musculoskeletal disorders.

- *Research partnerships* have been formed with domestic and international dairy researchers with the goal of increasing research capacity, and optimizing resources. We have partnered with the University of Texas Health Science Center in Tyler, TX (Southwest Ag Center), University of Iowa (Great Plains Ag Center), University of California Davis (Western Center for Agricultural Health and Safety), University of Nebraska (Central States Center for Agricultural Safety and Health), Wisconsin National Farm Medicine Center (National Children's Center for Agricultural Health and Safety) and University of Minnesota (Upper Midwest Agricultural Safety and Health Center).

- *International Dairy Research Consortium*. Additionally, we have partnered with researchers at the Swedish University of Agriculture Sciences in Alnarp, Sweden, to form the HICAHS International Dairy Research Consortium to address health and safety on dairy farms in the US, Europe and other dairy producing countries. New members of the consortium represent Italy, Germany, Denmark, Australia, Canada, Brazil, New Zealand, and Ireland. In the first meeting (July 2011) attendees identified current research, needs and issues in their respective countries and were able to establish short term, intermediate and long term objectives. The group's membership has increased and has continued meeting at International Agricultural/Dairy Conferences to begin to address these objectives. Several joint proposals have been developed among different members. The Consortium is working on a series of articles for a dedicated issue of the Journal of Agromedicine covering the state of current knowledge concerning the dairy industry, identification of gaps, and paths forward. This is scheduled to be published in July 2013. Upcoming meetings will be held in Spain (July 2012), Sweden (August 2012), and New Zealand (September 2012). Drs. Reynolds, Kiefer, Lee, and Lundquist were invited to organize a pre-conference program focusing on Dairy in conjunction with the Safety 2012 World Conference in New Zealand.

Research Accomplishments

The accomplishments of the 2007-2011 funding cycle laid the groundwork for additional research, evaluation, and outreach in the dairy industry for 2012 and beyond. Two HICAHS Research Projects focused on the dairy industry during 2007-2011, "Prospective Study of Occupational Lung Disease in Dairy Workers," led by Stephen Reynolds (page 41), and "Injury Risk Analysis in Large-Herd Dairy Parlors," (page 81) led by David Douphrate and John Rosecrance. In the current 2011-2016 funding cycle, HICAHS continued to make the dairy industry a top priority with about half of its projects directly pertaining to the dairy industry. Significant research findings include the identification of risk factors associated with the development of both musculoskeletal injury and respiratory illness.

In the past decade HICAHS researchers have worked closely with Dairy industry on a comprehensive approach to better understand the factors that cause respiratory disease among dairy workers, and to develop effective interventions for prevention and control.

- Factors for adjusting results of inhalable sampling devices were developed to improve exposure assessment for different agricultural environments including dairies.
- Exposures to inhalable dust and endotoxin from Gram negative bacteria were associated with elevated inflammatory responses and reduced lung function in a dose-dependent fashion. Results suggest that newer workers are more susceptible to the acute effects of endotoxin and that over time some workers develop resistance to the effects of endotoxin, or that sensitive workers who do not adapt leave the industry over time.
- Smoking and less time on the job (new workers) are important factors increasing the effects of inhalable dusts on respiratory disease. The use of pesticides or herbicides exacerbates the effects of dust inhalation. Pre-existing respiratory conditions, obesity, and genetic factors also play an important role. Results suggest that interventions need to include more comprehensive wellness programs in addition to exposure reduction strategies.
- More frequent washing of animal waste from surface areas in a milking parlor was effective at reducing worker exposure to the respirable fraction of organic dust and endotoxin aerosols.

Dairy Outreach – Outreach to the Dairy Industry has been very successful with the development and integration of three groups with expertise to assist HICAHS with research, prevention efforts and dissemination of materials. Multiple workshops have assisted with this process.

- **HICAHS partnered with the Southwest Ag Center to host two High Plains and Mountain Region Dairy Health and Safety Workshops 2009 and 2011 in Denver, Colorado.** Attendees included faculty from US and Swedish universities, dairy extension specialists (CO, TX, NM, SD, ND, IA, and UT); dairy owners and managers (CO, TX, NM, and SD); dairy equipment manufacturers, workers' compensation providers, and dairy producer organizations (CO, TX, and NM). The workshop enabled the identification and prioritization of dairy worker health and safety issues, and generated recommendations and strategies for dealing with the challenges of addressing worker health and safety.

- **Dairy Advisory Board.** Through stakeholder engagement, the HICAHS Dairy Advisory Board has been formed. Made up of dairy producers, extension specialists, and equipment manufacturers, the Board guides and directs all HICAHS dairy-related projects, as well as serves as a medium for dissemination of findings.

- **HICAHS Dairy Health and Safety Network.** The network was created with two goals: 1) to create mechanisms for improved multi-directional communication between researchers and producers, and 2) to develop a structure to efficiently disseminate information on evidence-based practices (R2P) to improve health on dairies. The Network consists of numerous producers and extension specialists in 10 states, equipment manufacturers, collaborating researchers at other Ag Centers, and producer organizations. .

Photo Courtesy of David Douphrate

Dissemination of Knowledge

- Through NIOSH Supplemental Funding, HICAHS partnered with the I-29 Dairy Consortium to sponsor five health and safety workshops in four states (MN, IA, SD, and NE) for the regional dairy industry entitled *What You Need to Know About OSHA Before OSHA Needs to Know About You*

- A HICAHS Translation project enabled a partnership with Utah State University and Utah Dairy Extension to offer a two-day workshop entitled *Agriculture Safety Management Using Lean Six Sigma.*

- HICAHS partnered with DeLaval Incorporated, the global leading manufacturer of dairy equipment, to offer a one-day workshop entitled *Worker Safety on Dairy Farms: How Does OSHA Apply?* The workshop was attended by 21 Wisconsin producers focusing on OSHA regulations related to insuring the health and safety of dairy workers

Evaluation Program Accomplishments

During the 2007-2012 funding cycle the Evaluation Program evaluated efforts regionally within the HICAHS and nationally through the Agricultural Center Evaluation project (ACE). Evaluation has been an integral component of the High Plains Intermountain Center for Agricultural Health and Safety (HICAHS) since the Center was first funded in 1991. Under the leadership of HICAHS Deputy Director Victoria Buchan, a program monitoring approach to the work, products and activities of all HICAHS Center personnel was developed in the early years of the Center. This process evaluation approach to documenting progress on NIOSH Objectives by Center projects utilized a database to collect information from Center personnel and served to provide project PIs with feedback from stakeholders. Over several years the process was revised and improved providing cumulative data for progress and year end reports to NIOSH, as well as annual reports to stakeholders.

Agricultural Center Evaluation (ACE) Project

Under the leadership of Dr. Buchan, the Ag Centers continued to evaluate the products and outcomes of Ag Center activities nationwide. The ACE Reports promoted Inter-Center collaboration by bringing together representatives from Ag Centers across the nation. Reports were published every year during the 2007-2011 funding cycle. Also, refer to Appendix 1 for the ACE Executive Summary of the last year of the funding cycle (Fiscal Year 2010). Seven Centers provided data on 134 projects into a copy of the ACCESS™ database which was forwarded to HICAHS for aggregating and reporting for FY 2010. Additional ACE Reports can be accessed at http://www.hicahs.colostate.edu/ace.html.

History The Agricultural Center Evaluation (ACE) Project began in response to the 1995 Kennedy Report that externally evaluated the NIOSH-funded Agricultural Centers. Representatives from each Center met during a series of workshops between the years 1997—1999 to develop a multisite approach to the evaluation of all the Centers. A multi-site program evaluation was conducted for fiscal years 1999-2001, and again with renewed funding 2004-2010. Together, the team created evaluation research questions and defined indicators to measure the work of the Centers overall. In conjunction with The Southwest Center for Agricultural Health, Injury Prevention, and Education (based in Texas), HICAHS led the development of a database that allowed each Center to collect their own data in a standardized and consistent manner. HICAHS aggregated each Center's data and published the first pilot report in 1999 and have continued to published reports annually, except when funding issues have prevented it. The ACE reports respond to the objectives set forth by NIOSH.

2007-2011 ACE Activities In addition to publishing annual reports, Workshops have been held annually in Fort Collins, CO in 2006-2010. During this period the ACE team integrated new variables into the data collection process and adapted to changes in NIOSH guidelines. For example, with the help of NIOSH personnel, the team developed categorical definitions of the Research to Practice (r2p) concept that are now identified by each Center and reported each year.

The evaluation model has also incorporated the change in NIOSH's National Occupational Research Agenda (NORA) to reflect the move to sector based projects. Beginning with fiscal year 2010, projects reported by the Center Initiative are also identifying cross-sector work. Finally, the database, with the assistance of the Southwest Agricultural Center, now includes the format and queries that enable Evaluation personal to print out progress and year-end reports for Project PIs from the database, in the format required by NIOSH. These reports include data entered for the project (for example: publications, presentations etc.) that shorten the reporting process for the investigator.

National Academy of Science (NAS) Reviews In 2006 NIOSH requested the National Academies of Sciences to conduct an evaluation the NIOSH Agriculture, Forestry and Fishing Research (AgFF) program since the 1995 Kennedy report. The panel reviewed Ag Center activities from 1996-2006, and through this evaluation effort a number of ACE team members and Center Directors had the opportunity to meet in Washington, D.C. during the first National Occupational Research Agenda II conference. The ACE Team members met with Dr. Roy Fleming to discuss the data requirements of the NAS evaluation and provided him with data and the ACE database data collection model.

The efforts of the ACE project, which involved representatives from each active Agricultural Health and Safety committee and a project officer from NIOSH highlighted the need for NIOSH to address evaluation first in the 2007-2011 RFP and then as a separate and requited component in the 2012-2016 PAR.

Internal HICAHS Evaluation

High Plains and Mountain Region Dairy Health and Safety Workshops. In 2009, Dr. Buchan assisted with the programming for the first HICAHS Dairy Workshop held in Denver, organized by Drs. Reynolds, Douphrate, and Rosecrance, and held in partnership with the Southwest Center for Agricultural Health, Injury Prevention, and Education. An evaluation of this workshop was designed to gather pretest/posttest rank ordering of topics that need addressing to identify change that may have occurred due to information shared during the two day workshop. In addition, follow-up telephone interviews addressed stakeholder needs and suggestions related to additional workshops, timeframe recommendations for workshops, and identification of additional partners to include

In addition this workshop broke attendees up into rotating workgroups to identify the key concerns in the following categories: Hired worker training, Worker Health, Dairy Management and Labor Issues. The results of these discussions can be found in Appendix 3.2, with the ranking provided at this workshop listing Hired Worker Training as the highest concern. The lowest ranking in the 2009 workshop was Ergonomics, the lowest in 2011 was infectious disease.

The 2011 Dairy Workshop included newly appointed Dairy Board Advisory members as well as representatives who had attended the 2009 Dairy Workshop. Pre/post interviews were again undertaken in order to see if changes had occurred since 2009 as well as if concerns changed from pre to post based upon the discussions that took place. Table 1 below provides the pre-post results from both workshops and illustrated the consistency in major concerns over time. Table 1

Table 1. *Pre-Post Ranking of Dairy Industry Concerns by Year*

2009	Pre- Workshop	Post-Workshop	Change
Sustainability	3.00	4.00	+1.0
Hired Worker Training	3.39	4.00	+.61
Infectious Disease	3.13	3.23	-.10
Cow Care	2.87	3.85	-.98
Ergonomics	3.65	2.85	-.8
Concerns Ranked			
1.	Ergonomics	Hired Worker Training	
2.	Hired Worker Training	Sustainability	
3.	Infectious Disease	Cow Care	
4.	Sustainability	Infectious Disease	
5.	Cow Care	Ergonomics	

2011	Pre-Advisory	Post-Advisory	Change
Hired Worker Training	3.44	3.91	+.47
Sustainability	3.56	3.64	+.08
Ergonomics	2.67	2.73	+.06
Cow Care	3.22	3.09	-.13
Infectious Disease	3.00	2.00	-1.0
Concerns Ranked			
1.	Sustainability	Hired Worker Training	
2.	Hired Worker Training	Sustainability	
3.	Cow Care	Cow Care	
4.	Infectious Disease	Ergonomics	
5.	Ergonomics	Infectious Disease	

Those attending the 2009 workshop were also asked to assign a perceived value between 1-5 (5=highest) to each of five statements related to the Dairy Industry. Table 2 presents the pre/post mean scores for these statements; while the order didn't change the level of perceived value related each statement increased during the workshop.

Table 2. *Pre-Post Workshop Ranking of Health & Safety Beliefs Regarding Dairy Production*

2009	Pre	Post	Ranking
Worker Health can Impact Production Efficiency	4.58	4.92	1
More Expensive to Replace than Maintain Workers	4.58	4.85	4
Comprehensive Approach is Desirable	4.50	4.77	3
Safety Issues Can Improve Efficiency	4.37	4.85	2
Comprehensive Approach could be Cost Effective	4.25	4.31	5

In addition attendees at the 2011 workshop were asked to rank order dairy projects that were underway at the time. Table 3 illustrates the rank ordering based upon mean scores of attendees on a 5 point Likert scale.

Table 3. *Dairy Advisory Board (DAB) Rank (on 5 point Likert Scale) of existing HICAHS Projects*

HICAHS PROJECTS	2011 DAB Mean
Farmworker Stress	4.82
Training for Workers	4.82
Training for Managers	4.73
Dairy Producer Outreach	4.64
Measuring Safety Training Effectiveness	4.45
OHSA Training Workshops	4.27
Exposure Assessment	3.73
Lean 6 Sigma	3.50

Needs Assessment A regional needs assessment was developed and undertaken in late 2008 and early 2009. Dr. Douphrate and Dr. Buchan developed a paper based survey that could be distributed at Cooperative Extension meetings in the regional states. A telephone survey was also completed with members of the HICAHS Advisory Board and reports on both efforts were provided to the Advisory Board and HICAHS staff in April 2009. See power point presentation in Appendix 5. The results indicated remarkable agreement between the two sample groups and helped HICAHS personnel as they began to plan projects which could address regional concerns in response to the next application cycle. Top priorities included concerns related to the need for training materials for workers and owner/operators, respiratory disease, chemical exposure, ergonomic injuries, large animal injuries.

Annual Evaluation Reports As part of the ACE process, Dr. Buchan with assistance from graduate research assistants (GRAs) has gathered the necessary data from HICAHS personnel to enter into the ACE ACCESS database. This data becomes part of the cumulative ACE report published each year and all outreach activities of HICAHS staff are reported, as well as lists of current year projects and products are also listed by type, language and by project PI. For the last 2 ACE reports the document was searchable by key words.

HICAHS Advisory Board evaluation efforts. In addition to their participation in the regional needs assessment indicated in the data provided above, the HICAHS Advisory Board has provided a sounding board over the years, as HICAHS personnel sought input from regional representatives and production industry representatives related to Center Direction. At the December 2010 Advisory Board Meeting, the evaluation staff briefly re-presented the updated regional needs assessment to set the stage for discussion of ideas for the next funding cycle, with the application due in 2011. HICAHS personnel were able to present ideas related to projected projects for the new funding cycle (to begin in 2012). Proposed projects were presented and Advisory Board member evaluation feedback was facilitated by V. Buchan of the evaluation unit. This process enabled project PIs to take Advisory Board feedback into consideration as they prepared for the application for the next funding cycle. The evaluation staff was also able to pretest an instrument developed specifically to address NIOSH's concept of "Research to Practice" that we hoped to include in the 2012 application. Note: this instrument was revised based upon Board feedback and is currently in use.

Function 2: Internal Advisory Committee

In 2010, a number of internal personnel and administrative changes took place. Dr. Douphrate, who served as HICAHS Scientific Coordinator and Researcher accepted a tenure-track faculty position at the University of Texas School of Public Health in San Antonio. Dr. Douphrate agreed to continue his HICAHS research and outreach activities in the dairy industry, and served as Director of the Prevention/Intervention Core. In October of 2010, Ms. Allison DeVries accepted the position as Center Coordinator. She brought experience working as a NIOSH researcher as well as a member of the National Occupational Research Agenda's (NORA) Agriculture, Forestry, and Fishing Committee. Ms. DeVries also has managerial experience on large-herd dairy farms in California. Dr. Vicky Buchan stepped down from her position as HICAHS Deputy Director, but continued as Director of the Education/Translation Core and the Evaluation Core. Dr. Stallones is an internationally recognized occupational epidemiologist and expert in agriculture health and safety. She assumed the role of Center Deputy Director and also now serves as the Director of the Outreach Core. Dr. Teresa Tellechea began working in the Center in 2011, first as an external consultant and then as a Colorado State University faculty member in January 2012. Dr. Tellechea brings a wealth of expertise on the Latin community as a native Spanish speaker and cultural anthropologist. She is assisting with tailoring HICAHS findings to the Spanish-speaking workers that are commonly employed on farms/ranches in the region.

Function 3: External Advisory Board

HICAHS continues to meet in person annually with its Advisory Board. The board has assisted HICAHS with connecting to the agricultural industry and dissemination of findings. For the 2011 Grant Renewal the board members also contributed to strategic planning and the development of the proposals and wrote letters of support to HICAHS. See Appendix 4 for a list of Dairy Board responsibilities.

The HICAHS Dairy Advisory Board was formed in 2010 of various stakeholders who had been involved in HICAHS projects. The first Dairy Advisory Board Meeting was held in April 2011 with 12 members representing dairy producers, extension specialists, and equipment manufacturers. The Board guides and directs all HICAHS dairy-related projects, as well as serves as a medium for dissemination of findings.

Function 4: Interdisciplinary Coordination Plan

A broad range of interdisciplinary teams was assembled for every project in the 2007-2011 funding cycle. The nationally recognized investigators brought expertise in occupational and pulmonary medicine, exposure assessment, ergonomics, education and evaluation, occupational psychology, microbiology, toxicology, environmental chemistry, epidemiology and biostatistics, agriculture, veterinary medicine, engineering, and human behavior. The Administrative team promoted interdisciplinary coordination through a variety of activities such as the monthly internal advisory committee meetings, training opportunities, seminars, and conferences (see Outreach section below). All Cores provided interdisciplinary training opportunities and regular seminars for graduate, post-doctoral students, and health and safety professionals.

Function 5: Outreach

HICAHS outreach activities included updating the website to more effectively communicate Center activities, translate research findings through project summaries, provide educational materials, announce coming events, and solicit pilot projects. HICAHS has continued to provide leadership to the ACE project (V. Buchan, PI) to develop more effective tracking methods of activities, products, and translation of research of findings. The ACE project has received continuation funding via a supplement to the Administrative Core. Our outreach efforts were coordinated closely with the Translation/Dissemination project and included activities in all states in Region VIII.

As researchers completed the first years of the funding cycle, dissemination and translation of findings were evident in a rise in conference and workshop presentations, newsletter submission, professional presentations, and trainings. The number and types of products produced by HICAHS (aside from pilot program recipients) has reached a total of 225 products as of the preparation of this application including conference presentations (82), reports (7), Webinars/CE (17), trade publications (9), standards (1), testimonies (1), student theses (20) conferences hosted and/or led (21) and peer reviewed articles (67). Outputs are listed in Appendix 2.

HICAHS is continuing to reach out to the agricultural community regarding emergency preparedness. Colorado State University Professor Thomas Johnson is evaluating strategies for decontaminating livestock in the case of nuclear fallout. To help disseminate prevention advice to farmers, HICAHS has utilized its network of partners to publicize the results of this ongoing project. Strategies for Radioactive Decontamination of Livestock Webinar accessible at http://texaseden.org/disaster-resources/2012/03/strategies-for-radioactive-decontamination-of-livestock-webinar/

Consultation

- Consultation was provided to constituents to resolve: 1) Health effects inside a tractor cab from exhaust and 2) Respiratory illness among veterinarians and livestock in a horse barn due to exposure to bioaerosols.
- HICAHS faculty worked with the Colorado Environmental Pesticide Education Program, helping to coordinate and support training programs specially targeting monolingual Spanish speaking workers using narrative story telling as a means to reach low literacy workers.
- Continued coordination with the OSHA Consultation program at CSU to identify needs among agricultural workers.
- Dr. Reynolds provided assistance to the Colorado Department of Public Health and Environment responding to an outbreak of E. coli O111 among inmates (18 cases) in a Colorado correctional facility that was associated with their dairy operation. NIOSH Western States Office also partnered on this effort. Infections were mainly seen among food service workers and cell mates of dairy workers, but were traced to the dairy cattle. Dairy facilities, operations, and work practices were reviewed and recommendations provided to prevent animal to human transmission of E. coli O111 in the dairy, and secondary transmission of E. coli from dairy workers to other inmates.
  Since the conclusion of the intervention the number of infections has been greatly reduced. There has been only one new reported case of STEC O157 infection at the facility (January 2011). This case did not result in transmission to other dairy workers or other locations in the prison. More information can be found in this CDC article: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6109a1.htm
- Dr. Reynolds served as backup for Dr. Roy Buchan as AIHA representatives on the NORA Agricultural Health Committee.
- HICAHS faculty worked with Claudia Arrieta and the staff of the Colorado Environmental Pesticide Education Program to deliver training video sessions to Colorado Corn and Potato Growers.

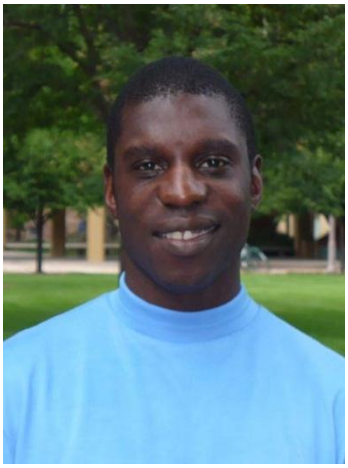
Function 6: Feasibility Projects

During the last cycle HICAHS distributed 12 pilot/feasibility awards, funded between $10,000 to $20,000 each. Sixteen applications were received during this period, with 2 of every 3 applications funded. The Pilot/Feasibility Program aims to foster the development and training of young researchers and junior investigators to conduct innovative research that promotes agricultural health and safety. Because the successful translation of research into practice requires market penetration and industry acceptance, the program is designed to foster collaborations between academic researchers and industry stakeholders. The Pilot/Feasibility Program has been a leader fostering innovation through collaboration.

Approach. Our application/review process is based on the grants programs administered by the National Institutes of Health (NIH), and helps familiarize our junior investigators with one of the most common federal grant systems (CDC/NIOSH uses the same system). Our merit review process mimics that of a typical study-section review. In addition to providing feedback from reviewers, HICAHS also facilitates mentoring by more seasoned investigators. We believe that bringing young investigators into the field of agricultural and forestry health and safety will pay strong dividends in the long term, as many of these investigators may choose to remain active in the field given an initial funding success. Developing new partnerships with other academic institutions, state and federal agencies, and with private industry has enabled HICAHS to promote agricultural health and safety through applied research.

Results. This program has been highly successful, leading to the generation of federally-funded R01 grants, the development of new educational materials and intervention techniques, the training of student and junior investigators, and publication of peer-reviewed journal articles and conference presentations. Of the twelve awards made from 2006-2011, all but two were made to junior investigators (7 assistant professors, 2 postdoctoral researchers, and one research associate). Six have received academic promotions and are now Assistant or Associate Professors making important contributions to agricultural health and safety at Colorado State University, the University of Nebraska, the University of Texas, and the University of Utah.
Two examples are highlighted below.

Dr. **Lawrence Goodridge**'s project "*Chemical Analyses of bacterial composition and potency in agriculture*" (funded in 2008) and *"Evaluation of a Bacteriophage Cocktail to Reduce E. coli O157:H7 Shedding in Beef Cattle"* (funded in 2004) investigated new ways to protect animals and food supplies from harmful bacteria. As a result of his studies, Dr. Goodridge partnered on a major research grant with the National Cattlemen's Beef Association in 2005. This pilot award facilitated expansion of Dr. Goodridge's research to include agricultural workers. Dr. Goodridge is now considered a leading expert on pathogen detection and food security in the U.S. He is now an Associate Professor in the Department of Animal Science at Colorado State University and He also became a very active collaborator and is Co-Director of the Research Core in the current HICAHS grant period (2011-2016).



Dr. Larry Goodridge has built a career on academic/industry partnerships.

Dr. Jill Poole presents research results to an audience at the National Institutes of Health.

Dr. **Jill Poole**'s project *"Inflammatory relationship of gram positive & gram negative bacteria in occupational & agricultural environments"* (funded in 2008) revealed the presence of new bacteria in large animal farming environments. A key finding is that the (new) Gram-positive bacteria are playing an important role in inflammatory lung disease. As a result of her pilot research, Dr. Poole recently was awarded a prestigious NIEHS Outstanding New Environmental Scientist Award (ONES) award (1R01ES019325, 9/2010-2015), entitled "Role of pattern recognition receptors in organic dust-induced airway inflammation' (DHHS 2010). Dr. Poole is a physician (allergist/immunologist) and is now an Associate Professor at the University of Nebraska Medical Center. She continues to work with HICAHS researchers and stakeholders.

Table 1. *HICAHS Pilot Program Grant Recipients (2007-2011)*

Year Funded	Principal Investigator(s)	Project Title
2011	Cheryl Beseler	Readiness to address water quality and quantity in Yuma County, Colorado
2010	Michael Pate	Reducing Injuries Associated with Confined Spaces in Agriculture
2010	Noa Roman-Muniz & Claudia Arrieta	Use of Pesticides and Other Chemicals on Colorado Dairy Farms
2010	William Hanneman	Herbicide Induced Reproductive Dysfunction
2010	Paul Gunderson	Feasibility of Analyses of Non-therapeutic Antimicrobial Agent Fate within Northern High Plains Calcareous Soil Zones and Implications for Agricultural Worker Health
2009	Louise Quijano	Seasonal and Migrant Farmworker Stress: Mental and Physical Health Implications
2009	David Douphrate	Direct Measurement of Physical Risk Factors of Awkward Posture and Repetition Involving the Upper Extremity among Large Herd Dairy Parlor Workers
2009	Chandran Achutan	Occupational Exposures to Fine Particulate Matter at an Animal Feeding Operation
2008	Jill Poole	Inflammatory relationship of gram positive & negative bacteria in occupational & agricultural environments

2008	Andrew Merryweather	Slip, Trip, and Fall Injuries Among Tractor Operators
2008	Lawrence Goodridge	Evaluating the Presence of CTX-M ESBLs in Colorado Dairy Workers
2008	Rena Saito	Chemical analyses of bacterial composition and potency in agriculture

Leveraged Funds

- **Jill Poole** (2010-2015). Outstanding New Environmental Scientist Award (ONES) award entitled "Role of pattern recognition receptors in organic dust-induced airway inflammation" (DHHS/NIEHS 2010 # 1R01ES019325).
- **Goodridge** (2005). Evaluation of a Bacteriophage Cocktail to Reduce Escherichia coli O157:H7 Shedding in Beef Cattle. Funded by the National Cattlemen's Beef Association (NCBA).
- Reynolds (2011-2016). Bioaerosol Exposures and Models of Human Response in Dairies and Cattle Feedlots. HICAHS R01 project funded by NIOSH. Leveraged in part through the work of pilot program recipients **Rena Saitu** and **Jill Poole**:

Please see Appendix 2 for a list of HICAHS Pilot Program Publications and Presentations

METHODOLOGY - Please see individual sections describing the functions above.

RESULTS AND DISCUSSION - Please see individual sections describing the functions above.

CONCLUSION

HICAHS projects were successful in meeting the goals of the 2007 grant proposal. Notable accomplishments were the formation of strategic partnerships in the dairy industry, creation of HICAHS Dairy Initiatives, and the various national and international leadership positions of HICAHS researchers. HICAHS continues to engage the community to promote agricultural health and safety. Its successful feasibility program is enhancing the sustainability of agricultural health and safety for future generations by training a new generation of researchers.

INCLUSION ENROLLMENT REPORT – Not applicable

INCLUSION OF CHILDREN – Not applicable

MATERIALS AVAILABLE FOR OTHER INVESTIGATORS – Not applicable here – see individual project reports.

PUBLICATIONS – *See Appendix 2*

Agricultural Center Evaluation (ACE) Project

Administration Core
Victoria V. Buchan (970-491-5211, Victoria.buchan@colostate.edu)
2006-2010

Section 1

SIGNIFICANT FINDINGS

Specific aim 1: Demonstrate Initiative progress and accountability on NIOSH objectives. Annual NIOSH Agricultural Center Initiative Evaluation (ACE) Project Reports were produced from 2006 - 2010. The last three reports included summary data for Fiscal Years 2007 –2010.

Specific aim 2: Facilitate inter-Center/NIOSH collaboration. Annually planned and conducted 2-day workshops for all ACE team members to discuss and modify program monitoring questions, database design, and reporting. Modifications to the database were made regularly to meet the Agricultural Center Initiative's needs. Collaboration within the ACE team facilitated communication regarding ongoing areas of interest (e.g. dairy health and safety) and the development of funded projects (e.g. Tractor Safety Initiative). Supporting participation in ACE, each team member was funded through NIOSH during Fiscal Years 2009 and 2010.

Specific aim 3: Assist Initiative and individual Center program planning. Over time, the monitoring model has provided a longitudinal perspective which allowed for a cumulative view on progress and programmatic changes by NIOSH or individual Centers. Individual Centers maintain ownership of their Center data and provided data to the lead Center for the aggregated ACE report. The Yearly ACE report provided NIOSH and each Center a snapshot of progress on NORA goals, demographics and about the target populations served by the Initiative.

Specific aim 4: Increase NIOSH AgFF Initiative effectiveness through consistent feedback and selective replication efforts. The ACE database and report provided a listing of all Agricultural Center Initiative activities and products which provided funding accountability. Reporting also assisted with the reduction in duplication of efforts related to Agricultural Center Initiative work and increased efforts to share materials, program, products to aid in decisions related to replication and/or piloting.

Specific aim 5: Revise database as necessary to increase utility for progress and year-end reporting requirements. With assistance from the Southwest Center, the ACE project was able to incorporate NIOSH progress and year-end reports into the project database.

TRANSLATION OF FINDINGS

The model for this project, program monitoring, provided a picture of the scope, reach, and intensity of the Agricultural Center Initiative's work across the nation. A monitoring approach to evaluation provides the administration with the access to information that improves Agricultural Center Initiative planning, enhances collaborative opportunities, addresses accountability, and helps set the stage for

targeted outcome assessment. The monitoring model also provides a longitudinal perspective on the Center Initiative's progress, populations served, and programmatic or structural changes.

OUTCOMES/IMPACT

Intermediate Outcomes

1. Developed and revised ACCESS database to incorporate PHS 2590.
2. Yearly NIOSH Agricultural Center Initiative Evaluation Project Report (2006-2010).
3. Annual 2-day workshops for all ACE team members.
4. Development of a model for multi-site evaluation without establishment in the cooperative agreements.
5. Through the process of the ACE project, evaluation become recognized and supported by NIOSH administrators.

Section 2

BACKGROUND

In 1990, the National Institute for Occupational Safety and Health (NIOSH) responded to Public Law 101-517 and developed a funding program to establish extramural centers for Agricultural Disease and Injury Research, Education, and Prevention. Due to the vast regional differences in agricultural production and practices across the United States, NIOSH chose to add additional Centers roughly corresponding to Public Health Service Regions. At recent cycle end (2006-20120), the Agricultural Center Initiative consisted of seven Agricultural Centers mandated to undertake research, develop prevention and education programs and provide consultation to constituents across the United States in an expanded North American Industry Classification System (NAICS), occupational sub code 11, Agriculture, Forestry, Fishing and Hunting.

The mission of the Agricultural Center Initiative is to reduce injury and disease in three of the most hazardous occupations in the United States: agriculture, forestry, and fishing. This mission is to be accomplished by addressing the following objectives:

1. Conduct research related to the prevention of occupational disease and injury among producers, workers and their families.

2. Develop, implement and evaluate educational and outreach programs for promoting health and safety for production agriculture/forestry/fishing including farmers, workers and their families. This would include providing consultation and/or training to researchers, health and safety professionals, graduate/professional students, agricultural extension agents, and others in a position to improve the health and safety of workers.

3. Develop, implement and evaluate model programs for the prevention of illness and injury among agriculture/forestry/fishing producers, workers and their families.

4. Develop linkages and communication with other governmental and non-governmental bodies involved in health and safety with special emphasis on communications with other agricultural/forestry/fishing health and safety programs (PAR-06-057).

In 1997 the High Plains Intermountain Center for Agricultural Health and Safety (HICAHS) obtained funding to begin the process of developing an Agricultural Center Initiative evaluation effort. Representatives from NIOSH and existing Centers attended biannual workshops, hosted by HICAHS, and collaboratively developed an Initiative database and defined indicators of progress on objectives. Reports were produced by the evaluation group for fiscal years 1999-2001, and with renewed funding 2004-2007.

NIOSH awarded supplemental funding to continue the multi-site program evaluation for fiscal years 2008 – 2010. The reports for each FY were slightly altered each year based upon feedback received and suggestions made by the ACE team. In addition, with the assistance of a small subgroup, consisting of NIOSH, the Southwest Center team members and HICAHS, forms were developed in ACCESS™ that allow

Centers to pull up reports by project with the necessary components to more easily respond to NIOSH requirements for year-end and progress reports.

SPECIFIC AIMS

Specific aim 1: Demonstrate Initiative progress and accountability on NIOSH objectives. Annual NIOSH Agricultural Center Initiative Evaluation (ACE) Project Reports were produced from 2006 - 2010. The last three reports included summary data for Fiscal Years 2007 –2010.

Specific aim 2: Facilitate inter-Center/NIOSH collaboration. Annually planned and conducted 2-day workshops for all ACE team members to discuss and modify program monitoring questions, database design, and reporting. Modifications to the database were made regularly to meet the Agricultural Center Initiative's needs. Collaboration within the ACE team facilitated communication regarding ongoing areas of interest (e.g. dairy health and safety) and the development of funded projects (e.g. Tractor Safety Initiative). Supporting participation in ACE, each team member was funded through NIOSH during Fiscal Years 2009 and 2010.

Specific aim 3: Assist Initiative and individual Center program planning. Over time, the monitoring model has provided a longitudinal perspective which allowed for a cumulative view on progress and programmatic changes by NIOSH or individual Centers. Individual Centers maintain ownership of their Center data and provided data to the lead Center for the aggregated ACE report. The Yearly ACE report provided NIOSH and each Center a snapshot of progress on NORA goals, demographics and about the target populations served by the Initiative.

Specific aim 4: Increase NIOSH AgFF Initiative effectiveness through consistent feedback and selective replication efforts. The ACE database and report provided a listing of all Agricultural Center Initiative activities and products which provided funding accountability. Reporting also assisted with the reduction in duplication of efforts related to Agricultural Center Initiative work and increased efforts to share materials, program, products to aid in decisions related to replication and/or piloting.

Specific aim 5: Revise database as necessary to increase utility for progress and year-end reporting requirements. With assistance from the Southwest Center, the ACE project was able to incorporate NIOSH progress and year-end reports into the project database.

METHODOLOGY

In 1995 an external evaluation was completed of the Centers and has become known as the Kennedy Report. In response to this report, one Center (HICAHS) proposed the establishment of a team consisting of representatives from each Center to design and develop a multisite approach to the evaluation of all the Centers as an Initiative: The Agricultural Center Evaluation (ACE) Project. Representatives from each Center met during a series of workshops between the years 1997—1999 to develop evaluation research questions and define indicators to measure the work of the Centers overall. The lead Center then developed a database which allowed each Center to collect data in a standardized

and consistent manner. The lead Center is responsible for the aggregation of all Centers' data into one database. The first pilot report was published in 1999 and reports have continued almost every year since with interruptions due to funding issues. Agricultural Center Initiative data combined the productivity of all Centers to provide the necessary results to address evaluation questions developed and revised by the ACE team.

Program Monitoring

Program process evaluation consists of continuous monitoring of indicators of selected aspect of program process…it can be a useful tool for facilitating effective management of social programs by providing regular feedback about how well the program is performing its critical functions (Rossi, Lipsey & Freeman, 2004, p. 177). Program monitoring is a major evaluation methodology utilized by business, government, and private enterprises. It involves the continuous collection of selected data, usually related to the objectives of the organization, and the use of a database or statistical package to analyze the information and produce reports. A monitoring approach to evaluation enhances "administrative intelligence" that is, continual access to information which improves the ability of administrators to plan, to revise operations, and to make midstream adjustments to programming (Rossi, Lipsey, & Freeman, 2004).

The database (Table 1) developed for the Agricultural Center Initiative offers a collective perspective on Initiative progress on NIOSH objectives and NORA research categories. Monitoring also provides an overview of the demographics and numbers of target populations served by the Center Initiative. Over time, the monitoring evaluation model provided a longitudinal perspective which allowed not only a review of progress, but follow-up information on programmatic and/or structural changes that had been made.

Research Questions

The evaluation questions that the ACE project sought to address each fiscal year are listed below:

1. What were the target populations or audience contacts by specific activities by the Center Initiative during FY 20__?
2. What were the target groups of the Center Initiative work during FY 20__?
3. What research projects did the Center Initiative undertake in FY 20__? By NORA research priority?
4. What special sector activities has the Center Initiative undertaken during FY 20__?
5. What products has the Center Initiative produced in FY 20__?
6. What collaborative efforts have occurred during FY 20__?
7. For what degrees and professional disciplines did the Center Initiative provide education during FY 20__?
8. What was the reported monetary value leveraged by the Center Initiative (in dollars and in-kind support) during FY 20__?
9. In which states was Center Initiative active during FY20__?
10. What types of agriculture were addressed nationwide by Center projects?
11. What research to practice (r2p) accomplishments were undertaken during FY20__?

Table 1. *Database Overview*

IDENTIFYING INFORMATION				
Center Name	**Project Title and Description**	**Center/Project Objective**	**PI /Project Contact Person**	**Project Dates**
KEY INDICATORS				
Type of Agriculture	**Contact Numbers**	**Activities**	**Academic Degrees**	**Products**	**Audience Demographics**
Collaboration	**Leveraging**	**Regionalization**	**Special Sector**		
NIOSH SPECIFIC INDICATORS				
Core **Administrative and Planning** **Education and Outreach** **Multi-Disciplinary Research** **Prevention-Intervention**	**NORA** **Priority Research Area (for Research)** **Disease and Injury** **Work Environment and Workforce** **Research Tools and Approaches**	**Research to Practice:** **Intervention and Education** **Research** **Field Use** **Policy** **Academia** **Evaluation** **Technical Assistance** **Surveillance**		

Beginning with Fiscal Year 2008 ACE reported cumulative data based upon the Agricultural Center Initiative's work since 2005. The Fiscal Year 2008 report summarized cumulative data for years 2005 – 2008. The Fiscal Year 2009 report summarized cumulative data for years 2007 – 2009. The final report for fiscal year 2009 summarized cumulative data for years 2001-2010. The cumulative reporting was based upon many of the same research questions identified for the individual fiscal years.

Limitations

Multisite evaluation efforts present methodological limitations for a number of reasons: the most difficult of these limitations is that they are usually begun "after the fact." The Agricultural Center Initiative had been in existence for seven years prior to working collaboratively, and each Center had developed its own methods of project evaluation and reporting format. The only logical approach therefore was to involve all of the Centers, and form a collaborative team approach to developing the evaluation model and implementations procedures. As Table 2 below illustrates, there were changes over the last funding cycle related to which Centers were funded and who provided data to the ACE project. The National Children's Center participated in 2006 and 2007, but has a different list of goals and objectives, which made a goodness of fit with the evaluation model difficult.

Table 2. *Funding for Centers under the Agricultural Center Initiative 2006 - 2010*

	Funding cycle 1					Funding cycle 2					
Fiscal Year	2006		2007			2008		2009		2010	
	Funded	Data	Funded	Data		Funded	Data	Funded	Data	Funded	data
Great Lakes Center	√	√	B	√		B	√	⊘	⊘	⊘	⊘
Great Plains Center	√	√	√	√		√	⊘	√	√	√	√
HICAHS	√	√	B	√		√	√	√	√	√	√
Northeast Center	√	√	√	√		√	√	√	√	√	√
PNASH	√	√	√	√		√	√	√	√	√	√
Southeast Center	√	√	√	√		√	√	√	√	√	√
Southern Coastal	√	√	B	√		B	√	⊘	⊘	⊘	⊘
Southwest Center	√	√	√	√		√	√	√	√	√	√
Western Center	√	√	√	√		√	√	√	√	√	√
Children's Center *	√	√	√	√		√	⊘	√	⊘	√	⊘

Note: * The National Children's Center for Rural and Agricultural Health and Safety responds to different legislation and objectives and has chosen not to submit data since FY 2007.

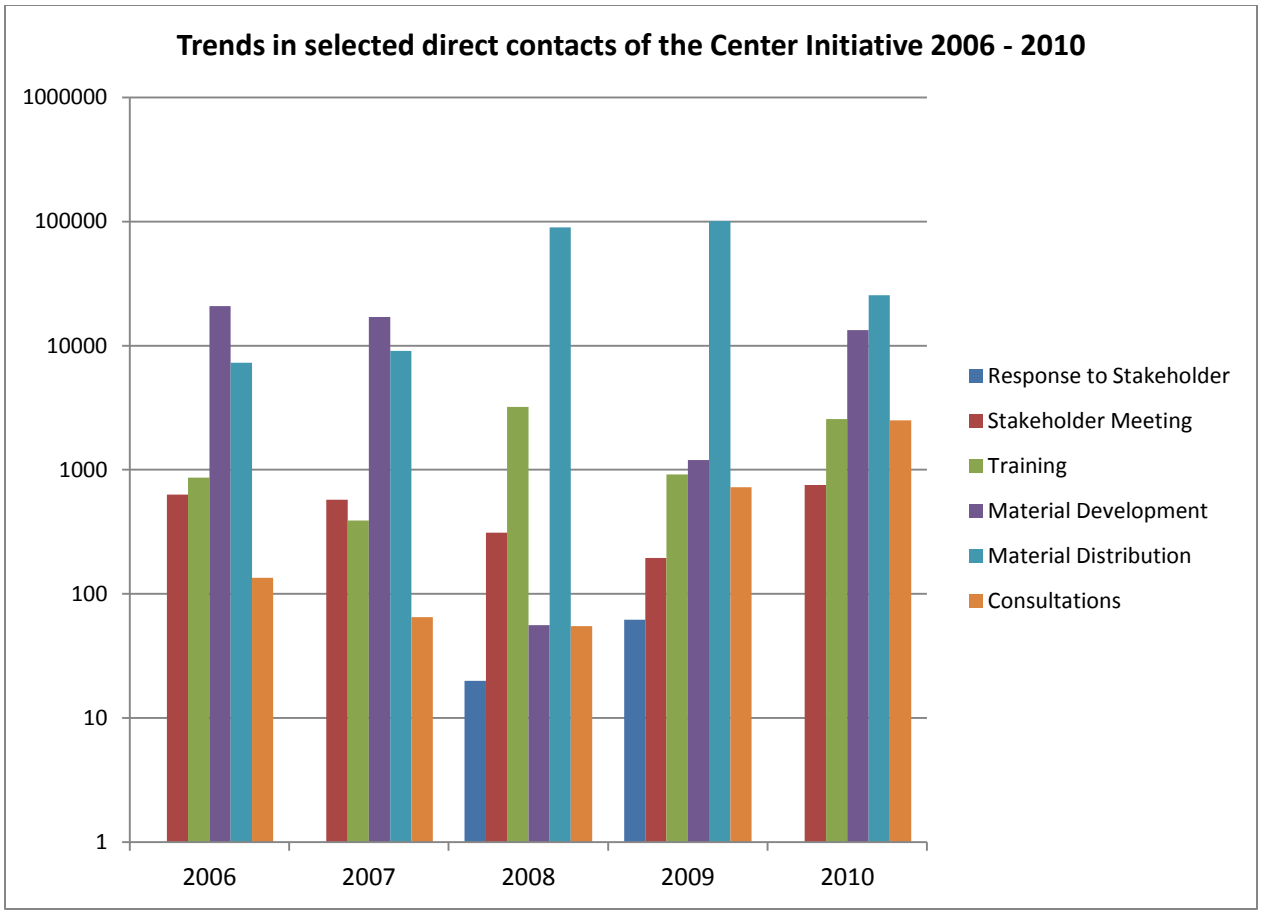
√ = Yes ⊘ = No B = Bridge funding to assist Center to reapply for full Center status

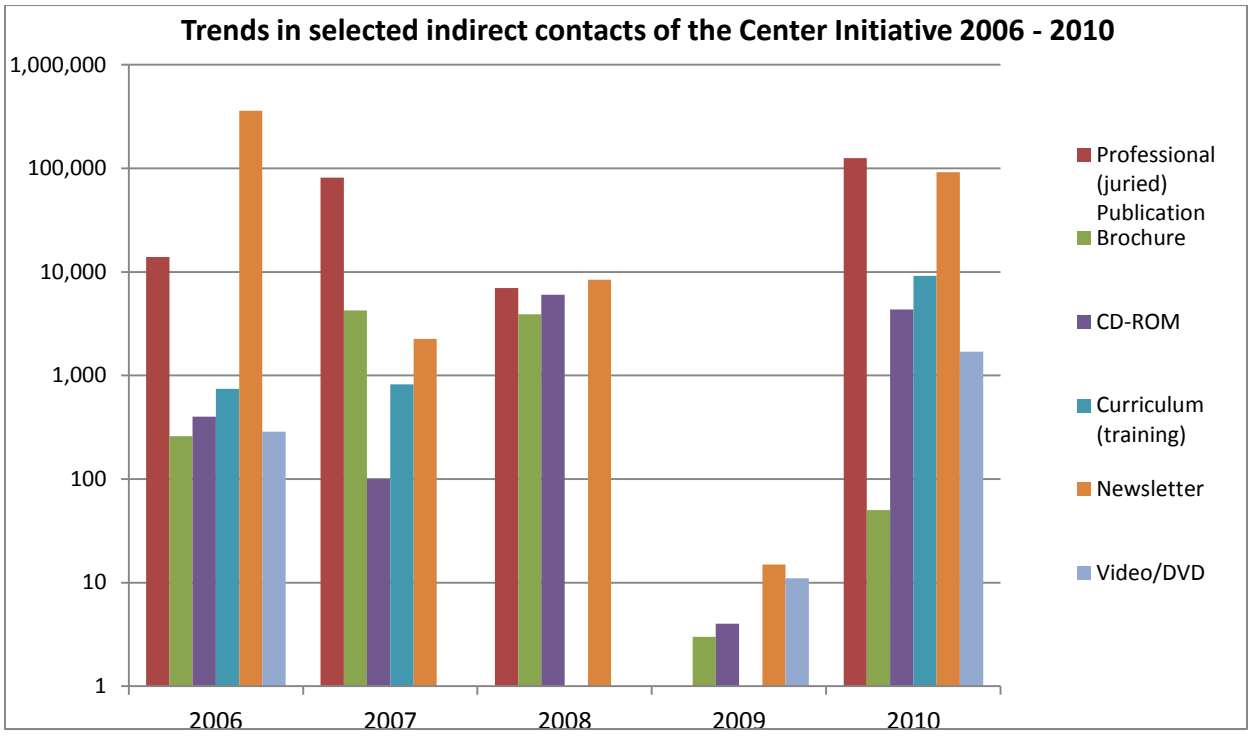
Both the reliability and validity of the data collected and forwarded to HICAHS are impacted by a number of limitations, key among these were personnel changes, and with those changes alterations in data collection procedures. It takes time to train ACE team members on both how to collect data on Center projects and how to enter it into the ACCESS database. They in turn need to work with their own Center principal investigators to provide the necessary data per project funded.

Our experience indicates that each time there are personnel changes either on Center projects or with ACE team participation, the potential exists for the Center to lose both data and reliability related to that data. Personnel changes are clearly unavoidable, but it is important to acknowledge the limitations that accompany such events. Part of the responsibility of the lead Center is to increase reliability by data editing as each team member forwards their Center data, a step which provides the opportunity to check back with team members to verify or correct information collected. During fiscal year 2010 seven AgFF Centers were fully funded.

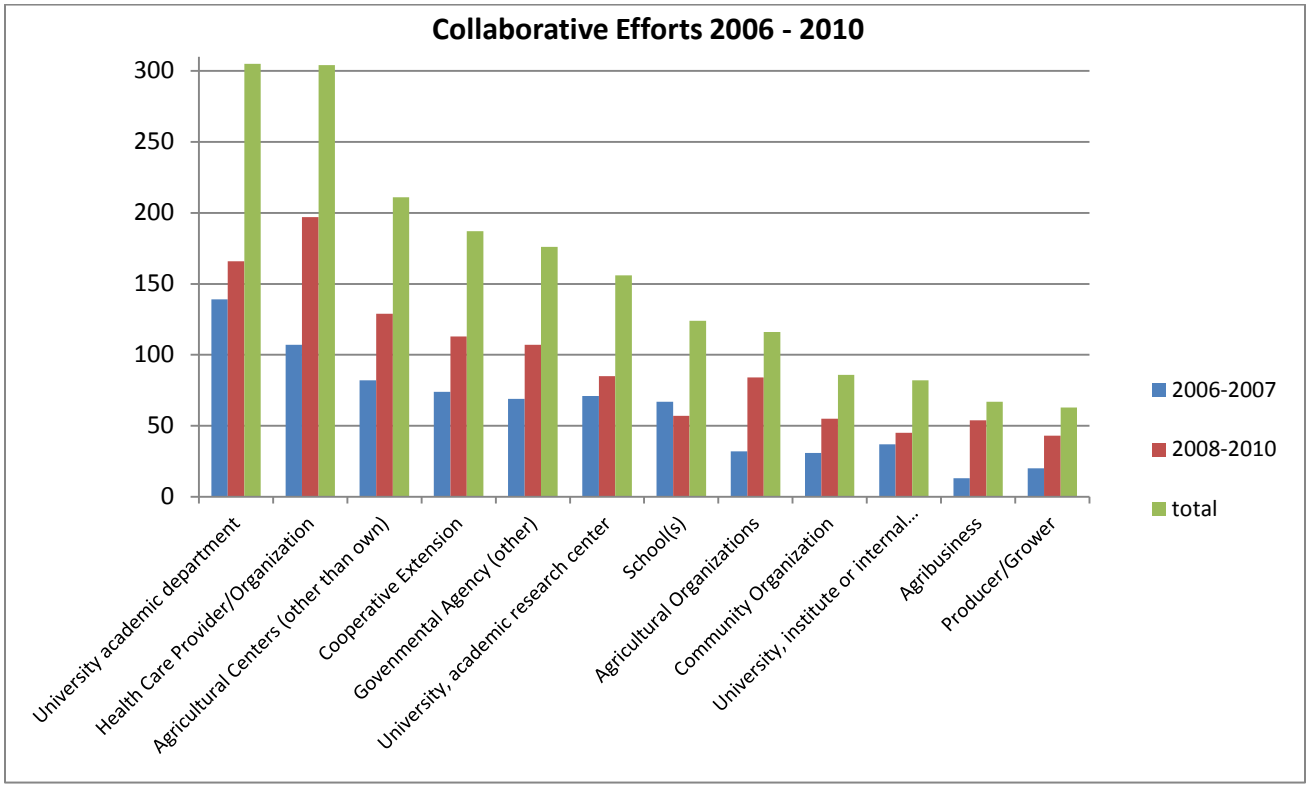
RESULTS AND DISCUSSION

[RQ 1] Almost a million (907,849) direct and over 2 million (2,867,454) indirect contacts have been made by Center personnel between 2006 and 2010. A total of almost 4 million (3,775,303) contacts have been made to include stakeholder meetings, training, material development, publications, DVD/Video, and training curriculums. The Center Initiative has met the mission of directly connecting with constituents in a variety of ways over the last funding cycle.

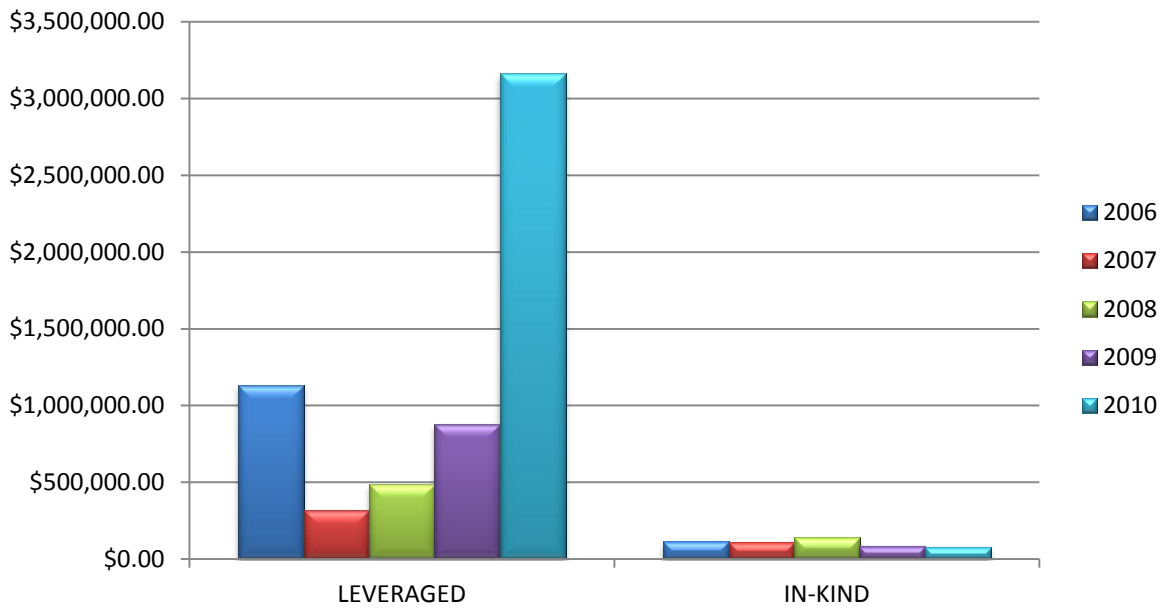

Trends in selected direct contacts of the Center Initiative 2006 - 2010
1000000
100000
10000
1000
100
10
1
2006
2007
2008
2009
2010
Response to Stakeholder
Stakeholder Meeting
Training
Material Development
Material Distribution
Consultations


Trends in selected indirect contacts of the Center Initiative 2006 - 2010
1,000,000
100,000
10,000
1,000
100
10
1
2006
2007
2008
2009
2010
Professional (juried) Publication
Brochure
CD-ROM
Curriculum (training)
Newsletter
Video/DVD

[RQ 6] Collaboration within the ACE team facilitated ongoing communication among Agricultural Centers' staff and investigators. The development of funded projects (e.g. Tractor Safety Initiative) and potential collaborations in areas of interest (e.g. dairy health and safety) were often developed out of the collaborative nature of the ACE project. Outside of the collaborations amongst Agricultural Centers, collaborations increased as the project and project researchers moved along in the funding cycle.



[RQ 8] The total dollars leveraged from 2006 – 2010 was over 6 million dollars ($6,510,190.00). The amount of money leveraged by the Initiative increased each year from 2007 to 2010. The leveraged dollars added considerable additional funding to support the work of the Centers and the Initiative.



From a funding cycle trend perspective, it appears that as collaborative relationships have grown and increased so too has the ability of the Initiative's Centers to leverage dollars.

CONCLUSION

Thanks to NIOSH for the continued support for evaluation; the AgFF Centers have completed a full funding cycle with continuous program monitoring. Over the years and despite some funding hiatuses, the ACE team has demonstrated remarkable collaboration both in development of the approach to the Center Initiative Evaluation as well as in making the necessary modifications in variable definitions and data collection procedures. NIOSH continued to play a very supportive and collaborative role. A key role the team played was to establish a second level of communication between the Centers (other than the Center Directors) which served to facilitate inter Center sharing of project information, products and the potential for collaborative projects.

INCLUSION ENROLLMENT REPORT – *Not applicable*

INCLUSION OF CHILDREN – *Not applicable*

MATERIALS AVAILABLE FOR OTHER INVESTIGATORS – *Not applicable*

PUBLICATIONS

Buchan, V. & Danhoff, K. (January, 2011). *The NIOSH Agricultural Center Initiative Evaluation Project Fiscal Year 2010 Report.* HICAHS, Colorado State University. Fort Collins, CO.

Buchan, V. & Holmquist-Johnson, H. (December, 2005). *The NIOSH Agricultural Center Initiative Evaluation Project – Pilot Report 2005.* (Contract # 212-200409852). HICAHS, Colorado State University. Fort Collins, CO.

Buchan, V. & Holmquist-Johnson, H. (January, 2006). *The NIOSH Agricultural Center InitiativeEvaluation Project.* (Contract # 212-200409852). HICAHS, Colorado State University. Fort Collins, CO.

Buchan, V. & Holmquist-Johnson, H. (January, 2007). *The NIOSH Agricultural Center Initiative Evaluation Project Fiscal Year 2006 Report.* (Contract # 212-200409852). HICAHS, Colorado State University. Fort Collins, CO.

Buchan, V. & Holmquist-Johnson, H. (January, 2008). *NIOSH Agricultural Center Initiative Evaluation Project fiscal year 2007 report.* HICAHS, Colorado State University. Fort Collins, CO.

Buchan, V. & Holmquist-Johnson, H. (January, 2009). *NIOSH Agricultural Center Initiative Evaluation Project fiscal year 2008 report.* HICAHS, Colorado State University. Fort Collins, CO.

Buchan, V. & Holmquist-Johnson, H. (January, 2010). *NIOSH Agricultural Center Initiative Evaluation Project fiscal year 2009 report.* HICAHS, Colorado State University. Fort Collins, CO.

Holmquist-Johnson, H. & Buchan, V. (March, 2002). *The NIOSH Agricultural Center Initiative Evaluation Project Fiscal Year 2006 Report.* HICAHS, Colorado State University. Fort Collins, CO.

Tungate, S. & Buchan, V. (June, 2000). *NIOSH Agricultural Center Initiative Multisite Evaluation Pilot Report.* HICAHS, Colorado State University. Fort Collins, CO.

Occupational Lung Disease and Endotoxin Exposure in New Dairy Workers

Research Core
Stephen J. Reynolds (970-491-3141, Stephen.Reynolds@Colostate.edu)
2007-2012

Section 1

SIGNIFICANT FINDINGS

In the past three decades the US Dairy industry has moved to a large-herd, mass production model with a goal of increased milk production at lower cost. Expanding production capacity has required a larger workforce, primarily comprised of non-English speaking Latino workers with minimal experience in agriculture. Despite significant advances in technology, respiratory disease remains an important problem for dairy workers, contributing to lost time and high turnover. Exposure to organic dusts generated during milking, moving cows, feeding and other tasks has been associated with increased inflammation and decreased lung function resulting in chronic obstructive pulmonary disease (COPD), and asthma-like diseases. Much research into the cause of respiratory disease in agriculture has focused on the role of endotoxins – a chemical component of Gram-negative bacteria. Recent research suggests that other components of these dusts such as Gram-positive bacteria and fungi are also important. Many new workers adapt to these exposures, and new evidence suggests that individual behavior and genetic factors play a key role in explaining why some workers are more susceptible. In a highly competitive global market it is critical that Dairy owners and managers sustain a healthy, productive workforce.

Specific Aim 1: Characterize worker (n=184) exposure to endotoxin, muramic acid and ergosterol-containing aerosols and evaluate respiratory outcomes including symptoms, pulmonary function and quantitation of cellular/immune markers (cytokines) of inflammation using both peripheral blood and nasal lavage. **Key Findings:** 89% of dairy workers were exposed to endotoxin concentrations that exceeded the recommended Occupational Exposure Limit (OEL) for workers, adjusted for average duration of work shift in dairies. Workers milking and moving cows were exposed to higher concentrations of bioaerosols. Over 50% of workers experienced a cross-shift decline in FVC and FEV_1. Workers with a cross shift increase in inflammatory response had a greater mean cross-shift decline in pulmonary function. While there was no clear simple relationship between exposures and pulmonary function, preliminary analyses suggest a possible influence of effect modifiers such as pesticide exposure or genetics as was observed in our previous study (Reynolds, 2012). Further analysis is currently underway to explore effect modifiers of lung function in relation to exposures.

Specific Aim 2: Compare the exposures and health outcomes among Colorado dairy workers to the results of a comparable study of California dairy workers (conducted by the Western Center for Agricultural Health and Safety) (n=200). **Key Findings:** Colorado and Wyoming dairy parlor workers were exposed to higher endotoxin concentrations in comparison to Californian dairy workers in similar

tasks/environments. Preliminary comparison showed pulmonary function findings from the California and Colorado studies to be similar – both indicated a mild cross shift obstructive effect. Further analysis comparing the two data sets is currently underway.

Specific Aim 3: Evaluate a subset of new (naïve) workers at 0 (n=92) and 1 month (n=92) and 1 year (n~46). – altered due to problems with recruitment. **Key Findings:** This Aim was dropped when the dairy industry experienced a severe downturn and stopped hiring new workers. Analyses for muramic acid and ergosterol were added to Aim 1.

Specific Aim 4: Evaluate whether endotoxin assay or GC/MS (specific 3 hydroxy fatty acids) is the best predictor of biomarkers and changes in pulmonary function. **Key Findings:** This analysis is in progress.

Specific Aim 5: Survey genetic markers related to lung disease and the endotoxin pathway by performing association testing for polymorphisms in the candidate innate immunity genes TLR4, TLR9, MD2, CD14, IL1-RN, IFN-gamma and TNF-alpha). **Key Findings:** This analysis is in progress.

Specific Aim 6: To identify job factors associated with highest exposures and greatest risk of respiratory disease and work with ILM and the dairy industry throughout the region to develop cost-effective, culturally acceptable interventions to reduce exposures; and to disseminate information on interventions via the dairy industry associations, and Cooperative Extension and by incorporation into ILM worker training programs. **Key Findings:** More frequent washing of dairy parlors during milking reduced endotoxin and respirable dust exposures.

TRANSLATION OF FINDINGS

The overall goal of this research program is to better understand the factors that result in respiratory disease in the dairy industry, and to develop effective interventions for prevention and control. We have worked closely with the dairy industry and other researchers on a comprehensive approach to:

- Improve methods for exposure assessment to ensure that measurements are accurate and relevant.
- Identify organic dust components that cause an inflammatory response in human lung cells.
- Understand the relationship between exposure and respiratory disease among dairy workers, and how this relationship is modified by other factors, such as genetic mutations.
- Evaluate the effectiveness of potential interventions to reduce exposures and prevent disease.

HICAHS researchers have disseminated relevant dairy-related health and safety information to producers via extension newsletters (e.g. New Mexico State University Dairy Extension Newsletter, Utah State University Dairy Extension Newsletter), Ag Center newsletters (e.g. AgConnections), and producer trade publications (e.g. DeLaval Environmental, Health & Safety Newsletter). Additionally, HICAHS researchers have published dairy-related research findings in several high-impact, peer-reviewed academic journals. Numerous journal submissions are currently in development. We are now working with dairy industry partners to identify and evaluate potential best practices to reduce worker exposure to bioaerosols. Based on the results of our previous work and this study, we are also working with the

industry to develop more comprehensive occupational health management programs that encompass more comprehensive wellness programs in addition to exposure reduction strategies.

OUTCOMES/IMPACT

Development of Exposure Assessment Methods

- Improved Gas Chromatography/Mass Spectroscopic methods for measuring 3-hydroxy fatty acids, muramic acid, and ergosterol were developed (Saito 2009, Poole 2011). *These improved methods for rFC endotoxin assay and GC/MSMS, were used to enhance research on exposure, health, and interventions in collaboration with researchers at the University of Texas Health Science Center in Tyler, TX (Southwest Ag Center), University of Iowa (Great Plains Ag Center), University of California Davis (Western Center for Agricultural Health and Safety), and internationally.*

Exposures Causing Inflammation

- Application of new molecular biology techniques has shown that bioaerosols in dairy and other environments are dominated by an incredibly diverse population of Gram-*positive* bacteria, which had been overlooked using traditional methods (Choudry 2012, Funk 2010).
- Dusts with high levels of Gram-positive bacteria and without Gram-negative bacterial endotoxin caused a significant inflammatory response in human lung cells (Poole 2010). *Following these results we are currently conducting new studies to more completely characterize the bioaerosol constituents in dairies and cattle feedlots and evaluating their potential for inflammatory effects using a novel sampling device incorporating human lung cells.*

Exposure – Response Epidemiological Studies

- The majority of dairy workers were exposed to high concentrations of aerosols, especially those involved in milking or moving cows. More than 50% of workers experienced a cross-shift decline in pulmonary function, indicating a mild obstructive effect. Preliminary analyses suggest a possible influence of effect modifiers such as pesticide exposure or genetics, consistent with our previous study (Reynolds, 2012). The results suggest that interventions among agricultural workers may need to include more comprehensive wellness programs in addition to exposure reduction strategies. (Reynolds 2009, Burch 2009, Reynolds 2012). *We are currently working with the industry to develop more comprehensive occupational health management programs that encompass more comprehensive wellness programs in addition to exposure reduction strategies.*

Evaluation of Interventions

- More frequent washing of animal waste from surface areas in a milking parlor was effective at reducing dairy parlor worker exposure to the respirable fraction of organic dust and endotoxin aerosols (Choudry 2012). *In collaboration with industry partners current efforts build on this*

work to conduct research applying these new tools to help develop and test improved strategies for reduction of exposures and prevention of respiratory disease.

Education/Training

- Continuing education to advance practice was provided to rural physicians, epidemiologists, industrial hygienists, engineers, toxicologists and chemists in the US and internationally.
- Ten new scientists received training (MS, PhD, Post-Doctoral). All are continuing to work in related fields, two hold faculty positions providing leadership specifically in agricultural occupational health.

Outreach

- Producers now often seek advice from HICAHS researchers for answers to address farm-specific safety issues. Producers have requested letters of support from HICAHS researchers (Douphrate and Reynolds) when applying for workers' compensation cost containment certification. Producer organizations have requested advice and assistance in addressing environmental air quality regulations as well as occupational regulations.
- HICAHS partnered with the Colorado Department of Public Health and the Environment (CDPHE), USDA Agricultural Research Service Laboratory, and the NIOSH Western States Office to investigate and resolve an outbreak of E. coli diarrheal illness among inmates at a prison. An occupational site assessment identified pathways for STEC O111 between the dairy and correctional facility and provided recommendations for prevention. Since the conclusion of the intervention there has been only one new reported case of STEC O157 infection at the facility (January 2011). This case did not result in transmission to other dairy workers or other locations in the prison.

Section 2

BACKGROUND

In the past three decades the US Dairy industry has moved to a large-herd, mass production model with a goal of increased milk production at lower cost. Expanding production capacity has required a larger workforce, primarily (> 90%) comprised of non-English speaking Latino workers with minimal experience in agriculture. Despite significant advances in technology, respiratory disease remains an important problem for dairy workers, contributing to lost time and high turnover. Exposure to organic dusts generated during milking, moving cows, feeding and other tasks has been associated with increased inflammation and decreased lung function resulting in chronic obstructive pulmonary disease (COPD), and asthma-like diseases. Much research into the cause of respiratory disease in agriculture has focused on the role of endotoxins – a chemical component of Gram-negative bacteria. Recent research suggests that other components of these dusts such as Gram-positive bacteria and fungi are also important. Many new workers adapt to these exposures, and new evidence suggests that individual behavior and genetic factors play a key role in explaining why some workers are more susceptible. In a highly competitive global market it is critical that Dairy owners and managers sustain a healthy, productive workforce. The overall goal of this program is to better understand the factors that result in respiratory disease in the dairy industry, and to develop effective interventions for prevention and control.

SPECIFIC AIMS

Specific Aim 1: Characterize worker (n=184) exposure to endotoxin, muramic acid and ergosterol-containing aerosols (these two analyses were added – see Aim 3) and evaluate respiratory outcomes including symptoms, pulmonary function and quantitation of cellular/immune markers (cytokines) of inflammation using both peripheral blood and nasal lavage.

Specific Aim 2: Compare the exposures and health outcomes among Colorado dairy workers to the results of a comparable study of California dairy workers (conducted by the Western Center for Agricultural Health and Safety) (n=200).

Specific Aim 3: Evaluate a subset of new (naïve) workers at 0 (n=92) and 1 month (n=92) and 1 year (n~46). – *This Aim was dropped when the dairy industry experienced a severe downturn and stopped hiring new workers. Analyses for muramic acid and ergosterol were added to Aim 1.*

Specific Aim 4: Evaluate whether endotoxin assay or GC/MS (specific 3 hydroxy fatty acids) is the best predictor of biomarkers and changes in pulmonary function.

Specific Aim 5: Survey genetic markers related to lung disease and the endotoxin pathway by performing association testing for polymorphisms in the candidate innate immunity genes TLR4, TLR9, MD2, CD14, IL1-RN, IFN-gamma and TNF-alpha). *Genetic analyses are being completed August 2012, due to delays in producing the SNP analytical kit.*

Specific Aim 6: To identify job factors associated with highest exposures and greatest risk of respiratory disease and work with ILM and the dairy industry throughout the region to develop cost-effective, culturally acceptable interventions to reduce exposures; and to disseminate information on interventions via the dairy industry associations, and Cooperative Extension and by incorporation into ILM worker training programs. *The HICAHS Outreach program and the Enhancing Translation/Dissemination Project will be instrumental in this effort.*

METHODOLOGY

The study population (n=116) was randomly recruited from 9 Colorado and Wyoming dairy operations which were identified through the Colorado Livestock Association and the Colorado State University ILM program (Table 1). Recruitment was facilitated through these contacts by disseminating flyers describing the study objectives and methods to their respective members. Dairy facility owners and operators were randomly selected and contacted to solicit managerial cooperation. All eligible workers, both males and females, were included unless they were under the age of 18. Both smokers and non-smokers were included; however, participants using steroidal or non-steroidal anti-inflammatory drugs were excluded from the study as these medications may interfere with the cytokine tests. The study received institutional review board approval and all participants provided informed consent in either English or Spanish. There was difficulty in recruiting naïve subjects for Aim 3 because of a decline in the milk market economy which resulted in a hiring freeze within the industry. Subsequently Aim 3 from the original report was abandoned, and muramic acid and ergosterol exposures were added to Aim 1.

Table 1. *Facility Characteristics*

	Facility								
Facility Characteristics	60	61	62	63	64	65	66	67	68
No. Employees Monitored	5	5	5	11	20	8	42	6	14
Herd Size	~1000	3000	750	1000	1300	2300	6080	1350	4000
Average Work Shift (hours)	12.0	10.6	9.2	9.6	8.9	8.7	9.0	10.3	8.6
Location	WY	CO	CO	CO	CO	CO	CO	CO	CO
Rank (smallest to biggest)	2	7	1	3	4	6	9	5	8

Following consent, study participation was completed over one full work shift, which included completion of the following: a questionnaire to ascertain demographic and work-related information; pre- and post-shift spirometry and blood sampling for cytokines; personal sampling for inhalable dust, endotoxin, muramic acid, ergosterol and ammonia during work; and, a post-shift nasal lavage and health questionnaire.

Pre- and post-shift questionnaires were based on the standard American Thoracic Society questionnaire, with modifications specific to agricultural populations that focused on acute and chronic respiratory symptoms (cough, phlegm, wheezing, shortness of breath, nasal irritation, fever/chills) and work history (job title and work duration, frequency and duration of work on dairy farms), including potential workplace exposure to hazardous or toxic substances (visible dust, metal fumes, gases/vapors, pesticide

use, respirator use), and respiratory health (allergies, asthma, chronic bronchitis, emphysema, lung cancer, cold/flu, sinus problems, pneumonia, anosmia). Questions related to symptoms not expected to be associated with organic dust exposure were included to serve as control symptoms. The post-shift questionnaire addressed cross-shift changes in acute symptoms, and the order of the questions was changed from the pre-shift to reduce possibility of subjects matching their responses with pre-shift responses.

All spirometry tests were conducted in accordance with NIOSH's Spirometry Procedure Manual using a KoKopell Spirometeri (Ferraris Respiratory Inc., Louisville, CO) , which exceeded the minimum recommendations of the American Thoracic Society and NIOSH . Pre- and post-shift temperatures were kept within 5 degrees Fahrenheit of each other to allow for accurate cross-shift comparisons of endpoints, which included: forced vital capacity (FVC); forced expiratory volume in one second (FEV_1); ratio of FEV_1 to FVC (FEV_1/FVC).

A nasal lavage fluid sample was collected at the end of each participant's work shift only because cross-shift comparisons of lavage constituents are susceptible to artifact. Collection procedures are previously described in Poole et al. (2010). Briefly, workers were seated with their necks extended back 30-40 degrees and 5 ml of normal saline were instilled in each nostril and held for 60 seconds. Subjects were instructed not to breathe through their nose or swallow. After 60s, subjects flexed their neck forward near horizontal to expel saline into a sterile container. Inflammatory cytokines tumor necrosis factor alpha (TNF-α), interleukins (IL) IL-6, IL-1β, IL-10, IFN-γ, IL-12, IL-4, IL-8, eosinophil cationic protein (ECP) and myloperoxidase were analyzed using enzyme-linked immunosorbent assay (ELISA) and normalized to albumin and total protein. Immunological analyses were conducted by Dr. Paul Siegel at NIOSH.

Venous blood samples (20 ml) were collected from the antecubital vein in the arm or from the back of the hand in vacuum tubes. Cytokines (TNF-α, IL-6, IL-1β, IL-10, IFN-γ, IL-12, and IL-4), complete blood count (CBC), and genetic analyses were conducted on pre-shift blood draws while only one additional sample was collected following the work shift for cytokine analysis using a commercially available ELISA Biorad Multiplex Assay.

A whole-blood aliquot was used to evaluate cytokine production by endotoxin-stimulated peripheral-blood leukocytes. Heparinized blood was diluted in RPMI-1640 with L-glutamine culture medium (Sigma) supplemented with 10 percent heat-inactivated fetal-bovine serum (Gibco-Invitrogen, Grand Island, NY). Cells were stimulated in triplicate in 24-well cell culture plates with 10 μg of lipopolysaccharide (E. *coli* 0555:B5; Sigma Aldrich, St Louis, MO) for 24 hours in an environment of 5 percent carbon dioxide in humidified air. Each sample was tested in duplicate by the serial dilution of a standard supplied by the company with a known cytokine level. Differential blood cell counts were also performed.

Inflammatory cell markers were measured, which included a complete blood count with differential, erythrocyte sedimentation rate, and C-reactive protein. Soluble CD14, a high affinity receptor complex of LPS and LPS-binding protein, was also measured in the serum from centrifuged blood using a commercially available ELISA (R&D systems, Minneapolis, MN).

DNA isolation and genetic analysis was conducted by initially collecting blood draws into Qiagen *PAXgene* tubes. Genetic analyses are currently being completed by Dr. Ivana Yang at the University of Colorado Denver.

Personal breathing zone samples were collected for inhalable particulate matter over one work shift using SKC Button samplers with 25mm PVC filters with a 5µm pore size (SKC Inc., Eighty Four, PA). Personal sampling pumps (MSA Scientific, Lake Forest, CA; SKC Inc, 84, PA) were calibrated to a flow rate of 4 L/min, and calibration was rechecked following each shift. Inhalable dust samples were analyzed by weighing the internal cassette and filter as a single unit using a Mettler MT5 balance (Mettler-Toledo, Columbus, OH). The internal cassette and filter assembly were desiccated as a unit pre- and post-weighing. Field and laboratory blanks were analyzed in a similar manner. The time-weighted average (TWA) exposure for airborne dust (and for endotoxin) was determined for each subject by dividing the weight of dust or endotoxin units on each filter by the volume of air sampled.

Each filter sample was extracted in sterile, pyrogen-free water containing 0.05% Tween-20 for 1 hour (h) at 22°C with continuous shaking. A portion of each extract was analyzed for endotoxin using recombinant factor C (rFC) assay (Lonza, Allendale, NJ), (see Reynolds et al 2009 and Thorne et al 2011) and other portions were stored at -70°C before they were lyophilized for determination of endotoxin's 3-hydroxy fatty acid (3-OHFA), muramic acid, and ergosterol via a GC/MS method modified for these environments as described previously Poole at all 2011.

The rFC endotoxin assay is based on the Gram-negative infection of *Limulus polyphemus* that results, at the molecular level, in the activation of a serine protease catalytic coagulation cascade (Alwis and Milton, 2006). The activation of rFC is the first component of the cascade, which can be measured by fluorescence generated by the enzymatic cleavage of a peptide-coumarin substrate. Two-fold serial dilutions of endotoxin standards and sample extracts were added to a 96-well followed by a 100 µl mixture of enzyme, buffer, and fluorogenic substrate. The plate was incubated at 37°C for 1 h and fluorescence quantified by a microtiter plate reader (Biotek Instruments FLX800TBIE, Winooski, VT) at excitation/emission 380/440nm. Background (0 EU/ml) fluorescence was subtracted and log delta fluorescence against log endotoxin concentration. Log fluorescence was proportional to log endotoxin concentration and linear from 0.01 to 10EU/ml. Four assay reagent blanks were used to control for the pyrogen-free status of the reagent water, centrifuge tubes, pipette tips, and microplates. Quality assurance spiking assays were performed to assess matrix interference or enhancement.

GC-MS/MS Analyses

3-OHFA, muramic acid, and ergosterol were separately analyzed with a Waters Quattro Micro GC-MS/MS system operated in the electron ionization (EI) positive mode. The carrier gas was ultra high purity helium at a head column pressure of 69kPa. Injections were made using an Agilent 7683B autosampler in the splitless mode onto a DB-5ms capillary column (30mm X 0.25mm I.D., 0.25um film thickness) (J&W Scientific, Santa Clara, CA).

3-OHFA Analysis

GC/MS/MS analysis was modified from previous studies (Saito et al., 2009, Reynolds et al., 2005). To prepare samples for GC/MS/MS analysis of 3-hydroxy fatty acids (3-OHFAs; marker of LPS), lyophilized dust samples and standards (C_8-C_{10} and C_{12}-C_{18} at 0, 1, 2, 5, 20, 100, 500 ng) were spiked with 25ng of C_{11} as a surrogate and digested in 0.5ml of methanolic HCl overnight at 85°C. Samples were diluted with 1ml of Lonza pyrogen-free water and spiked with 10uL of 100ug/ml pentadecanol prior to solid phase extraction (SPE). Strata-X 60mg/3ml polymeric reversed phase columns were conditioned with 1ml of diethyl ether and 1ml of water. Samples were loaded to the column and pulled through drop-wise with vacuum. Cartridges were dried under full vacuum for 20 minutes. 3-OHFA was eluted from the column with diethyl ether and the eluent dried under a gentle stream of nitrogen. Dried samples were incubated with 50 ul BSTFA/1%TMCS and 5 ul pyridine at 85°C for 30 min to form trimethylsilyl derivatives. Following derivatization, cooled samples were diluted to 100 ul with heptane for GC/MS/MS analysis.

3-OHFA were separated by gas chromatography with an inlet temperature of 280°C and an oven temperature profile of 90 to 250°C at 5°C/min, 250 to 290°C at 20°C/min, holding 290°C for 5 min. The GC-mass spectrometer interface temperature was 300°C. The mass spectrometer was operated in multiple reactions monitoring (MRM) mode with fragment ions generated with collision energy of 10eV. The two MRM transitions (quantitation and confirmation) monitored for each 3OHFA in their respective retention time windows were as follows: C_8 m/z 231>189, 131, C_9 m/z 245>203, 131, C_{10} m/z 259.02>217, 131, C_{11} m/z 273>241, 131, C_{12} m/z 287>255, 131, C_{13} m/z 301>269, 131, C_{14} m/z 315>283, 131, C_{15} m/z 329>297, 131, C_{16} m/z 343>311, 131, C_{17} m/z 357>325, 131, and C_{18} m/z 371>339, 131.

Muramic Acid Analysis

To prepare samples for GC/MS/MS analysis of muramic acid (marker of PGN), lyophilized samples and standards (0, 2, 5, 10, 50, 100, or 500 ng) were digested in 1 ml of methanolic HCl overnight at 100°C. A solution of C_{13} muramic acid as an isotope dilution internal standard was obtained by digestion of 4mg of C_{13}-labeled algal cells (99% C_{13}) as for the samples. Prior to SPE, 30 ul of the C_{13} muramic acid solution was spiked into each sample and standard as an internal standard. SPE of the sample was done with Strata-XC 60mg/3mL strong cation exchange columns conditioned with 2 ml of methanol and 2 ml of aqueous 0.1% H_3PO_4. Samples were loaded to the column with vacuum assistance and then dried under full vacuum for 20 min. Muramic acid was eluted from the column with 5% NH_4OH in acetone. Ten ul of 100ug/ml pentadecanol was added to the eluent and then dried under a stream of nitrogen. Dried samples were incubated with 50ul BSTFA/1%TMCS and 5ul pyridine at 85°C for 30 min to form trimethylsilyl derivatives. Following derivatization, cooled samples were diluted to 100ul with heptane for GC/MS/MS analysis.

Muramic acid was analyzed with an oven temperature profile of 120 to 290°C at 20°C/min, holding 280°C for 4 min. The inlet temperature was 260°C and the GC-mass spectrometer interface temperature was set at 300°C. The mass spectrometer was operated in MRM mode with fragment ions generated

with collision energy of 6eV. The two MRM transitions monitored for muramic acid were m/z 185>142 and 185>130 and m/z 190>145 for C_{13} muramic acid.

Ergosterol Analysis

To prepare samples for GC/MS analysis of ergosterol (marker of fungal biomass), lyophilized samples and standards (0, 1, 4, 10, or 40 ng) were spiked with 10 ng of D2-ergosterol as an internal standard and digested in 3 ml of 10% methanolic KOH for 90 min at 80°C. SPE was done with Strata-X 60mg/3ml polymeric reversed phase columns conditioned with 2 ml of methanol and 2 mL of water. Samples were loaded to the column, pulled through drop-wise with vacuum and then dried under full vacuum for 20 minutes. Ergosterol was eluted from the column with 10% methanol in methyl tert-butyl ether. Twenty ul of 0.1% paraffin oil in acetone was added to the eluent and then dried under a stream of nitrogen. Dried samples were incubated with 50uL of 1:1 BSTFA/1%TMCS and hexane at 80°C for 30 min to form trimethylsilyl derivatives.

Ergosterol was analyzed with an oven temperature profile of 90 to 280°C at 20°C/min, holding 280°C for 15 min. The inlet temperature was 280°C and the GC-mass spectrometer interface temperature was set at 300°C. The mass spectrometer was operated in single ion monitoring (SIM) mode targeting m/z 363, 337, and 378. For quantification, m/z 363 and 365 were monitored for ergosterol and D2-ergosterol respectively.

A Grimm sampler (Grimm Technologies, Douglasville, GA), Q-Trak (TSI, Minneapolis, MN), and Toxirae (RAE systems, San Jose, CA) were used to characterize particle size distribution of organic aerosols, air quality, and ammonia, respectively, in the workplace environment. The Grimm is a direct-reading aerosol spectrophotometer, was used to characterize the particle size distribution of organic aerosols. The Grimm provided real-time size selective evaluation of aerosol counts and mass over a range of 0.35 to 20μm and 0 to 100μg/L, respectively. The sampling flow rate was 1.2 L/min.

The Q-Trak measured airborne carbon dioxide (CO_2), carbon monoxide (CO), temperature and relative humidity in the workplace environment of these dairy farms. Carbon dioxide was measured using a non-dispersive infrared detector, and carbon monoxide using a chemical sensor. Q-Traks were calibrated using standard gases, and a sling psychrometer before and after each sampling session. A direct-reading ToxiRae was used to measure ammonia with a limit of detection of 1 ppm. This device was calibrated using standard gas.

Statistical analyses were performed using SAS V.9.3 (SAS Institute, Inc., Cary, NC) and Minitab V.16 (Minitab, State College, PA). Graphing was undertaken using Sigma Plot V. 12 (Systat Software, San Jose, CA) Data were initially tabulated and natural log transformed. The Kolmogirov-Smirnov test for normality was performed with a critical p value of 0.05 and indicated that bioaerosol and environmental data were not normally distributed. Descriptive statistics and correlations were calculated by task and facility as well as overall subjects. Proc GLM was used to examine the effects of tasks, facility, season, and workshift on exposures.

Lung function values were standardized for each participant using age and height-adjusted reference equations.(Hankinson et al., 1999) Percent change in predicted lung function values over the course of the work shift were calculated using the following equation:

[(post-shift % predicted value – pre-shift % predicted value)/pre-shift % predicted value] * 100.

General linear models were used to assess the multivariable relationships between dust and endotoxin exposures and lung function. Inhalable dust, endotoxin, total 3-OHFA, and even-chain 3-OHFA were assessed separately in exposure-response models. Based on *a priori* decisions, multivariable models were adjusted for age, sex, and current smoking. We evaluated differences in adjusted mean lung function changes across tertiles of dust/endotoxin groups using the least-significant difference method. P-values were used to assess the differences between the mean lung function change for each tertile of exposure using the lowest tertile as the reference group. To more closely approximate the distribution of exposure concentrations within tertiles, we assessed trend across the tertiles by using the midpoint of the natural log-transformed exposure concentration within each tertile as a continuous variable in the model. Additionally, regression diagnostics were used to assess the potential for influential observations.

Effect modification was assessed by stratifying the population by the potential effect modifier and presenting lung function changes across tertiles of exposure separately for each modifier. The entire population was used in evaluating the interactions between the full shift dust/endotoxin concentrations and the potential effect modifiers (via p-values for the parameter estimate obtained from multiplying the exposure concentration by the potential effect modifier). Potential effect modifiers included current smoking, self-reported pesticide/herbicide application, living on a farm, time at the job (assessed with a 1 year cut-point), obesity status, age (assessed with an approximate median split for age categorization), Hispanic or Latino ethnicity, self-reported allergy and/or asthma, education, medication use, secondhand smoke exposure on the day of sampling, primary task on the day of sampling, having pets within the last 12 months, season during sampling, any alcohol use compared to none, current self-report of respiratory symptoms, and inflammatory markers (assessed by median-split categorization of the markers). Future work will also evaluate the potential for effect modification by the presence/absence of a genetic polymorphism in the TLR4 gene.

RESULTS AND DISCUSSION

The population characteristics from personal sampling of Colorado and Wyoming dairy workers between September 2008 and June 2011 are presented in Table 2.

Table 2. *Population Characteristics*

Population: N (percent)	Total	Male	Female
Gender (N=116)			
Male	103 (88.8%)		
Female	13 (11.2%)		
Age distribution (N=116)			
<18 years	1 (0.9%)	1 (1.0%)	0
18-24 years	32 (27.6%)	30 (29.1%)	2 (15.4%)
25-40 years	55 (47.4%)	50 (48.5%)	5 (38.5%)
41-72 years	28 (24.1%)	22 (21.4%)	6 (46.2%)
Ethnicity (N= 116)			
Hispanic or Latino	106 (91.4%)	95 (92.2%)	11 (84.6%)
Not Hispanic or Latino	10 (8.6%)	8 (7.8%)	2 (15.4%)
Education (English or Spanish) (N=110)			
Primary	52 (47.3%)	45 (45.9%)	7 (58.3%)
Middle	12 (10.9%)	11 (11.2%)	1 (8.3%)
High	34 (30.9%)	34 (34.7%)	0
University	11 (10.0%)	7 (7.1%)	4 (33.3%)
Don't Know	1 (0.9%)	1 (1.0%)	0
Exposure to Env Tobacco Smoke (N=115)			
No	89 (77.4%)	77 (75.5%)	12 (92.3%)
Home only	7 (6.1%)	6 (5.9%)	1 (7.7%)
Work only	16 (13.9%)	16 (15.7%)	0
Home and work	3 (2.6%)	3 (2.9%)	0
Job duration (N=113)			
≤ 1 year	15 (12.9%)	13 (12.6%)	2 (15.4%)
> 1 year	101 (87.1%)	90 (79.6%)	11 (84.6%)
Current Smoker (N=114)			
No	97 (85.1%)	85 (84.2%)	12 (92.3%)
Yes	17 (14.9%)	16 (15.8%)	1 (7.7%)
Smoked During Monitoring (N=115)			
No	108 (93.9%)	95 (88.0%)	13 (100.0%)
Yes	7 (6.1%)	7 (%)	0
Overweight (N=)			
No	39 (33.6%)		
Yes	77 (66.4%)		
Obesity (N=116)			
No	88 (75.9%)		
Yes	28 (24.1%)		
Consume Alcohol (N=108)			
No	33 (29.2%)	27 (27.0%)	6 (46.1%)
Yes	80 (70.8%)	73 (73.0%)	7 (53.9%)

The recruited study population consisted primarily of Hispanic males aged 25 to 40 years. The percentage of Hispanic workers (91.4%) in the Colorado and Wyoming study population appear to be higher in comparison to the northeast and total dairy industry. This is consistent with our previous studies of dairies in the region. Stack et al. (2006) observed that Hispanic populations on New York dairies range from 5.3% to 51.5%, while Costa et al. (2009) estimates that the foreign labor workforce account for 41% of the total dairy industry workforce.

The proportion of smokers (14.9%) was lower than the general population with 20.2%, but similar to the national rate of 14.2% for Hispanic smokers (CDC, 2010). The low percentage smokers in the dairy population is encouraging because smoking can have additive effect on farm exposures and the occurrence chronic bronchitis, as well the more insidious development of chronic farmer's hypersensitivity pneumonitis disease (Kirkhorn and Schenker, 2002). Conversely, alcohol consumption amongst the research group was higher in comparison to the general population 71.3% compared to 61.2% respectively (CDC, 2010). However, consideration also needs to be given to the quantity and frequency of alcohol consumption between the two populations. Further analysis is being undertaken in this area to ascertain if alcohol consumption has an effect on respiratory health outcomes.

The average age of male workers was 32.2 years, and 36.3 years for females (Table 3), which is similar to previous findings that majority of Hispanic workers on dairy farms are young males (Maloney and Grusenmeyer, 2005, Stack et al., 2006). The dairy workers schedule differs from the traditional 8 hour workshift, 5 days week. This is reflected in the mean workshift duration of 9.3 hours, and mean working week of 5.9 days. The shift from traditional working hours means that current occupational exposure limits will need to be adjusted to account for increased exposure times.

Table 3. *Worker Characteristics*

Worker Characteristics: Mean (SD); Range	Total (N=116)	Male (N=103)	Female (N=13)
Age	32.7 (9.7); 17-66	32.2 (9.7);17-66	36.3 (9.5); 23-51
Mean number of years in dairy.	7.1 (9.3); 0-56	6.9 (9.4); 0-56*	8.3 (8.5); 0-22
Mean number of hours per shift	9.3 (1.4); 2-12	9.2 (1.4); 2-12*	9.5 (1.1); 8-12
Mean number of consecutive work days	5.9 (1.1); 4-7	5.9 (0.4); 4-7	5.9 (0.3); 5-6
Mean number of consecutive days off	1.1 (0.1); 1-7	1.2 (0.7); 1-7*	1.1 (0.3); 1-2

* N=101

The primary tasks undertaken on the dairy varied considerably. The major groups where workers undertook only one task during monitoring were milking and medical which included health care, maternity and calving/calf raising (Figure 1). A significant proportion of the workers also undertook multiple tasks over the work day. The major task groups appear to be similar for both females and males (Figure 2). However, the small number of female subjects precludes any in-depth comparison between the two groups.

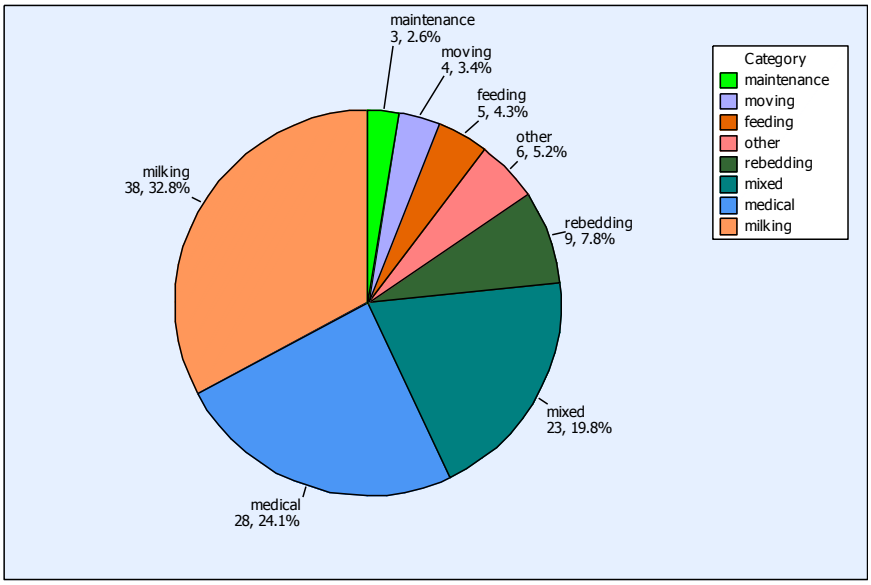


Figure 1. *Primary Tasks Undertaken by Dairy Workers on Day of Monitoring*

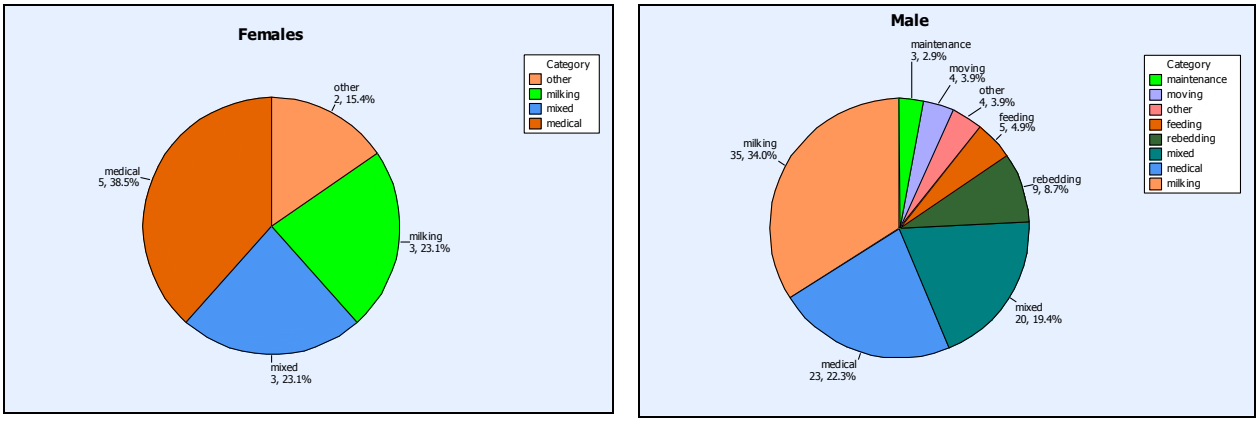


Figure 2. *Primary Tasks Undertaken by Male and Female Workers on Day of Monitoring*

Worker Exposure to Bioaerosols and Associated Respiratory Outcomes (Specific Aim 1)

The most significant finding for exposure monitoring was that 89% of dairy workers were exposed to endotoxin concentrations that exceeded the recommended OEL of 67 EU/m3 (Table 4). This OEL was derived from the Dutch Expert Committee on Occupational Health Safety's (2012) OEL of 90 EU/m3 for an 8 hour workday, 5 day work week. Endotoxin is known pro-inflammatory biological agent which can reduce lung function in exposed workers, as well as result in dry cough, shortness of breath, fever and general tiredness (Dutch Expert Committee on Occupational Safety, 2010). The high proportion of the population exceeding the recommended endotoxin OEL suggests that endotoxin exposure may be associated with the large proportion of the workforce that exhibited cross shift declines in lung function, as well as exhibiting reduced pre-shift lung function (Table 5). Analysis of variance (ANOVA) however did not identify a clear significant relationship between either predicted or cross-shift variation in lung function in relation to bioaerosol exposures. Adjustments were included in the ANOVA for smoking, sex and age. It is possible that relationship between lung function and bioaerosols is being obscured by the small population which varied widely in the task undertaken on the day of monitoring (9 categories in all), and/or an effect modifier such as pesticide exposure or genetics as was observed in our previous study (Reynolds, 2012). Further analysis is currently underway to explore effect modifiers of lung function in relation to bioaerosol exposures.

Table 4. *Bioaerosol and Organic Dust Exposures*

Bioaerosols	n	Geometric Mean	GSD	Range	95th Percentile	Occupational Exposure Standard*	Number of Exposures Exceeding OES
Organic Dust (mg/m3)	115	0.68	2.6	0.02-6.82	3.21	1.8 mg/m3^	12 (10%)
Endotoxin (EU/m3)	114	469	3.6	13-4430	3775	67 EU/m3#	102 (89%)
3-Hydroxy Fatty Acids (ng/m3)	94	359	2.6	35-2112	1716	NA	
Muramic Acid (ng/m3)	83	11.3	3.8	0.6-250.0	101.7	NA	
Ergosterol (ng/m3)	21	11.9	3.9	1.7-536.9	112.5	NA	
Ammonia (ppm)	102	0.32	6.0	0.01-20.09	6.03	5.6˘~	5 (5%)

* adjusted for 54 hour work (9 hour by 6 days) using OHSA Model (TLVadj=TLV x (40/54))

^ recommended total dust exposure standard 2.4 mg/m3 (8 hours)Donham et al. (2000)

#recommended endotoxin exposure standard of 90 EU/m3 (8 hours)Dutch Expert Committee on Occupational Safety (2010)

˘ recommended ammonia exposure standard 7.5 ppm (8 hours) Reynolds et al. (1996) and Donham et al. (1995)

~ OSHA short term exposure limit 35ppm for 15 minutes with no more than 4 excursions per shift

In addition to endotoxin, the recommended organic dust OEL of 1.8 mg/m^3 was exceeded by 10% of the population, while the ammonia recommended OEL of 5.6ppm was exceeded by 5% of the population (Table 4). As with endotoxin exposure, no relationship was identified between these bioaerosols and either the cross-shift fluctuation of lung function or predicted pre shift lung function variables. The lack

of awareness regarding the use of respiratory personal protective equipment (PPE) is concerning. Only 4 of the 116 workers indicated that they wore respiratory protection during dusty tasks. Of these workers 3 of wore bandanas which are unsuitable for reducing inhalation of particles, and only 1 wore an approved dust mask (filtered).

Over 50% of the workers experienced a cross-shift decline in the Forced Expiratory Volume in one second (FEV_1) and Forced Vital Capacity (FVC) Table 5. In a daytime work shift, healthy workers typically exhibit an increase in lung function. Approximately 4% of the population had a pre-shift FEV_1 that was less than 80% of the predicted value based on their age, weight and height. This is a standard clinical guideline and indicates that these workers are exhibiting a mild respiratory obstruction. This result is similar to findings from the California study (Schenker 2011).

Preliminary univariate analyses suggest a possible influence of alcohol consumption (Figure 3), pesticide application (Figure 4) and being overweight (Figure 5) on FVC. However, the difference between the populations for each factor was not significant at the p=0.05 level (pesticides p = 0.06). Analysis of muramic acid and ergosterol exposure suggests pet exposure may be a potential effect modifier of FEV_1 (Figures 6 and 7).

Table 5. *Lung Function*

Population: N (percent)	Total	Male	Female
Cross-Shift Decline in FEV1			
No	53 (45.7%)	50 (48.5%)	3 (23.1%)
Yes	63 (54.3%)	53 (51.5%)	10 (76.9%)
Cross-Shift Decline in FVC			
No	51 (44.0%)	49 (47.6%)	1 (7.7%)
Yes	65 (56.0%)	54 (52.4%)	12 (92.3%)
Cross-Shift Decline in Ratio			
No	62 (53.4%)	52 (50.5%)	10 (76.9%)
Yes	54 (46.6%)	51 (49.5%)	3 (23.1%)
Pre-shift FEV1 <80% predicted			
No	111 (95.7%)	100 (97.1%)	11 (84.6%)
Yes	5 (4.3%)	3 (2.9%)	2 (15.4%)
Pre-shift FEV <95% predicted			
No	68 (58.6%)	62 (60.2%)	6 (46.2%)
Yes	48 (41.4%)	41 (39.8%)	7 (53.9%)

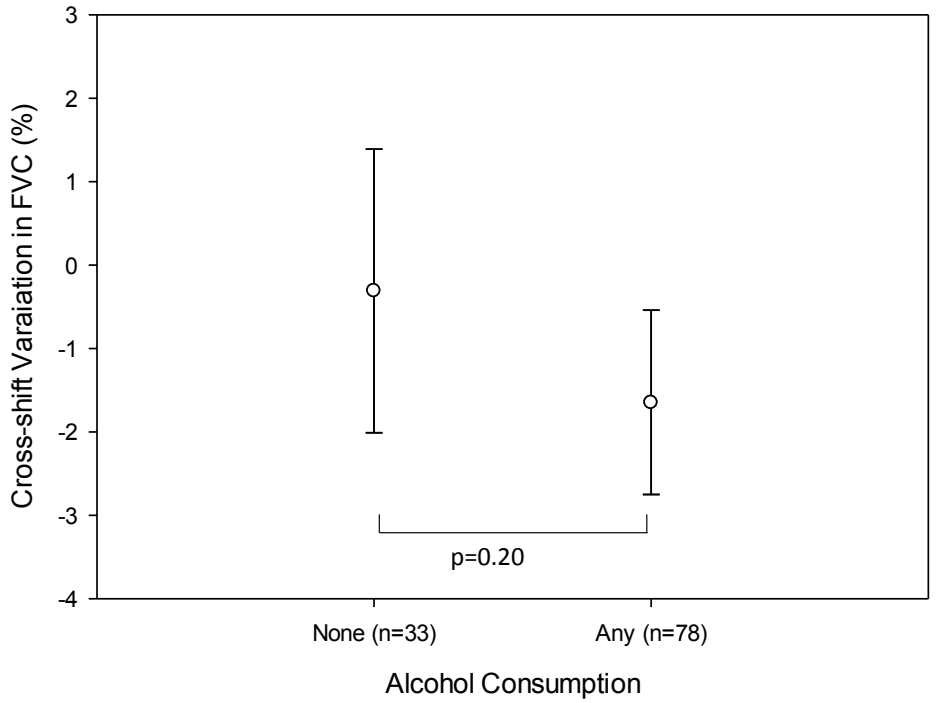


Figure 3. *Effect of alcohol consumption on Cross-shift variation in FVC*

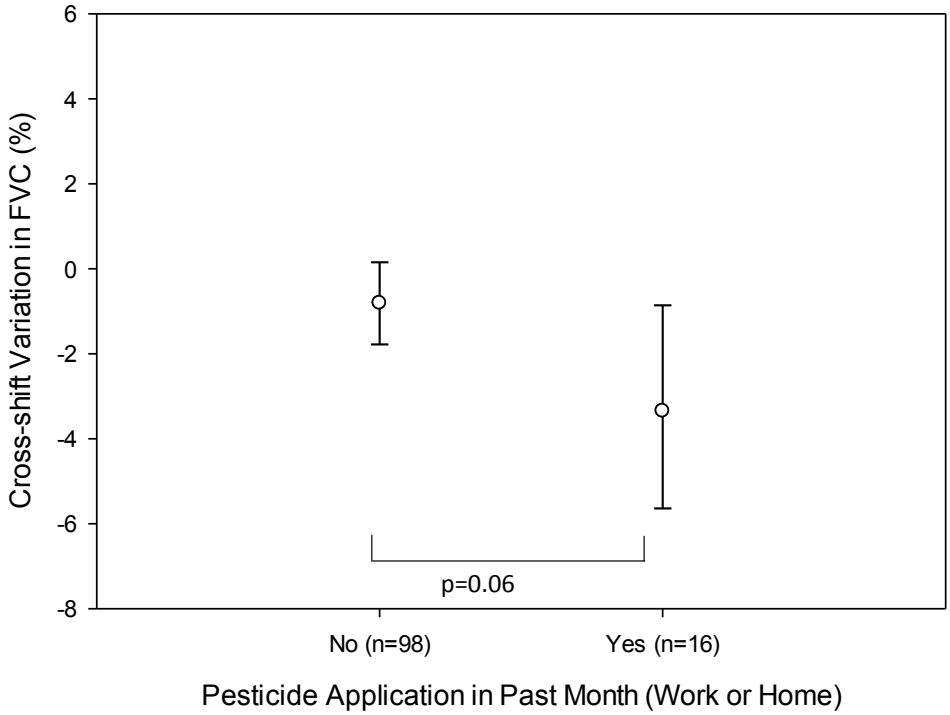


Figure 4. *Effect of Pesticide Application on Cross-shift variation in FVC*

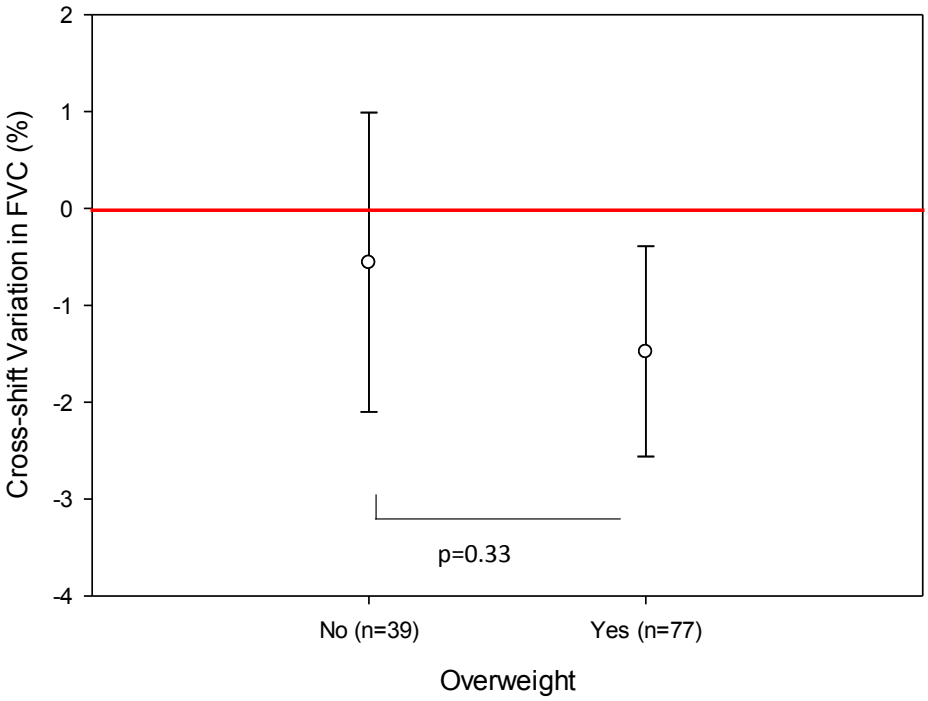


Figure 5. *Effect of Being Overweight on Cross-shift variation in FVC*

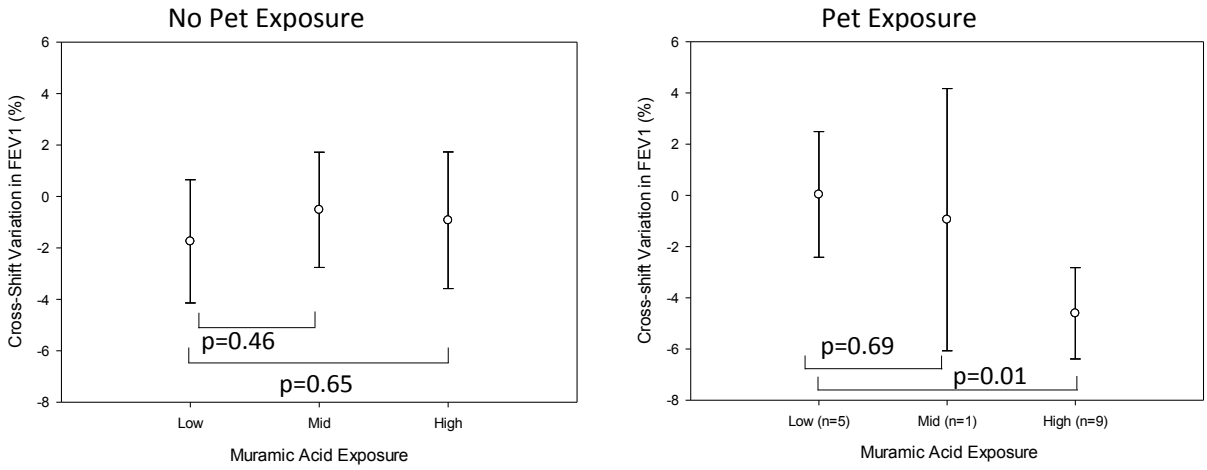


Figure 6. *Effect of Pet Exposure Versus No Pet Exposure on Response between Muramic Acid and FEV_1*

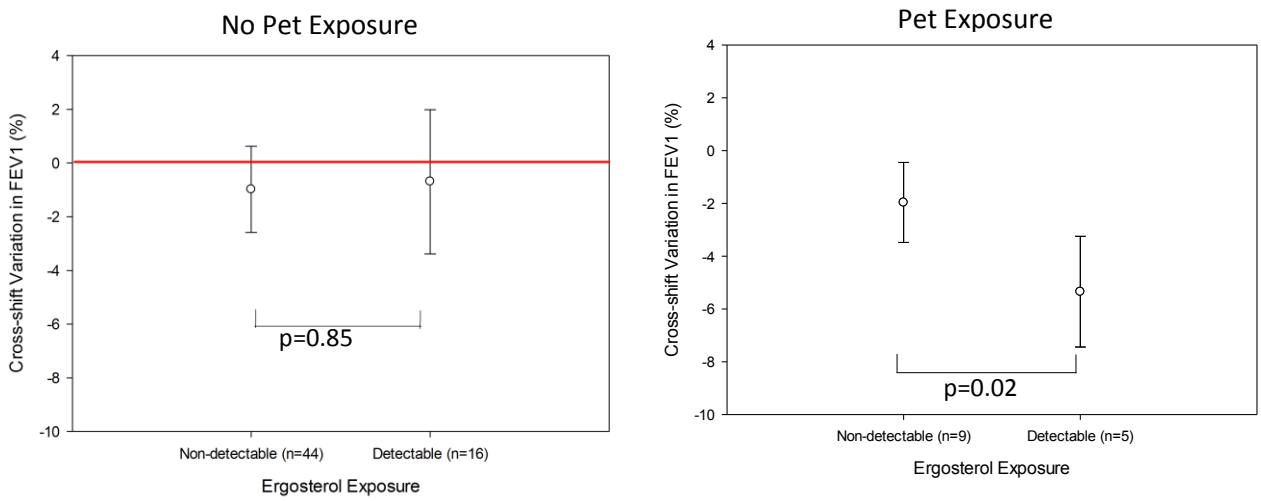


Figure 7. *Effect of Pet Exposure Versus no Pet Exposure on Response between Ergosterol and FEV_1*

Worker Exposure to Bioaerosols and Associated Cytokine Response (Specific Aim 1)

The cross-shift increase in inflammatory cytokines was largest for IL-6 (39.8%) and IL-8 (45.6%), while TNF-α only increased in 22.3% of workers. An interesting trend was observed that workers with a cross shift increase in IL-6 (Figure 8), IL-8 (Figure 9) and TNF-α (Figure 10) had a greater mean cross-shift decline in FVC. However, it must be noted that the difference between the groups was not significant at the p=0.05 level.

Table 6. *Cytokine Response*

Population: N (percent)	Total
Cross-shift increase in IL-6	
No	62 (60.2%)
Yes	41 (39.8%)
Cross-shift increase in IL-8	
No	80 (77.7%)
Yes	23 (22.3%)
Cross-shift increase in TNF-α	
No	56 (54.4%)
Yes	47 (45.6%)

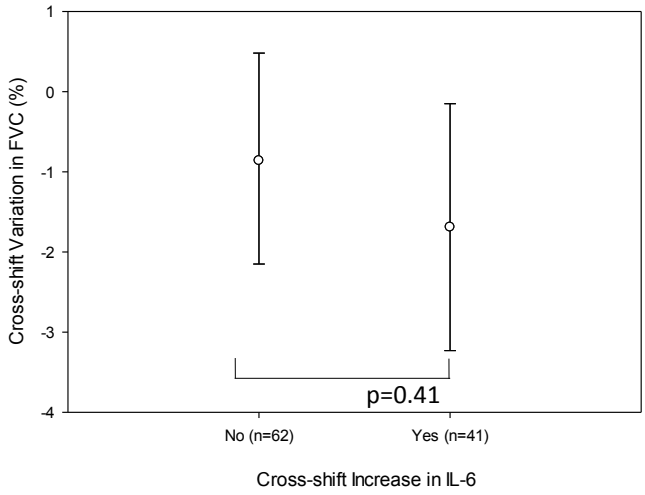


Figure 8. *Relationship between Cross-shift Variation in FVC(%) and IL-6*

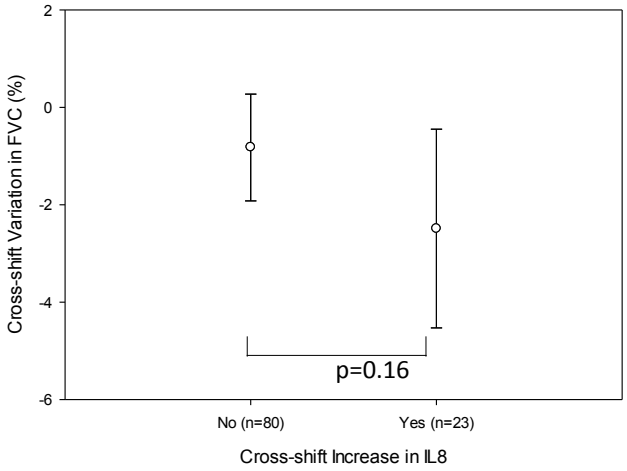


Figure 9. *Relationship between Cross-shift Variation in FVC(%) and IL-8*

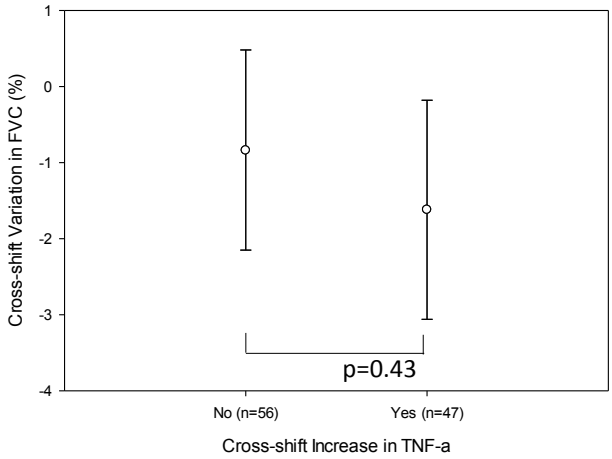


Figure 10. *Relationship between Cross-shift Variation in FVC(%) and TNF-α*

Respiratory Symptoms

A significant proportion of participants reported current or chronic symptoms at work (cough, mucous, phlegm, sneezy runny blocked nose, Cough, Wheeze, Chest Tight, Short of Breath).

Table 11. *Summary of Self-Reported Symptoms*

	Total
Current Cough	15 (13%)
Current mucous or phlegm	19 (17%)
Any current Symptom	41 (35%)
Ever had sneezy, runny, blocked nose without cold or flu	15 (13%)
Cough, Wheeze, Chest tightness, short of breath at work	10 (9%)

Comparison of Exposure and Health Outcomes for Colorado and Californian Dairy Workers (Specific Aim 2)

Specific Aim 2: Compare the exposures and health outcomes among Colorado dairy workers to the results of a comparable study of California dairy workers (conducted by the Western Center for Agricultural Health and Safety). Analysis of endotoxin and 3-OHFA for the California study were performed by our group.

Table 7 indicates that the task breakdown for the Colorado study were comparable to the Californian study with the predominating tasks including milking, medical and mixed tasks. However, there was some variation in bioaerosol exposures. Workers (n=35) in Colorado and Wyoming milking parlors had a higher geometric mean endotoxin and dust exposure of 1015 EU/m^3 and 0.82 mg/m^3 respectively in comparison to Californian workers (n=91) with 420 EU/m^3 and 0.79 mg/m^3.(Table 8). This pattern was also repeated for workers moving cows. In contrast, Californian dairy workers had greater endotoxin and dust exposures during feeding and rebedding of stalls. The higher endotoxin exposures in the Colorado milking parlors could be related to a concentration of indoor pollutants due to the enclosed nature of the building structures to address adverse winter weather conditions, whereas California being more temperate climate may have more open style milking parlors. The Californian study currently has one paper published from which the Table 7 data was obtained (Garcia, 2012), and another under review. A preliminary comparison showed pulmonary function findings from the California and Colorado studies to be similar – both indicated a mild cross shift obstructive effect.

Further analysis comparing the two data sets is currently underway with two manuscripts in preparation 2012.

Table 7. *Task Breakdown for Colorado and Californian Dairy Population Tasks*

Tasks	Colorado Study n=116	Californian Study* n=226
Milking	38 (32.8%)	91 (40.3%)
Medical	28 (24.1%)	28 (12.4%)
Moving	4 (3.4%)	12 (5.3%)
Rebedding	9 (7.8%)	5 (2.2%)
Mixed	23 (19.8%)	77 (33.1%)
Maintenance	3 (2.6%)	
Feeding	5 (4.3%)	15 (6.6%)
Other	6 (5.2%)	

*Taken from Garcia et al (2012)

Table 8. *Comparison of Colorado and Californian Bioaerosol Exposures*

	Colorado Study		Californian Study*	
Tasks	Dust (mg/m^3)	Endotoxin (EU/m3)	Dust (mg/m^3)	Endotoxin (EU/m^3)
Milking	0.82	1015	0.79	320.2
Feeding	0.54	98	0.92	163.3
Medical	0.45	264	0.88	351.1
Moving	0.96	846	0.79	368.9
Rebedding	0.66	240	1.03	293.0

*Taken from Garcia et al (2012)

Exposure of Naïve Workers to Bioaerosols (Specific Aim 3)

Specific Aim 3: Evaluate a subset of new (naïve) workers at 0 (n=92) and 1 month (n=92) and 1 year (n~46). – altered due to problems with recruitment

This aim had to be halted due to a fall in the milk market which caused a hiring freeze and paucity of naïve workers to study. However, it was noted that the majority of new workers (67%) that worked less than 1 year in the industry were employed in the milking parlors which as previously noted had the highest endotoxin exposures. The placement of new workers in the parlor could put them at higher risk of adverse health effects in comparison to other working areas of the dairy. This is because endotoxin typically causes ill effects in persons who have not previously been exposed, and the worker then acquires a tolerance with long term exposures, with symptoms typically only reappearing after a prolonged absence from work or a very high exposure. Very few older employees worked in the milking parlors, 14% for 6-10 years and one worker who had been working for more than 31 years. We will evaluate this issue further in this data set.

Evaluation of rFC endotoxin assay and GC-MS analysis of 3-OHFA in predicting changes in pulmonary function and biomarkers (Specific Aim 4)

Specific Aim 4: Evaluate whether endotoxin assay or GC/MS (specific 3 hydroxy fatty acids) is the best predictor of biomarkers and changes in pulmonary function.

This aim is currently being investigated to determine if worker health (pulmonary function, cytokines, symptoms) is more closely related to endotoxin, total chain 3-OHFA, odd chain 3-OHFA or even chain 3-OHFA exposures. We are also expanding this aim to include muramic acid and ergosterol exposures.

Survey of genetic markers relating to lung disease and endotoxin pathway (Specific Aim 5)

Specific Aim 5: Survey genetic markers related to lung disease and the endotoxin pathway by performing association testing for polymorphisms in the candidate innate immunity genes TLR4, TLR9, MD2, CD14, IL1-RN, IFN-gamma and TNF-alpha).

We are currently awaiting genetic data, due August 15, 2012 due to delay in manufacturing SNP kits, for addressing this aim.

Identification of high risk jobs within the dairy industry (Specific Aim 6)

Specific Aim 6: To identify job factors associated with highest exposures and greatest risk of respiratory disease and work with ILM and the dairy industry throughout the region to develop cost-effective, culturally acceptable interventions to reduce exposures; and to disseminate information on interventions via the dairy industry associations, and Cooperative Extension and by incorporation into ILM worker training programs. The HICAHS Outreach program and the Enhancing Translation/Dissemination Project will be instrumental in this effort.

Analysis of individual tasks undertaken by dairy workers indicated that workers in the milking parlor, moving stock and undertaking mixed tasks had the greatest geometric mean exposures to dust and endotoxin (Figures

12 and 13). In contrast, exposure to 3-OHFA was higher in workers conducting other tasks such as management in comparison to the mixed task category (Figure 14), while moving cattle resulted in the highest mean muramic acid exposure (Figure 15). Comparison of ergosterol exposure for different tasks was hindered by the small number of samples above the detectable limit (n=22). However, there were some very high exposures in for medical work in comparison to other tasks monitored (Figure 16). The greater exposure to bioaerosols during these tasks indicates that workers may be at greater risk of developing adverse health conditions in these environments, and the need for initial targeting of interventions within these areas of the dairy.

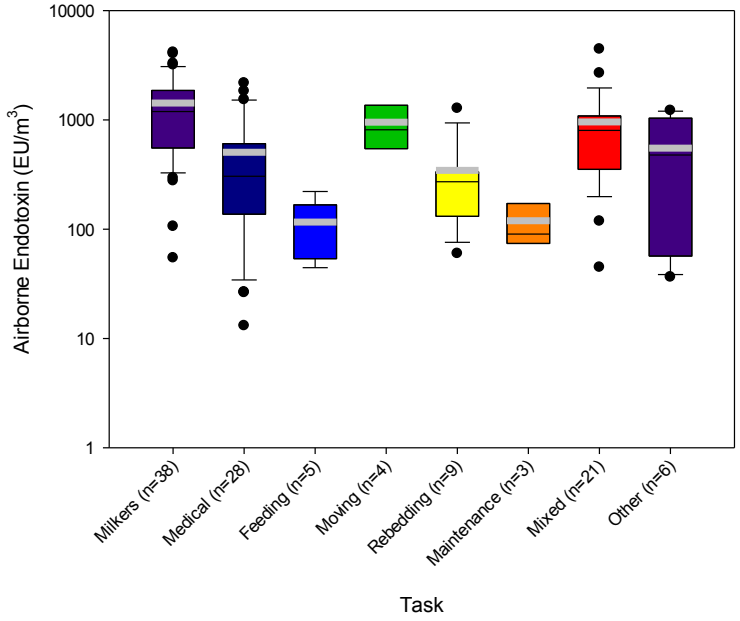


Figure 12. *Endotoxin Exposure (EU/m3) During Dairy Tasks*

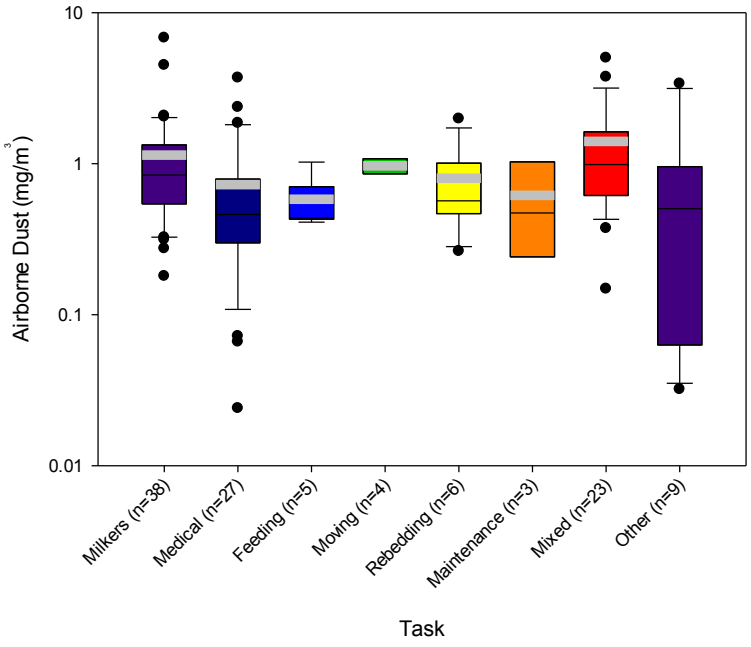


Figure 13. *Dust Exposure (mg/m3) During Dairy Tasks*

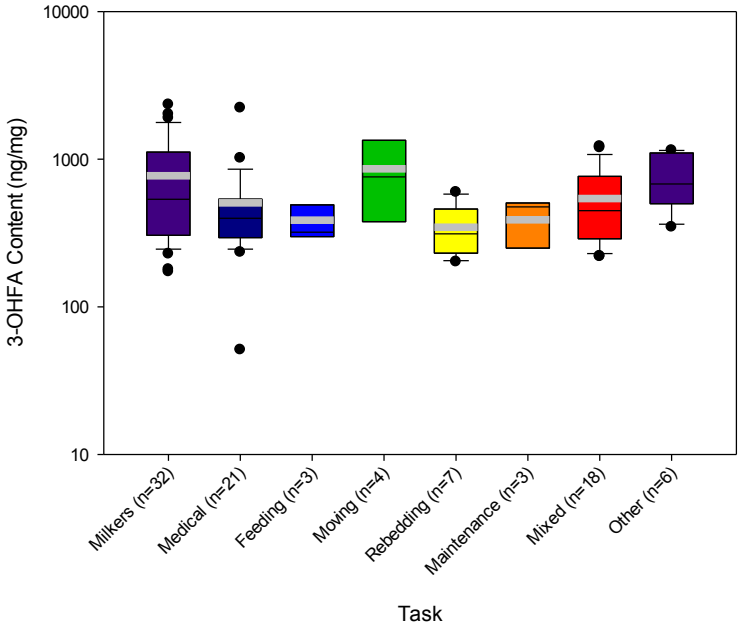


Figure 14. *3-OHFA Exposure (ng/m^3) During Dairy Tasks*

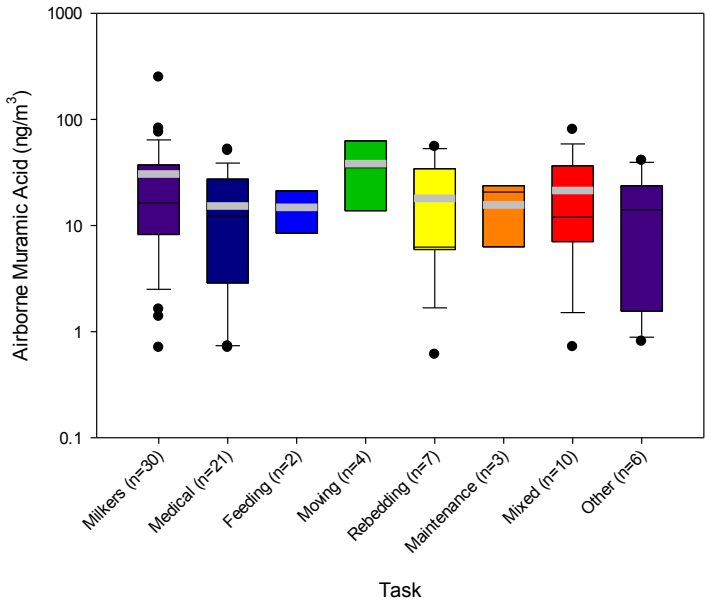


Figure 15. *Muramic Acid Exposure (ng/m^3) During Dairy Tasks*

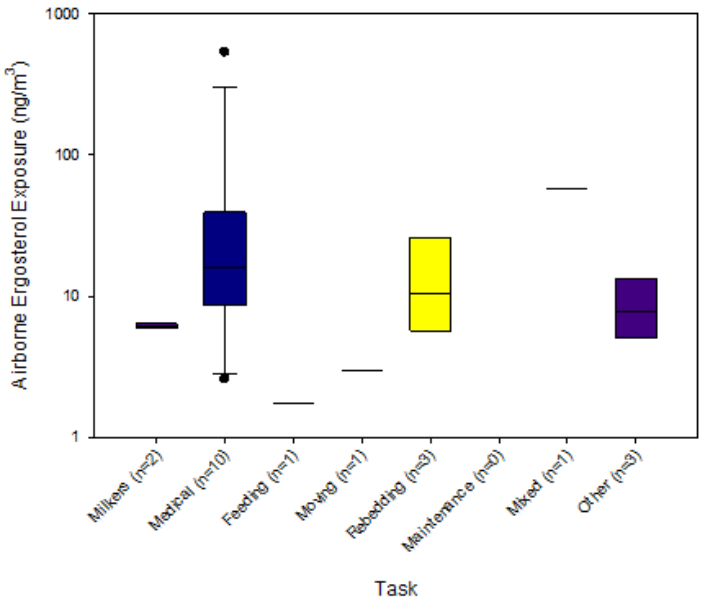


Figure 16. *Ergosterol Exposure (ng/m^3) During Dairy Tasks*

The bioaerosol content of the dust (e.g. EU/mg dust vs. EU/m^3 presented earlier) was also examined and the results are displayed in Figures 17-21. Data analysis indicated that the dust in the milking parlor and during moving cows or completing other tasks contained the highest concentrations of endotoxin and 3-OHFA. These results reflect the higher exposure measurements (m3) recorded for these tasks. Muramic acid content varied from the other bioaerosols, with workers feeding cattle having a higher mean exposure than milkers. However, these results are likely to have been influenced by small sample sizes for a number of tasks, including feeding (n=2). Further analysis is currently being undertaken on a subject by subject basis to identify important factors influencing exposure. The ergosterol content was highest in dusts generated during medical tasks (data not shown), which fits with the finding of highest ergosterol exposures occurring in the medical workers (Figure 16). The profile of odd and even 3-OHFA also varied between tasks, with the greatest difference evident in the 14 Carbon 3-OHFA chain group (Figures 20 and 21). This 3-OHFA chain data is currently undergoing further analysis, and comparison with the results for the Californian study.

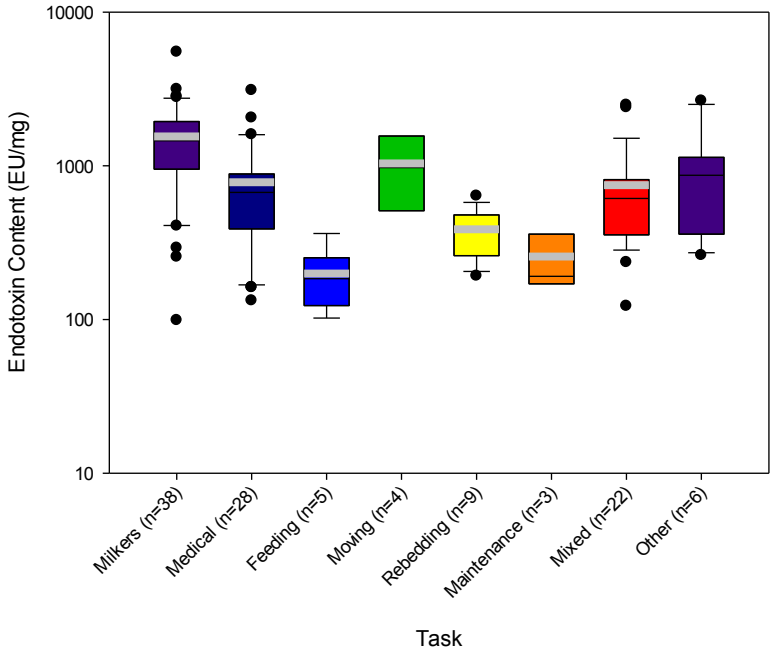


Figure 17. *Endotoxin Content of Dust Generated during Various Tasks*

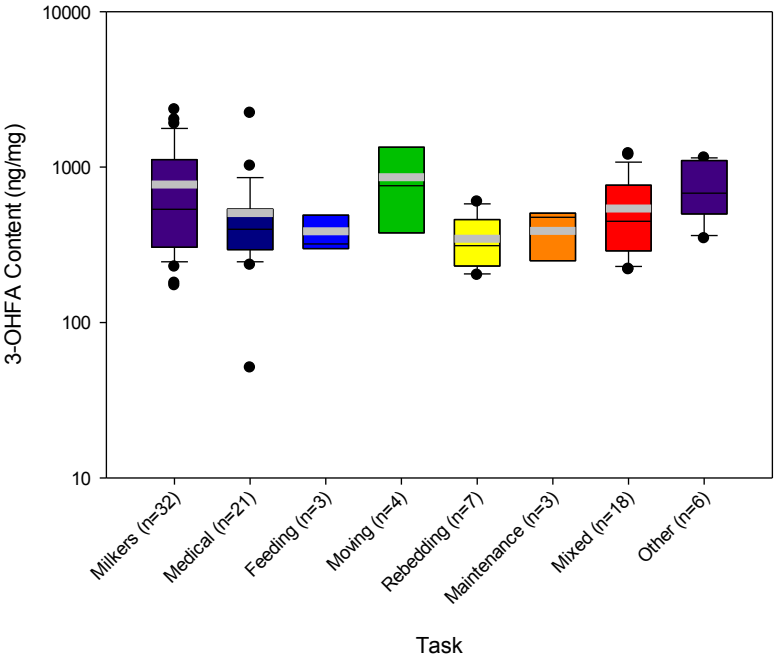


Figure 18. *3-OHFA Content of Dust Generated during Various Tasks*

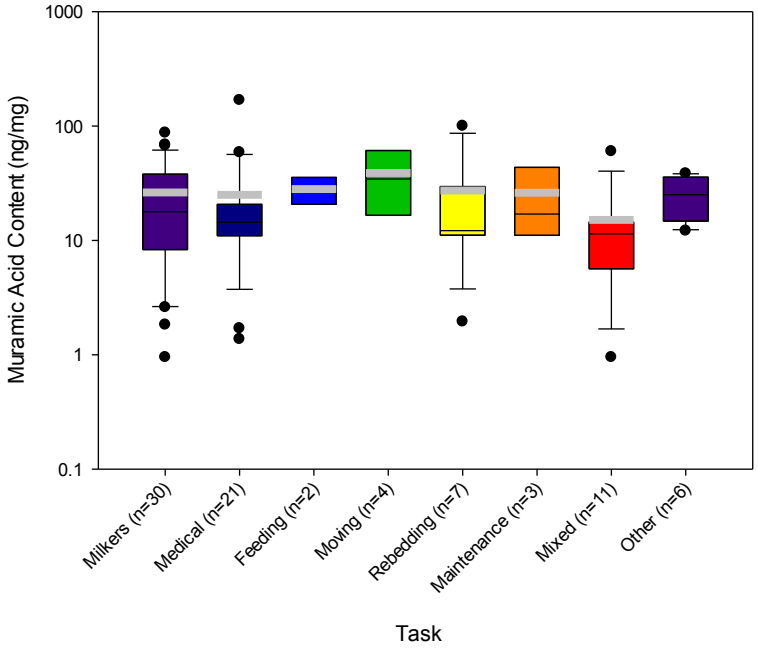


Figure 19. *Muramic Acid Content of Dust Generated during Various Tasks*

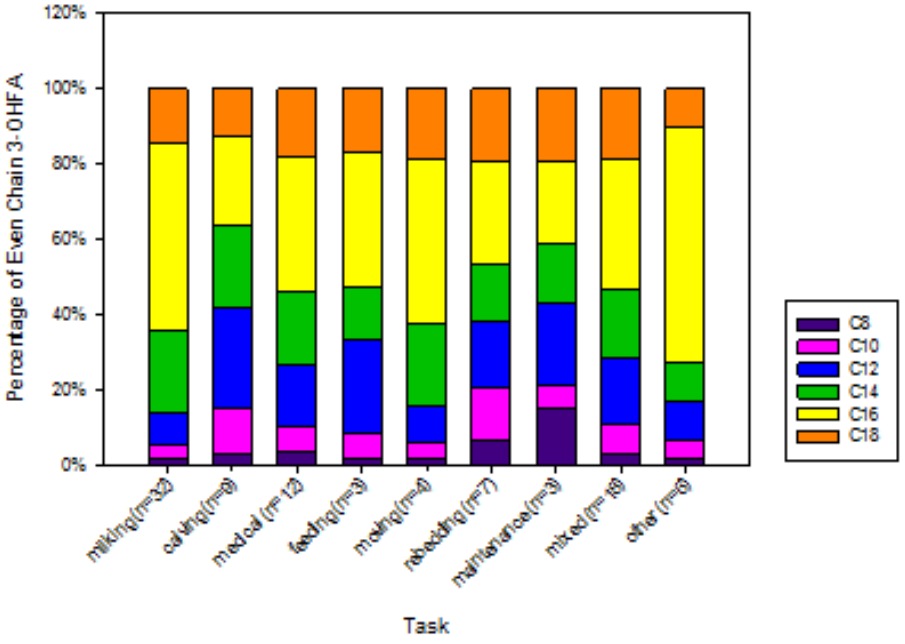


Figure 20. *Even Chain 3-OHFA Profile According to Task*

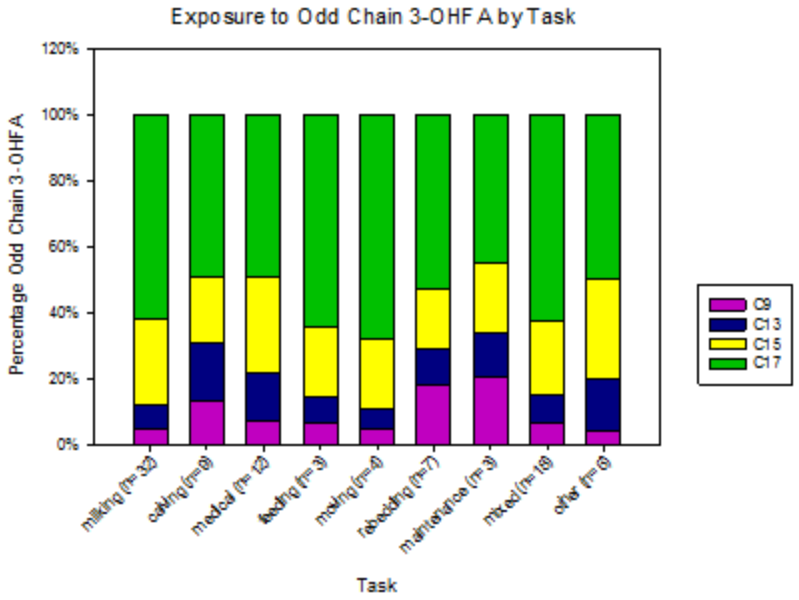


Figure 21. *Odd Chain 3-OHFA Profile According to Task*

Exposure Predictors

A one-way ANOVA analysis of critical factors influencing exposures indicated that task had the strongest relationship on the variation in bioaerosol exposures, notably for endotoxin and 3-OHFA (Table 8). Other significant factors included facility and location of task (indoor/outdoor). Muramic acid and ergosterol exposure had insufficient sample size for analysis. No significant influenced was identified for smoking, work shift (AM/PM) or season.

Table 8. *One-Way ANOVA analysis of Factors Influencing Bioaerosol Exposure*

	Dust	Endotoxin	3-OHFA	Ammonia
Task	R^2=13.9% p=0.022 n=115	R^2=33.0% p<0.0001 n=114	R^2=25.7% p<0.001 n=94	R^2=18.0% p=0.008 n=102
Facility	R^2=6.6% p=0.492 n=115	R^2=15.1% p=0.024 n=114	R^2=16.3% p=0.048 n=94	R^2=17.5% p=0.018 n=102
Length of work shift	R^2=8.3% p=0.755 n=115	R^2=28.1% p<0.001 n=114	R^2=15.6% p=0.266 n=94	R^2=20.1% p=0.032 N=102
Indoor/Outdoor	R^2=2.10 p=0.123 n=114	R^2=18.69 p<0.0001 n=113	R^2=9.87 p=0.003 n=93	R^2=2.77% p=0.094 n=101

EVALUATION OF INTERVENTIONS

Two intervention studies have been undertaken as part of this project supported with supplemental funds. The first was conducted by Choudry (Nonnenmann et al., 2012), which identified that more frequent washing of animal waste in milking parlors was an effective means of reducing airborne exposure to reparable dust and endotoxin. The dissemination of this information and application in Colorado dairy parlors could help to reduce worker exposure to dust and endotoxin to levels similar to those in the Californian study, and/or below the recommended OELs.

The second intervention study observed the influence of ventilation on bioaerosol exposure in milking parlors (Funk, 2011). This study indicated that the modern design of the dairy facilities assessed could have aided in the reduction of dust and endotoxin exposures, and that the study findings could be applied as a best practice guide for the construction of new dairy parlors.

There is ongoing collaboration with industry partners to build on the bioaerosol work and conduct research applying these new tools to help develop and test improved strategies for reduction of exposures and prevention of respiratory disease.

Education/Training

- Continuing education to advance practice was provided to rural physicians, epidemiologists, industrial hygienists, engineers, toxicologists and chemists in the US and internationally.
- Outreach consultation on a variety of problems was also provided to agricultural producers.
- Eight new scientists received training. All are continuing to work in related fields, two hold faculty positions providing leadership specifically in agricultural occupational health.

Intervention/Outreach

In 2010 the High Plains Intermountain Center for Agricultural Health and Safety partnered with the Colorado Department of Public Health and the Environment (CDPHE), USDA Agricultural Research Service Laboratory, and the NIOSH Western States Office to investigate an outbreak of diarrheal illness among inmates at a minimum security prison. An occupational site assessment identified pathways for transmission of STEC O111 between the dairy and correctional facility and provided recommendations for prevention. HICAHS staff, with unique knowledge about dairy industry best practices, were key to constructive evaluation of existing occupational policies and procedures. Infection control recommendations were tailored to the correctional facility, taking into consideration security requirements, space limitations, and substance-control restrictions.

An infection control policy was adopted by the Colorado Department of Corrections for the dairy facility. Recommendations for controlling the transmission of enteric diseases included:

- Definition of clean, transition and contaminated zones, and control of work flow patterns.
- Consistent use of appropriate PPE (coveralls, boots, rubber gloves).
- Provision of hand sanitizers/soap in the dairy
- Inmate training on hazards of working with animals
- Enforcement of a sick policies for food handlers

Results were disseminated to educate health care providers, public health agencies, Extension agents, and members of the public in all 50 U.S. states and internationally through:

- A webinar hosted by the AgriSafe Network
- Presentations at the Western Regional Epidemiology Network Conference (WREN), the National Symposium on Agriculture, Forestry and Fishing Health and Safety, the Council of State and Territorial Epidemiologists (CSTE) Annual Conference, and other venues.
- An article was published in the Center for Disease Control and Prevention's "Morbidity and Mortality Weekly" publication.

Since the conclusion of the intervention the number of infections has been greatly reduced. There has been only one new reported case of STEC O157 infection at the facility (January 2011). This case did not result in transmission to other dairy workers or other locations in the prison.

CONCLUSION

The majority (89%) of dairy workers in this study were exposed to endotoxin at levels exceeding recommended exposure guidelines. Exposures were highly variable for all tasks, however workers involved in milking and moving cows appear to be at greatest risk of overexposure. A significant proportion of participants reported current or chronic symptoms at work (cough, mucous, phlegm, sneezy runny blocked nose, shortness of breath). Inflammatory cytokines also increased in a significant proportion of workers across the workshift - IL-6 (39.8%), IL-8 (45.6%), TNF-α (22.3%). Also, workers with a cross shift increase in IL-6 , IL-8 and TNF-α had a greater mean cross-shift decline in FVC. Over 50% of workers experienced a cross-shift decline in FVC and FEV_1. While there was no clear simple relationship between exposures and pulmonary function, preliminary analyses suggest a possible influence of alcohol consumption , pesticide application and being overweight on FVC. Analysis of muramic acid and ergosterol exposure suggests having pets at home may be a potential effect modifier of FEV_1. In comparison to the California study, exposures were somewhat higher for Colorado dairy workers. A preliminary comparison showed pulmonary function findings from the California and Colorado studies to be similar – both indicated a mild cross shift obstructive effect. It is possible that the relationship between lung function and bioaerosol exposures is being obscured by the small population which varied widely in the task undertaken on the day of monitoring (9 categories in all), and/or an effect modifier such as pesticide exposure or genetics as was observed in our previous study (Reynolds, 2012). Further analysis is currently underway to explore effect modifiers of lung function in relation to exposures. Further analysis of immunological and genetic results is also in progress. We have also begun evaluation of potential interventions, demonstrating that increasing the frequency of flushing dairy parlors was effective in reducing dust and endotoxin exposure. We are now working with dairy industry partners to identify and evaluate potential best practices to reduce worker exposure to bioaerosols. Based on the results of our previous work and this study, we are also working with the industry to develop more comprehensive occupational health management programs that encompass more comprehensive wellness programs in addition to exposure reduction strategies.

Program Director/Principal Investigator (Last, First, Middle): Reynolds, Stephen J.

Inclusion Enrollment Report

This report format should NOT be used for data collection from study participants.

Study Title: Occupational Lung Disease and Endotoxin Exposures in New Dairy Workers

Total Enrollment: 116 **Protocol Number:** 09-904H

Grant Number: 5U54OH008085

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race

Ethnic Category	Sex/Gender			
	Females	Males	Unknown or Not Reported	Total
Hispanic or Latino	11	95	0	106 **
Not Hispanic or Latino	2	8	0	10
Unknown (individuals not reporting ethnicity)	0	0	0	0
Ethnic Category: Total of All Subjects*	13	103	0	116 *
Racial Categories				
American Indian/Alaska Native	2	0	0	2
Asian	0	1	0	1
Native Hawaiian or Other Pacific Islander	0	0	0	0
Black or African American	0	1	0	1
White	3	24	0	27
More Than One Race	0	0	0	0
Unknown or Not Reported	8	77	0	85
Racial Categories: Total of All Subjects*	13	103	0	116 *

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)

Racial Categories	Females	Males	Unknown or Not Reported	Total
American Indian or Alaska Native	2	0	0	2
Asian	0	1	0	1
Native Hawaiian or Other Pacific Islander	0	0	0	0
Black or African American	0	0	0	0
White	1	17	0	18
More Than One Race	0	0	0	0
Unknown or Not Reported	8	77	0	85
Racial Categories: Total of Hispanics or Latinos**	11	95	0	106 **

* These totals must agree.
** These totals must agree.

INCLUSION OF CHILDREN – Not applicable

MATERIALS AVAILABLE FOR OTHER INVESTIGATORS

Protocols for analysis of agricultural dusts were created for:

- Endotoxin by rFC
- 3-OHFA by GC-MS/MS
- Muramic Acid by GC-MS/MS
- Ergosterol by GC-MS/MS

Please contact Dr. Stephen Reynolds (Stephen.Reynolds@Colostate.edu)

PUBLICATIONS

Peer Reviewed Journal Articles

N Comstock, M Towle, A Warner, SJ Reynolds, L Durso, C Campbell, M Kiefer, SA. Bosch. Outbreak of Shiga Toxin—Producing *Escherichia coli* O111 Infections Associated With a Correctional Facility Dairy—Colorado, 2010, JAMA 2012; 308 (5): 447 – 449.

Reynolds, S., Clark, M. L., Koehncke, N., Von Essen, S., Prinz, L., Keefe, T., Mehaffy, J., Bradford, M., Cranmer, B., Davidson, ME., Yang, IV., Burch, J. B. (2012). Pulmonary function reductions among potentially susceptible subgroups of agricultural workers in Colorado and Nebraska. JOEM 2012: 54(5)632-641.DOI: 10.1097/JOM.0b013e31824d2e1c

Choudhry, A., Reynolds, S. J., Mehaffy, J., Levin, J. L., Gilmore, K., Douphrate, D., & Nonnenmann, M. W. (2012). Evaluation of parlor washing as an intervention for decreasing occupational exposure to organic dust and endotoxin among dairy parlor workers--a pilot study. Journal of Occupational & Environmental Health, In Press.

J Garcia, DH Bennett, D Tancredi, MB Schenker, D Mitchell, SJ Reynolds, GP Dooley, J Mehaffey, FM Mitloehner. Characterization of Endotoxin collected on California Dairies Using Personal and Area Based Methods. JOEH 2012, In Press.

J Garcia, DH Bennett, DJ Tancredi, MB Schenker, DC Mitchell, S Reynolds, FM Mitloehner. Occupational exposure to particulate matter and endotoxin for California dairy workers *International Journal of Hygiene and Environmental Health, In Press, Corrected Proof, Available online 12 May 2012*

Poole JA, Gleason AM, Bauer C, West WW, Alexis N, van Rooijen N, Reynolds SJ, Romberger DJ, Kielian T. $CD11c^{+}/CD11b^{+}$ Cells are Critical for Organic Dust-Elicited Murine Lung Inflammation. American Journal of Respiratory Cell Molecular Biology In Press 2012.

Poole JA, Gleason AM, Bauer C, West WW, Alexis N, van Rooijen N, Reynolds SJ, Romberger DJ, Kielian T. T Cells and a Mixed Th1/Th17 Response are Important in Organic Dust-Induced Airway Disease. Annals of Allergy Asthma and Immunology. In press 2012.

Comstock, N., Towle, M., Warner, A., Reynolds, S. J., Durso, L., Campbell, C., Kiefer, M., Bosch, S. A. (2012). Epidemiologic and occupational investigation of an Escherichia coli O111 outbreak associated with a correctional facility dairy--Colorado, 2010. Morbidity and Mortality Weekly Report (March 9, 2012).

Poole, J. A., Dooley, G. P., Saito, R., Burrell, A. M., Bailey, K. L., Romberger, D. J., Mehaffy, J., Reynolds, S. J. (2010). Muramic Acid, Endotoxin, 3-Hydroxy Fatty Acids, and Ergosterol Content Explain Monocyte and Epithelial Cell Inflammatory Responses to Agricultural Dusts. Journal of Toxicology and Environmental Health, Part A: Current Issues, 73(10), 684 - 700. doi: 10.1080/15287390903578539

Thorne PS, Perry SS, Saito R, O'Shaughnessy PT, Mehaffy J, Metwali N, Keefe T, Donham KJ, Reynolds SJ. Evaluation of the Limulus Amebocyte Lysate and Recombinant Factor C Assays for Assessment of Airborne Endotoxin. AEM August 2010, 76(15) 4988-4995.

Kirychuck SP, Reynolds SJ, Koehncke NK, Lawson J, Willson P, Senthilselvan A, Marcinuik D, Classen HL, Crowe T, Dosman J. Levels of Endotoxin and Dust at Respirable and Non-respirable Particle Sizes are not Consistent between Cage and Floor-housed Poultry Operations. Annals of Occupational Hygiene 2010 Volume54, Issue7 pp. 824-832.

Burch, J. B., Svendsen, E., Siegel, P. D., Wagner, S. E., von Essen, S., Keefe, T., Mehaffy, J., Martinez, A.S., Bradford, M., Baker, L., Cranmer, B., Saito, R., Tessari, J., Prinz, L., Andersen, C., Christensen, O., Koehncke, N., Reynolds, S. J. (2009). Endotoxin Exposure and Inflammation Markers Among Agricultural Workers in Colorado and Nebraska. Journal of Toxicology and Environmental Health, Part A: Current Issues, 73(1), 5 - 22.

Reynolds, S., Burch, J., Wagner, S., Svendsen, E., Siegel, P., von Essen, S., Koehncke, N. (2009). Endotoxin Exposure, Inflammation Markers, and Pulmonary Function among Agricultural Workers in Colorado and Nebraska. Paper presented at the U.S.A AIOH 27th Conference Canberra 2009, New and Emerging Issues.

Kirychuk SP, Reynolds SJ, Koehncke NK, Nakatsu J, Mehaffy J Comparison of Particle Bounce and Endotoxin Assay in Marple Cascade Samplers With and Without Impaction Grease. 2009 J Agromedicine 14(2):242-9.

Plummer, L. E., Pinkerton, K. E., Reynolds, S., Meschke, S., Mitloehner, F., Bennett, D., Schenker, M. B. (2009). Aerosols in the Agricultural Setting. Journal of Agromedicine, 14(4), 413 - 416. doi: 10.1080/10599240903260527

Reynolds, S. J., Nakatsu, J., Tillery, M., Keefe, T., Mehaffy, J., Thorne, P. S., Donham, K., Nonnenmann, M., Golla, V., O'shaughnessy, P. (2009). Field and Wind Tunnel Comparison of Four Aerosol Samplers Using Agricultural Dusts. Annals of Occupational Hygiene, 53(6), 585-594. doi: 10.1093/annhyg/mep021

Saito, R., Cranmer, B. K., Tessari, J. D., Larsson, L., Mehaffy, J. M., Keefe, T. J., & Reynolds, S. J. (2009). Recombinant Factor C (rFC) Assay and Gas Chromatography/Mass Spectrometry (GC/MS) Analysis of Endotoxin Variability in Four Agricultural Dusts. Annals of Occupational Hygiene, 53(7), 713-722. doi: 10.1093/annhyg/mep052

O'Shaughnessy PO, Lo J, Golla V, Nakatsu J, Tillery MI, Reynolds SJ: Comparison of Aerosol Samplers Relative to the Inhalable and Respirable Collection Criteria. JOEH 4:237-245, 2007.

Conferences /Presentations

Davidson, M., Clark, M. L., Keefe, T., Mehaffy, J., Bradford, M., Roman-Muniz, N., . . . Reynolds, S. J. (2012, August 27-29). Similar exposure group (task) based analysis of bioaerosol exposures in dairies. Presented at the Nordic Meeting on Agricultural Occupational Health and Safety, Ystad, Sweden.

Stephen J. Reynolds, Maggie L. Clark, Margaret E. Davidson, Thomas Keefe, John Mehaffy′ Mary Bradford, Noa Roman-Muniz, Gregory Dooley, Jill Poole, FM Mitloehner, MB Schenker. Exposures to Organic Aerosols and Effects on Pulmonary Function Among Western US Dairy Workers. Nordic Meeting on Agricultural Occupational Health & Safety Ystad, Sweden, August 27-29, 2012

Funk, S., Reynolds, S. J., Volckens, J., Dowd, S., & Nonnenmann, M. W. (2011, May 16-19). Evaluation of seasonal ventilation changes and their effect on ambient dust, endotoxin and bioaerosol concentrations in a dairy parlor. Presented at the American Industrial Hygiene Conference and Exposition, Portland, OR.

Mitchell, D., Schenker, M. B., Armitage, T., Bennett, D., Tancredi, D., Eastman, C., Reynolds, S . . Mitloehner, F. (2011, September 7-9). Are respiratory decrements associated with exposure to particles including endotoxins on large California dairies? Presented at the EPICOH International Conference on Epidemiology in Occupational Health, Oxford, UK.

Reynolds, S. J. (2011, May 4). What's hanging in dairy; avoiding udder disaster: High Plains Intermountain Dairy Health and Safety Initiatives-Projects and Partnerships. Presented at the NFMC, Marshfield, WI.

Reynolds, S. J., Campbell, C., Towle, M., Warner, A., Kiefer, M., Ray, B., & Comstock, N. (2011, June). Investigation of an Escherichia coli O111 outbreak at a state-run correctional facility dairy facility. Presented at the National Symposium on Agriculture, Forestry and Fishing Health and Safety, Boise, ID.

Reynolds, S.J. et. al. (2011). Integrating Occupational Health with Mainstream Public Health: Investigation of an Escherichia Coli O111 Outbreak, Colorado 2010. Council of State and Territorial Epidemiologists (CSTE) Annual Conference, Pittsburgh, PA.

Reynolds, S. J., Clark, M. L., Davidson, M., Keefe, T., Mehaffy, J., Bradford, J., . . . Poole, J. A. (2011, June). Agricultural dust exposures and pulmonary function among grain elevator, cattle feedlot, dairy, and corn farm workers in Colorado and Nebraska. Presented at the National Symposium on Agriculture, Forestry and Fishing Health and Safety, Boise, ID.

Reynolds, S. J., Clark, M. L., Davidson, M., Keefe, T., Mehaffy, J., Bradford, J., . . . Poole, J. A. (2011, August 22-24). Exposure to endotoxin, muramic acid, ergosterol and effects on pulmonary function among western dairy workers. Presented at the Irish Meeting on Agriculural Occupational Safety and Health, Dublin, Ireland.

Reynolds, et. al. (2010). Incorporating occupational health into a public health investigation of an Escherichia coli O111 outbreak associated with a correctional dairy facility. Western Regional Epidemiology Network Conference. Ashland, OR.

Reynolds, S. J. (2009, May 27). Prospective study of occupational lung diseases and endotoxin exposure in new dairy workers. Presented at the Farm Bureau Safety and Health Network Conference, Fort Collins, CO.

Reynolds, S., Burch, J., Wagner, S., Svendsen, E., Siegel, P., von Essen, S., . . . Koehncke, N. (2009). Endotoxin Exposure, Inflammation Markers, and Pulmonary Function among Agricultural Workers in Colorado and Nebraska [Keynote]. Presented at the U.S.A AIOH 27th Conference Canberra 2009, New and Emerging Issues.

Reynolds, S. J., Cranmer, B., Keefe, T., Mehaffy, J., Martinez, A. S., Bradford, M., . . . Von Essen, S. (2009). Endotoxin exposure and respiratory outcomes among dairy, cattle feedlot, and grain elevator workers in Colorado and Nebraska. Presented at the Thomas L. Petty Lung Conference 52nd Annual Meeting "The Environment and the Lung: Detection, Prevention, and Mechanisms of Disease".

Reynolds, S. J. (2008, November 13). Panel: Bioaerosols in Dairy Barns. Presented at the New Paths, Health and Safety in Western Agriculture, Cel Elum, WA.Reynolds, S. J. (2008, September 25-26). Roundtable discussion on NIOSH Ag Centers and ERCs. Presented at the Western States Occupational Network (WestON), Denver, CO.

Reynolds, S. J., Cranmer, B., Keefe, T., Mehaffy, J., Serrano Martinez, A., Bradford, M., . . . Von Essen, S. (2008, October 19). Endotoxin exposure and respiratory outcomes among dairy, cattle feedlot, and grain elevator workers in Colorado and Nebraska. Presented at the Public Health and the Agricultural Rural Ecosystem, Saskatchewan, Saskatoon, Canada.

Seminars/Webinars/CE/Lectures/multimedia

Reynolds SJ et al. AGRISAFE NETWORK WEBINAR **-** Epidemiologic and Occupational Investigation of an Escherichia coli O111 Outbreak Associated with a Correctional Facility Dairy — Colorado, 2010. Provided on November 9, 2011

Reynolds SJ. Australian Occupational Hygiene Association **"**Endotoxin Sampling and Analysis" Professional Development Course, 3.5 hours, Australian Institute for Occupational Hygiene, Canberra, Australia, December 6, 2009

Reynolds SJ. University of Texas Health Sciences Center at Tyler, Innovative Training Experiences for Occupational Medicine Residents in Non-Urban and Agricultural Settings. Webinar: Agricultural Dusts and Respiratory Disease, May 12, 2008

Reynolds SJ. University of Texas Health Sciences Center at Tyler, Innovative Training Experiences for Occupational Medicine Residents in Non-Urban and Agricultural Settings. Webinar: Endotoxin Exposure and Genetic Factors in Organic Dust Lung Disease, May 12, 2008

Conference Leadership

Reynolds, S. J. (2012). Pre-Conference Workshop Organizer--Agricultural Health and Safety with Emphasis on Dairy, September 29-30. At 11th World Conference on Injury Prevention and Safety Promotion, Wellington, NZ. October 1-4.

Reynolds, S.J. (2011). Organizer, session moderator, International Dairy Initiative meetings organizer. Irish Meeting on Agricultural Occupational Health and Safety. August 22-25.

Reynolds, S.J. et al (July 11-13, 2011). Conference organizer and moderator. HICAHS International Dairy Research Consortium—Inaugural Meeting.

HICAHS (2011). Organizer and Host. Dairy Advisory Board Meeting. Fort Collins, CO.

Douphrate, D., Reynolds SJ, Rosecrance J (2009). High Plains and Mountain Region Dairy Health & Safety Workshop Denver, CO, October 15-16.

HICAHS (2009). Founder and Organizer. Dairy Advisory Board Meeting. Fort Collins, CO.

Reports

Campbell, C., Kiefer, M., & Reynolds, S. J. (2010). Occupational Investigation of an Escherichia coli O111 outbreak at the Colorado Department of Corrections Four Mile Correctional Facility: National Institute for Occupational Safety and Health Western States Office and the High Plains Intermountain Center for Agricultural Health and Safety at Colorado State University.

Standards

ANSI/ASABE. (2011). Ventilating Manure Storages to Reduce Entry Risk (S607 OCT2010). Reynolds co-author

Graduate Students Trained – MS and PhD

Shelley Kirychuk, 2008, PhD At University of Saskatchewan, Canada
PARTICULATE DISTRIBUTION AND RELATIONSHIP TO ENDOTOXIN IN POULTRY PRODUCTION OPERATIONS
Reynolds Co-Chair

Rena Saito, 2008 PhD (Environmental and Radiological Health Sciences)
Analyses and exposure assessment of bacterial endotoxin in agricultural environments
Reynolds Chair

Luna Bevine 2009 MS (Environmental and Radiological Health Sciences)
Endotoxin air sampling : a comparison between the Recombinant Factor C (rFC) and Limulus Amebocyte Lysate (LAL) endotoxin assays
Reynolds Chair

Sara Funk, 2011 MS (Environmental and Radiological Health Sciences)
Evaluation of seasonal ventilation changes and their effect on ambient dust, endotoxin and bioaerosol concentrations in a dairy parlor
Reynolds Chair

Sorrentino, J. 2011, MS. A comparison of the Limulus amebocyte lysate (LAL) and recombinant Factor C (rFC) endotoxin bioassays: Characterization of aerosols and settled dust on a sheep farm. MS, Colorado State University, Fort Collins, CO.
Reynolds Chair

Ioannis Basins 2011, PhD (Aarhus Universitet, Aarhus Denmark)
Dust and Endotoxin Exposure in Animal Farming Population; Formulating the Basis for a Model-based Exposure Assessment Approach
Reynolds Opponent

Mwangi Ndonga 2012, MS (Environmental and Radiological Health Sciences)
A Portable Spectrometer for Measuring Inhalable Aerosol Size Distributions
Volckens Chair

Douglas Robinson, 2012, MS (Environmental and Radiological Health Sciences)
Evaluation of Bacterial Sampling Methods for Use with the Bacterial Tag-Encoded Flexible (FLX) Amplicon Pyrosequencing (bTEFAP) Technique: A Standardized Approach.
Reynolds Chair

REFERENCES

CDC 2010. Vital Signs: current cigarette smoking among adults aged >18 years --- United States, 2009. *Morbidity and Mortality Weekly Report,* 59**,** 1135-1140.

DONHAM, K. J., CUMRO, D., S.J., R. & MERCHANT, J. A. 2000. Dose-response relationships between occupational aerosol exposures and cross-shift declines of lung function in poultry workers: Recommendations for exposure limits. *Journal of Occupational and Environmental Medicine,* 42**,** 260-69.

DONHAM, K. J., REYNOLDS, S. J., WHITTEN, P., MERCHANT, J. A., BURMEISTER, L. & POPENDORF, W. J. 1995. Respiratory dysfunction in swine production facility workers: Dose-response relationships of environmental exposures and pulmonary function. *American Journal of Industrial Medicine,* 27**,** 405-418.

DUTCH EXPERT COMMITTEE ON OCCUPATIONAL SAFETY 2010. Endotoxins: health-based recommended occupational exposure limit. *In:* NETHERLANDS, H. C. O. T. (ed.). Den Haag: Health Council of the Netherlands.

FUNK, S. 2011. *Evaluation of seasonal ventilation changes and their effect on ambient dust, endotoxin and bioaerosol concentrations in a dairy parlor.* MS, Colorado State University.

HANKINSON, J. L., ODENCRANTZ, J. R. & FEDAN, K. B. 1999. Spirometric Reference Values from a Sample of the General U.S. Population. *Am. J. Respir. Crit. Care Med.,* 159**,** 179-187.

KIRKHORN, S. R. & SCHENKER, M. B. 2002. Current Health Effects of Agricultural Work: Respiratory Disease, Cancer, Reproductive Effects, Musculoskeletal Injuries, and Pesticide–Related Illnesses. *Journal of Agricultural Safety and Health,* 8**,** 199-214.

MALONEY, T. & GRUSENMEYER, D. C. 2005. Survey of Hispanic Dairy Workers in New York State. New York: Cornell University.

NONNENMANN, M. W., CHOUDRY, A., MEHAFFY, J., DOUPHRATE, D., LEVIN, J. L., GILMORE, K. & REYNOLDS, S. J. Year. Evaluation of a parlor washing system to reduce exposure to inhalable aerosols during dairy parlor work--A pilot study. *In:* Nordic Meeting on Agricultural Occupational Health and Safety, August 27-29 2012 Ystad, Sweden.

REYNOLDS, S. J., DONHAM, K. J., WHITTEN, P., MERCHANT, J. A., BURMEISTER, L. F. & POPENDORF, W. J. 1996. Longitudinal evaluation of dose-response relationships for environmental exposures and pulmonary function in swine production workers. *American Journal of Industrial Medicine,* 29**,** 33-40.

REYNOLDS, S. J., MILTON, D. K., HEEDERIK, D., THORNE, P. S., DONHAM, K. J., CROTEAU, E. A., KELLY, K. M., DOUWES, J., LEWIS, D., WHITMER, M., CONNAUGHTON, I., KOCH, S., MALMBERG, P., LARSSON, B. M., DEDDENS, J., SARAF, A. & LARSSON, L. 2005. Interlaboratory evaluation of endotoxin analyses in agricultural dusts--comparison of LAL assay and mass spectrometry. *J Environ Monit,* 7**,** 1371-7.

SAITO, R., CRANMER, B. K., TESSARI, J. D., LARSSON, L., MEHAFFY, J. M., KEEFE, T. J. & REYNOLDS, S. J. 2009. Recombinant factor C (rFC) assay and gas chromatography/mass spectrometry (GC/MS) analysis of endotoxin variability in four agricultural dusts. *Ann Occup Hyg,* 53**,** 713-22.

STACK, S. G., JENKINS, P. L., EARLE-RICHARDSON, G., ACKERMAN, S. & MAY, J. J. 2006. Spanish-Speaking Dairy Workers in New York, Pennsylvania, and Vermont -- Results from a Survey of Farm Owners. *Journal of Agromedicine,* 11**,** 37 - 44.

Injury Risk Analysis in Large-Herd Dairy Parlors

Prevention/Intervention Core
David Douphrate (210-562-5505, David.I.Douphrate@uth.tmc.edu),
John Rosecrance (970-491-1405, John.Rosecrance@colostate.edu),
2008-2012

Section 1

SIGNIFICANT FINDINGS

Dairy farming is among the most dangerous occupations and accounts for a disproportionately large percentage of all injuries in livestock-related agriculture. Dairy workers remain a vastly understudied population and minimal research has addressed prevention efforts that lead to the reduction of unintentional injuries among this working group. This study addresses an important problem that is relevant to the dairy industry. Over the past three decades the US dairy industry has moved to a more industrialized, mass production model. With the goal of increased milk production at lower cost, dairy capacity will continue to grow. The new mega-herd dairy operation will likely increase occupational risk factors for workers. Higher repetitions, reduced rest time, awkward postures, and high muscle loads all increase the risk for musculoskeletal injuries. No studies have investigated musculoskeletal disorders among US large-herd dairy workers. Additionally, no comprehensive efforts have characterized or compared workplace risk factors or animal-worker interactions as they relate to worker injury in large-herd dairy parlors. The long-term goal of this project is to reduce or eliminate injuries among a vulnerable workforce in industrialized milking facilities.

This project was conducted with the intent of identifying intervention needs and priorities within large-herd dairy parlors by administering a musculoskeletal symptom survey to large-herd parlor workers. A robust sample of 452 large-herd parlor workers representing 33 dairies in 5 states (CO, SD, UT, NM and TX) was recruited. All surveys were administered on-site at each dairy. Sampled dairies represented herringbone, parallel and rotary style parlors to allow for comparison between the three configurations. Specific Aims and Key Findings include the following:

Specific Aim 1: Identify upper extremity workplace risk factors associated with MSS among workers in parallel, herringbone, and rotary dairy parlors. Key Finding: Large-herd parlor workers are exposed to high repetitions, awkward postures and high muscle loads, all of which are recognized as risk factors for the development of musculoskeletal disorders.

Specific Aim 2: Assess the risk for traumatic injury as it related to worker body positioning and animal behavior in different parlor configurations. Key Finding: Parlor workers are at high risk for sustaining traumatic injury as a result of being kicked by a dairy cow. This is the result of the close worker-cow interface.

Specific Aim 3: Determine the 12-month period prevalence of musculoskeletal symptoms among workers in parallel, herringbone and rotary style dairy parlors. Key Finding: Large-herd parlor workers report high prevalences of musculoskeletal symptoms to the upper extremity and feet.

Specific Aim 4: Determine the association between parlor exposures or personal factors with prevalent musculoskeletal symptoms among workers in dairy parlors. Key Finding: Novice workers are at greater risk for acute injury and the development of musculoskeletal symptoms.

Specific Aim 5: Identify safety interventions through active participatory partnerships with dairy operators. Key Finding: Administrative interventions such as job rotation, strategic rest breaks and adequate staffing, as well as engineering interventions such as a lightweight milking cluster, novel udder preparation milking tool, and optimal pit height may reduce the risk for the development of musculoskeletal disorders.

TRANSLATION OF FINDINGS

This study was conducted with the intent of identifying intervention needs and priorities within large-herd dairy parlors. Research findings identified specific risk factors associated with the development of work-related musculoskeletal disorders. Future investigative activities will focus on the evaluation of targeted interventions including a lightweight milking cluster, udder preparation tool, as well as the determination of an optimum milking pit height.

OUTCOMES/IMPACT

Preliminary findings revealed the following:

- A large percentage (85%) of workers having been kicked by a cow
- Alarmingly high percentages of work-related pain in the shoulders, back, wrist, and neck
- Identification of specific milking tasks as being more hazardous to the worker
- Identification of specific job factors recognized as being associated with work-related injury or pain

Researchers determined no differences in parlor configurations as they relate to milker reported musculoskeletal symptoms. Intervention efforts will concentrate on specific milking tasks and how to most cost-effectively reduce their associated ergonomic exposures. Researchers have partnered with dairy producers, equipment manufacturers and extension specialists to identify specific ergonomic interventions (i.e. lightweight milking cluster, udder preparation tool, varying pit heights) to reduce risk factors in the milking parlor that are associated with the development of musculoskeletal disorders. These studies are currently ongoing.

Numerous presentations were given at producer and academic conferences to educate the public about the project and its findings. Participants included dairy owners and managers, state dairy extension specialists, dairy equipment manufacturers, and agricultural health and safety researchers.

Section 2

BACKGROUND

Within the United States (US) agriculture industry, dairy workers have the second highest prevalence of injuries [Boyle et al., 1997, Crawford et al., 1998, NIOSH, 1993]. Studies have estimated over 80% of dairy workers have musculoskeletal symptoms (MSS), with milking and feeding tasks being the most demanding [Gustafsson et al., 1994, Pinzke, 2003, Stål et al., 1996]. An analysis of workers' compensation claims data among Colorado dairy workers revealed an injury rate of 8.6 injury claims per 200,000 work hours [Douphrate et al., 2006], which is higher than the national injury rate among dairy workers (6.2 per 200,000 hours) [BLS, 2004]. This study revealed the largest percentage (35%) of injury claims involved the upper extremity.

Dairy workers remain a vastly understudied population and there has been very little research of prevention efforts leading to the reduction of *unintentional injuries* among this group. Dairy production in the US is steadily moving toward large-herd industrialized parlor operations because of associated economies of scale [Reinemann, 2001]. From 1992 to 2002, the number of US large-herd (≥500 head) dairy operations increased by 71 percent and the number of small-herd (<500 head) operations decreased by 40 percent. In Public Health Service (PHS) Region 8 (Utah, Colorado, Wyoming, Montana, North Dakota and South Dakota), the number of large-herd operations increased 163% in the same time period. The states of South Dakota, Utah and Colorado have increased their large-herd operations by 1700%, 330% and 58% respectively.

Three milking parlor configurations are commonly used in US large-herd dairy operations: parallel, herringbone and rotary. These configurations present different workstation designs and worker demands. Prior to this study, *no* research efforts compared musculoskeletal symptoms (MSS) among large-herd parlor workers in these configurations. In addition, *no* comprehensive efforts characterized or compared workplace risk factors or animal-worker interactions as they related to worker injury in these parlor configurations. Our long-term goal is to reduce the incidence of musculoskeletal injuries and illnesses among dairy workers.

SPECIFIC AIMS

The specific aims of this study included the following:

Specific Aim 1: Identify upper extremity workplace risk factors associated with MSS among workers in parallel, herringbone and rotary style dairy parlors.

Specific Aim 2: Assess the risk for traumatic injury as it relates to worker body positioning and animal behavior in different parlor configurations.

Specific Aim 3: Determine the 12-month period prevalence of musculoskeletal symptoms among workers in parallel, herringbone and rotary dairy parlors.

Specific Aim 4: Determine the association between parlor exposures or personal factors with prevalent musculoskeletal symptoms among workers in dairy parlors.

Specific Aim 5: Identify safety interventions through active participatory partnerships with dairy operators.

METHODOLOGY

In Specific Aim 1, milking tasks from large-herd milking parlors (representing herringbone, parallel and rotary parlors) were analyzed via direct observation as well as video analysis using RULA (Rapid Upper Limb Assessment), a semi-quantitative evaluation tool. RULA is easy to use and has proven to be a reliable and valid tool that can be used to assess the biomechanical and postural loading on the upper extremity in the workplace [McAtamney and Corlett, 1993, Shuval and Donchin, 2005]. For Specific Aim 2, video-based data collection enabled the analysis of specific job tasks and worker postures, as well the worker-cow interface. For Specific Aim 3, a musculoskeletal symptom survey was administered to determine the prevalence of MSS among dairy parlor workers. The Nordic Musculoskeletal Questionnaire (NMQ) was created by a team of researchers whose goal was to create a simple standardized questionnaire that could be used as a screening method for musculoskeletal disorders as part of ergonomic programs and for epidemiologic studies of musculoskeletal disorders [Baron et al., 1996]. The NMQ was translated into Spanish for this study. For Specific Aim 4, work-related musculoskeletal symptoms and the job and personal factors contributing to these symptoms were determined through on-site symptom and job factors survey of dairy parlors and workers. Musculoskeletal symptom data gathered from the worker questionnaire in Specific Aim 3 was utilized. The same questionnaire also provided parlor worker personal factors (e.g. age, gender). Investigators collected information on parlor work variables (e.g. parlor style, herd size) and risk factors (e.g. RULA score) through on-site parlor observations. Logistic regression analysis will be used to evaluate the association between work-related or personal factors and MSS prevalence among workers in parallel, herringbone and rotary dairy parlors (ongoing). For Specific Aim 5, structured focus groups were conducted with parlor workers. Qualitative data was collected which helped identify potential safety intervention for use in large-herd milking parlors.

RESULTS AND DISCUSSION

A total of 452 symptom questionnaires were administered on –site at 32 dairies (TX, NM, CO, UT, & SD). Only 6 milkers elected not to participate in the study, equating to a 98.6% response rate. The vast majority of milkers were male (89%) and Hispanic (97%). The average milking herd size among large-herd diaries sampled was 2,673 cows (range: 791-6,000)

Simplified preliminary findings from the questionnaire revealed the following:

- 85% of parlor workers have been kicked by a cow while milking
- 76% report having a job-related pain in any body part
    - 42% report job-related pain in the upper back,
    - 40% report in the shoulders
    - 32% report in the wrists/hands
- When asked to rate the level of difficulty of parlor work aspects (0 to 10 Likert scale), highest rankings involved:
    - Continuing to work when injured or hurt (7.5),
    - Working in hot, cold, wet humid conditions (7.1)
    - Working at or near physical limits" (5.8)

The highest prevalences of job-related pain were primarily in the upper extremity and upper back. These findings suggest the highly repetitive nature of parlor milking, combined with sustained awkward upper extremity and trunk postures may contribute to the development of job-related musculoskeletal symptoms. Video-based observations as well as RULA assessments support these findings. A tertiary analysis comparing milkers in different parlor configurations revealed no significant differences in reported symptoms in different body regions. A small sample of female participants prevented a statistical comparison based on gender. Preliminary results also indicate a high percentage of milkers report as having been kicked by a cow during milking. This finding is not surprising given the close interaction between the worker and cow. Additionally, the highest-rated job factor among parlor workers was related to continuing to work when injured, reflecting the physically-demanding nature of working in a large-herd parlor. Workers also rated having to work in hot, cold, wet or humid conditions as being a difficult factor related to parlor milking. Therefore, environmental conditions may contribute do the development of work-related musculoskeletal symptoms or disorders. Of note, the third highest rated job-factor related to level of difficulty was related to having to work at or near the milker's physical limits. Seven focus groups consisting of a total of 50 parlor workers was also conducted and analysis is currently ongoing.

CONCLUSION

Over the past three decades the US dairy industry has moved to a more industrialized, mass production model with the goal of increased milk production at lower costs. Dairies will continue to become larger with increases in work task specialization. These new mega-herd dairy operations will introduce significant occupational risk factors for workers. Higher repetitions, reduced rest times, awkward upper extremity postures, and increased close-proximity interactions with the animal all increase the risk for musculoskeletal disorders and acute traumatic injury. More focused research should investigate milking practices and parlor designs as they relate to worker safety and health. Targeted interventions should address identified risk factors involving the upper extremity and upper back. Additional dairy-related injury research is vital given the trend towards large industrial milking operations.

This investigation was *novel* because it was the first to address the health and safety of US large-herd dairy workers. The study is *significant* because of the national trend toward mass milk production

operations, and the lack of research addressing these new working environments. The results of this study identified safety *interventions* that may reduce the risk of injury among dairy parlor workers. This research addressed the research priority areas of the National Occupational Research Agenda (NORA) for the agriculture sector. Results from this study have been and continues to be disseminated to dairy operations and associations, and is being incorporated in current HICAHS Intervention and Translation projects.

Program Director/Principal Investigator (Last, First, Middle): Reynolds, Stephen J.

Inclusion Enrollment Report

This report format should NOT be used for data collection from study participants.

Study Title: Injury Risk Analysis in Large Herd Dairy Parlors-Symptom Surveys

Total Enrollment: 452 Symptom Questionnaires **Protocol Number:** 09-595H

Grant Number: 5U54OH008085

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race

Ethnic Category	Sex/Gender: Females	Males	Unknown or Not Reported	Total
Hispanic or Latino	48	391	0	439 **
Not Hispanic or Latino	0	13	0	13
Unknown (individuals not reporting ethnicity)	0	0	0	0
Ethnic Category: Total of All Subjects*	48	404	0	452 *
Racial Categories				
American Indian/Alaska Native	0	9	0	9
Asian	0	3	0	3
Native Hawaiian or Other Pacific Islander	0	0	0	0
Black or African American	0	3	0	3
White	35	292	0	327
More Than One Race	0	0	0	0
Unknown or Not Reported	13	97	0	110
Racial Categories: Total of All Subjects*	48	404	0	452 *

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)

Racial Categories	Females	Males	Unknown or Not Reported	Total
American Indian or Alaska Native	0	8	0	8
Asian	0	2	0	2
Native Hawaiian or Other Pacific Islander	0	0	0	0
Black or African American	0	2	0	2
White	35	283	0	318
More Than One Race	0	0	0	0
Unknown or Not Reported	13	96	0	109
Racial Categories: Total of Hispanics or Latinos**	48	391	0	439 **

* These totals must agree.
** These totals must agree.

INCLUSION OF CHILDREN – Not applicable

MATERIALS AVAILABLE FOR OTHER INVESTIGATORS

Research Tools. A Spanish-version of the Nordic Musculoskeletal Questionnaire was developed and could be used in other Spanish-speaking agricultural working populations.

PUBLICATIONS

Academic Publications

Douphrate D, Nonnenman M, Fethke N, Rosecrance J. (in preparation). Full-shift exposure measurement of muscle forces among large herd dairy parlor workers: a feasibility study. To be submitted to International Journal of Industrial Ergonomics.

Douphrate D, Rosecrance J, Gimeno D, Nonnenmann M, and Reynolds S, (in preparation). Injury risk analysis in large herd dairy parlors. To be submitted to American Journal of Industrial Medicine.

Patil A*, Rosecrance J, Douphrate D, Gilkey D. (2012). Prevalence of carpal tunnel syndrome among dairy workers. American Journal of Industrial Medicine. 55:127-135. DOI: 10.1002/ajim.21995 .

Douphrate D, Fethke N, Nonnenmann M, Rosecrance J, Reynolds S. (2012). Full shift arm inclinometry among dairy parlor workers: a feasibility study in a challenging work environment. Applied Ergonomics. 43:604-613. DOI: 10.1016/japergo.2011.09.007.

Douphrate D, Nonnenmann M, Rosecrance J. (2009). Ergonomics in industrialized dairy operations. Journal of Agromedicine. 14:406-412. PMID: 19894161.

Douphrate D, Rosecrance J, Reynolds S, Stallones L, Gilkey D. (2009). Tractor-related injuries: an analysis of workers' compensation data. Journal of Agromedicine.14:190-197. PMID: 19437278.

Douphrate D, Rosecrance J, Stallones L, Reynolds S, Gilkey, D. (2009). Livestock-handling injuries in agriculture: an analysis of Colorado workers' compensation data. American Journal of Industrial Medicine.52:391-407. PMID: 19197949.

Douphrate D, Rosecrance J, Wahl G. (2006).Workers' compensation experience of Colorado agriculture workers, 2000-2004. American Journal of Industrial Medicine.49:900-910. PMID: 17036351.

Trade Publications

Douphrate D. Special Issue: Dairy Farm Safety and OSHA—Approaches for Effective Management and Worker Training. New Mexico State University Dairy Extension Newsletter, September 2011, Volume 2, Number 5.

Douphrate D. Special Issue: Dairy Farm Safety and OSHA—Approaches for Effective Management and Worker Training. New Mexico State University Dairy Extension Newsletter, September 2011, Volume 2, Number 4.

Douphrate D. Dairy Farm Safety and OSHA—Approaches for Effective Management and Worker Training. Utah State University Dairy Extension Newsletter, June 2011, Volume 34, Number 3.

Presentations

Douphrate D, Fethke N Hagevoort R, Nonnenmann M, Mixco A, Tellechea-Sanchec T, Rosecrance J, Reynolds S (2012, September 3-6). Ergonomic exposures of posture and muscle activity among US large-herd dairy parlor workers. International Conference on Safety, Health and Welfare in Agriculture and Agro-food Systems--SHWA 2012, Ragusa Ibla Campus- Italy.

Douphrate D, Fethke N Hagevoort R, Nonnenmann M, Mixco A, Tellechea-Sanchec T, Rosecrance J, Reynolds S (2012, August 27-29). Ergonomic exposures of posture and muscle activity among US large-herd dairy parlor workers. Presented at the Nordic Meeting on Agricultural Occupational Health and Safety, Ystad, Sweden.

Douphrate D, Rosecrance J, Reynolds, S. Ergonomic exposures of posture and muscle activity among US large herd dairy parlor workers. Nordic Meeting on Agricultural Occupational Health & Safety 2012. August 27-29, 2012, Ystad, Sweden.

Douphrate D and Rosecrance C. Ergonomic exposure assessment of posture and muscle activity among dairy parlor workers in US large herd operations. International Conference on Safety, Health and Welfare in Agriculture and Agro-food Systems--Ragusa SHWA 2012, September 3-6, 2012, Ragusa Ibla Campus- Italy.

Douphrate D. Incorporating worker safety into daily farm management activities. 2011 Dairy Summit, December 7-8, 2011, Wisconsin Dells, WI.

Douphrate D, Rosecrance J, Reynolds S (2011). Musculoskeletal symptoms and physical exposures among US large- herd milking parlor workers. Irish Meeting on Agricultural Occupational Safety and Health, August 22-24, 2011, Dublin, Ireland.

Douphrate D. Dairy farm safety and OSHA: Approaches for effective management and worker training. Dairy Calf and Heifer Conference, April 5-6, 2011, Lake Geneva, WI.

Douphrate D, Rosecrance J. Industrialization of Dairy Operations: Ergonomic Implications. International Conference of Work Safety and Risk Prevention in Agro-food and Forest Systems, Ragusa SHWA2010 - Ragusa Ibla Campus- Italy, September 16-18, 2010.

Douphrate D, Rosecrance J. Livestock Handling Injuries in the United States. International Conference of Work Safety and Risk Prevention in Agro-food and Forest Systems, Ragusa SHWA2010 . Ragusa Ibla Campus- Italy, September 16-18, 2010 .

Douphrate D. Rosecrance J, Kolstrup, C, Pinske S, and Stål M. Musculoskeletal Disorders and Ergonomic Challenges in Modern Dairy Production: European and US Perspectives. Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders. Angers, France, August 29-September 3, 2010. (presenter and symposium moderator).

Douphrate D, Kolstrup C, Rosecrance J, Reynolds S, Lundqvist P, Pinske S, Stål M. European and US dairy production: challenges of work-related musculoskeletal disorder prevention. Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders. Angers, France, August 29-September 3, 2010.

Kolstrup C, Douphrate D, Pinske S, Stål M, Lundqvist P, Rosecrance J, Reynolds S. Musculoskeletal symptoms among US and Swedish dairy workers. Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders. Angers, France, August 29-September 3, 2010.

Rosecrance J, Douphrate D, Patil A. Carpal tunnel syndrome among US dairy parlor workers. Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders. Angers, France, August 29-September 3, 2010.

Douphrate D, Rosecrance J, Fethke N, and Nonnenmann M. Full-shift upper extremity direct exposure assessment of US dairy parlor workers. Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders. Angers, France, August 29-September 3, 2010.

Douphrate D, Rosecrance J, Reynolds S, Rosas-Goulart C, Roman-Muniz N, and Nonnenmann M. NIOSH protecting workers in agriculture: an example of immediate r2p in an ergonomic research project in large herd dairies. NIOSH Invitational Intra/Extramural Agriculture, Forestry and Fishing Safety and Health Workshop, Cincinnati, OH, August 11-12, 2009.

Douphrate D. and Rosecrance J. (2009) Ergonomics needs assessment of large-herd dairy parlor operations. 21st Annual International Occupational Ergonomics and Safety Conference, Dallas, TX, June 11-12, 2009.

Douphrate D. and Rosecrance J. Livestock-handling injuries in Colorado agriculture. New Paths Conference: Health and Safety in Western Agriculture, Cle Elum, WA, November 11-13, 2008.

Rosecrance J. and Douphrate D. Ergonomics and dairy operations. New Paths Conference: Health and Safety in Western Agriculture, Cle Elum, WA, November 11-13, 2008.

Douphrate D, Rosecrance J and Reynolds S. Tractor-related injuries on farms: an analysis of workers' compensation data. Sixth International Symposium on Public Health and the Agricultural Rural Ecosystem, Saskatoon, SK, Canada, October 19-23, 2008.

Douphrate D, Rosecrance J. and Reynolds S. Dairy farm injuries: an analysis of workers' compensation data. Sixth International Symposium on Public Health and the Agricultural Rural Ecosystem, Saskatoon, SK, Canada, October 19-23, 2008.

Douphrate D, Rosecrance J and Reynolds S. What can workers' compensation data tell us about livestock-handling injuries in agriculture? Sixth International Symposium on Public Health and the Agricultural Rural Ecosystem, Saskatoon, SK, Canada, October 19-23, 2008.

Douphrate D and Rosecrance J. The analysis of agriculture injuries using workers' compensation data. Presented at the 6th Annual Regional National Occupational Research Agenda Young Investigators Symposium, Salt Lake City, UT, April 17-18, 2008.

Douphrate D, Rosecrance J, and Wahl G. Workers' compensation experience of Colorado agriculture workers, 2000-2004. Presented at the National Occupational Research Agenda Symposium, Washington, DC, April 18-20, 2006.

Developing and Testing Interactive CD Health and Safety Curricula for 4-H Youth.

Education and Translation Core
Victoria V. Buchan (970-491-5211, Victoria.Buchan@colostate.edu),
Robert Seiz, and Juhua Liu
2007-2010

Section 1

SIGNIFICANT FINDINGS

Teaching youth about safety is an important step to preventing accidents on farms. Tractors, ATVs, chemicals, handling animals and grain each pose a hazard when living and working on farms. Surveillance statistics indicate that there are over 20,000 injuries to youth under age 20, and that the highest rate of injury is in youths who are part of a farm household. The project "Developing and Testing Interactive CD Health and Safety Curricula for 4-H Youth" builds upon a previous HICAHS project to create a safety training curriculum for children in grades 3-6. This project "Developing and Testing Interactive CD Health and Safety Curricula for 4-H Youth" had five specific aims:

Specific Aim 1: Evaluate the impact of an interactive computer based agricultural health and safety education intervention (4-H CD1) in three different agricultural regions of the U.S. (Northeast, Southwest, and Southeast). The research design to evaluate 4H CD1 included randomly assigned treatment and control groups of youth in grades 3-6 in New York, Kentucky, Oklahoma, and Texas. The youth were tested on their knowledge before and after taking the training and parents were interviewed on whether their children changed their behavior following the training. Significant differences were found between the test scores of treatment and control groups. A sample of parents of both groups were interviewed and reported that their youth had brought home health and safety topics to discuss and some changes in safety behaviors were also identified.

Specific Aim 2: Assess how well the content of the existing 4-H CD1 meets the needs of youth and families in three different agricultural regions of the U.S. Based upon the feedback of panels of parents, children and 4-H personnel in Texas, Kentucky and New York, the topics included in 4-H CD1 were appropriate to the three different agricultural regions in the study. In fact, several of the topics (ATV, animal handling, and chemicals) were identified by the panels as selections to include in 4-H CD2 but with more depth of information to be included.

Specific Aim 3: Identify additional health and safety teaching modules (or modifications of current modules) based on feedback from three regional panels. The three regional panels, as well as health and safety experts in each participating region were asked to identify specific health and safety modules that they would like to be included in the second CD to be produced. Through a process of content analysis of the data received, five topics were selected to include in the second CD. Three of these were requesting additional information be included related to ATVs, Large Animal handling and showing, and

Chemical Safety on the farm. In addition, farm machinery safety and a farm safety walk about were selected to add to the second CD.

Specific Aim 4: Based upon the needs identified in Specific Aim 3, develop and formatively evaluate a second agricultural health and safety educational CD (4-H CD2) to meet the needs of a broader national audience. Once the topics were identified, each participating Center (New York, Kentucky and Texas) took responsibility for taking video material related to one or more of the topics and forwarded them to HICAHS to begin the process of editing for the new CD. Once the video material was selected, HICAHS personnel wrote a script for each video section which was then timed to fit each video clip. Each participating Center then identified regional youth who were willing to narrate portions of the video, so it would be youth speaking to youth about the importance of agricultural health and safety. The HICAHS team also wrote quiz questions to be included with pop-up responses to immediately reinforce whether answers were correct or incorrect. The finalization of 4-H CD2 has been delayed due to the sudden and unexpected death of Dr. Liu's wife. Once the materials are received from him, the team intends to complete the project as all that remains is loading the materials onto a CD with the appropriate working coding. Formative evaluation can be accomplished in Colorado.

Specific Aim 5: Develop with the Advisory Team, a dissemination plan of the two CDs through the national 4-H, the HICAHS Translation project, and other appropriate venues. The 4-H CD1 has been fairly extensively disseminated as each participating 4-H Treatment group in the three collaborating regions of the country received one for pre testing or after the post test in the case of the control groups. A HICAHS Advisory Board member has offered to assist the PI with gaining National 4-H Curriculum approval for both CDs.

TRANSLATION OF FINDINGS

The purpose of developing the 4-H CDs was to begin agricultural health and safety education early in the lives of future farmers/ranchers or for those who might be visiting in agriculture. If children and families can be encouraged to discuss the potential hazards that may exist in production agriculture, that knowledge may be transferred to safer habits and behaviors as the youth age and become owner/operators or hired workers. The educational modules will also be available on the HICAHS website to be used in schools as well as 4-H clubs across the country.

OUTCOMES/IMPACT

- 4H CD1 evaluated and revised based upon panels of stakeholders in the NE, SE and SW regions of the country
    - Significant differences in **knowledge** were found between treatment and control groups on post test scores (N = 345) both overall and in each region of the country.
    - Parent surveys illustrated a difference between treatment and control group parents in observed **safety behavior**.
- 4-H CD1 copies utilized in regional farm shows, participating 4-H youth groups received copies.

Section 2

BACKGROUND

This project proposed two primary objectives. The first objective was an outcomes assessment in three diverse agricultural regions of the United States, of a recently developed agricultural health and safety interactive computer based CD targeting children in grades 3-6 who are members of 4-H. The second objective was to assess the regional appropriateness of the 4-H CD1, and to complete a needs assessment in the diverse agricultural regions for additional educational modules to develop a second interactive CD (4-H CD2). The proposed project sought to respond to the need identified in the literature for experimentally tested and theoretically based educational interventions addressing children and youth living and working in an agricultural environment. The project was multi-disciplinary, involving engineering, industrial hygiene, social work, public health, and nursing to create the interactive curriculum.

Need

There are over seven million (7,090,920) participants in 4-H across the United States with participants in every state, six territories and the District of Columbia. Participants include children and youth, ages 5 through 19, from kindergarten through high school, and post high school. Approximately one half of these youth still live on the farm or in small rural communities. Fifty percent (3,549,109) of all those youth enrolled are in the targeted grades for this project, 3rd through 6th. Juxtaposed with these 4-H figures is the estimated injury rate experienced by children and youth in agriculture broken down by age group. Extrapolating from 2001 data reported by NIOSH, approximately two-thirds of agricultural injuries to children occur in the grades targeted by the two Interactive 4-H CDs this project seeks to evaluate (4-H CD1), and to develop (4-H CD2).

EPIDEMIOLOGY OF CHILD INJURY AND ILLNESS

Injuries

According to NIOSH, in 2001 there were approximately 1.9 million farms in the US, with an estimated 1,075,759 youth living in these farm households (NIOSH, 2004-172). Based upon 2001 data there were 16,851 non-fatal injuries to these youth who were members of the farm household for a rate of approximately 16 injuries per 1000 household youth. If the data expanded to those youth who work on or visit farm operations (see Table 1), the injuries during 2001 increased to 22,648 for those youth under age 20. Broken down by age group, 31% happened to children under age 10, 46% to children age 10-15, and 23% to adolescents age 16-19. A further breakdown can be done by region of the country and rate of injury per 100 farms.

Table 1. *US Childhood Agricultural-Related Injuries, 2001*

Region	Total Injuries	% of Injuries to Happen In Region	Injuries per 100 Farms
Northeast	1,386	6%	1.5
South	6,847	31%	1.0
Midwest	10,959	48%	1.7
West	3,456	15%	1.5
US	22,648		1.4

2001 Childhood Agricultural Related Injuries, Released January 8, 2004, by the National Agricultural Statistic Service (NASS), Agricultural Statistics Board, U.S. Department of Agriculture

Approximately 62% of the youth injuries happen to males versus 38% of the injuries occurring in females. The most common type of injuries reported for 2001 were broken bones (32%), with extremities such as foot, ankle, hand, fingers and arms being the most common sites at 16% each (NIOSH, 2004-172).

Fatalities

Agriculture is also the most hazardous industry for young workers based upon fatalities, accounting for 42% of all work-related fatalities of young workers between 1992 and 2000 (NIOSH, 2003-128). For agricultural workers aged 15-17, the risk of fatal injury is four times the risk for youth working other industrial sectors. Between 1992 and 2000, 76% of the fatal injuries to agricultural workers under age 16 involved work in a family business. Again there are differences based upon gender; 53% of male fatalities occur in crop production while the majority of female fatalities occur in livestock production. The majority of these deaths were related to machinery (25%) followed by motor vehicles including all-terrain vehicles (ATVs). Agriculture is a very hazardous industry, according to the most recent NAICS statistics (CFOI, 2003 data); the private industry category with the highest fatal work injury rate was "Agriculture, forestry, fishing and hunting, 31.2 fatalities per 100,000 workers."

Farm environment

It is important to also cite the context within which youth are working when addressing injuries and fatalities. As Waters and Wilkins state (2002), "Agriculture is one of the few industries in which children and adolescents are considered an integral component of the workforce." Youth working in agriculture have a high risk of getting injured because for many the farm is their place of residence in addition to being a place of hazardous work (NIOSH, 2001-154). Living in such a hazardous environment presents ample opportunity for injuries both on and off the job. DeMuri and Purschwitz (2000) believe additional factors contributing to injuries may include lack of parental supervision, unreasonable expectations for children to work long hours, tasks to complete that are inappropriate for age, and financial stresses that increase the dependence on children to work on the farm. Financial factors may also result in older equipment that is poorly maintained and without safety devices, increasing youth's risk of injury (DeMuri & Purschwitz, 2000).

Children in agriculture do not receive the same level of protection from occupational hazards as they do in other occupations. The Fair Labor Standard Act (FLSA) sets the minimal age for child labor and is the least protective for children working in agriculture. On small farms, children younger than twelve may work unlimited hours (Partners in Agricultural Health, 2001). Additionally, the Occupational Safety and Health Act (OSHA) covers only 5 percent of farms in the U.S.A. with safety regulations (Partners in Agricultural Health, 2001).

EDUCATION EFFORTS TARGETING CHILDREN & YOUTH

Safety and health promotion has been typically addressed through a combination of educational and environmental supports for actions and improvement of conditions of living and working in the farm environment. According to Murphy (2003) past and current efforts for modifying farm worker safety behavior can generally be grouped into educational activities, legislative initiatives and engineering endeavors. Murphy (1992) states "safety and health education is a loosely defined phrase covering a range of concepts, principles, philosophies, practices, and activities concerning hazard and injury prevention and control." [The primary objective of educational efforts] "is a non-coercive, voluntary directing of human learning and behavior in such ways that hazards and injury are avoided or minimized" (p. 136).

Examples of Educational products

A number of educational products targeting children and youth have been developed over the past 10 to 15 years. A number of videos have been developed, for example: "Livestock Safety for Kids" (Oklahoma State Cooperative Extension, 2000), and "Be Safe and Sound says Safety Hound" (Contact Perceptions, Inc. 1993), and a number of products by Farm Safety 4 Just Kids (1989 & 1999) to name just a few. Websites of interest to children have also been created (Children's Center, HICAHS, Farm Safety for Just Kids, John Deere); as well as kits for Farm Safety Day Camps (Farm Safety 4 Kids) and guidelines for farm visits. Curriculum containing multiple modules have also been developed targeting specific age groups such as "ABC" (North Dakota Farm Bureau, 1992), and "The High School Vocational Agricultural Curriculum" (HICAHS, 2006).

Critiques of educational products

These educational efforts from multiple sources including NIOSH Agricultural Centers, USDA, Cooperative Extension, FFA and others have specifically targeted children and youth; but several weaknesses related to many of these efforts have been pointed out. First, a number of authors indicate that few of these educational products or projects have been rigorously evaluated (Murphy, 2003; Shutske, 1994; Aherin, Murphy, & Westaby 1990). This lack of good evaluation research methodology has led to the belief that education, as a primary means of injury control, is ineffective. A second weakness identified by Murphy (2003) is that few of the education projects have been theory driven, a weakness that would make both educationally sound projects and effective evaluation research impossible.

The current project seeks to address both of these identified weaknesses by building upon a product that has a theoretical base, has undergone formative and process evaluation during development and is proposed to be evaluated using acceptable experimental methodology for applied research.

BACKGROUND LITERATURE

The use of computers as an adjunct educational teaching tool has increased logarithmically in the last decade and there are a number of conceptual arguments for this increase based in educational and developmental theory. Below we will discuss a few key aspects of this apparent paradigm shift that provide support for the use of interactive CDs to teach children about agricultural health and safety issues.

Rural Computer Access

The most recent NASS (2005) data indicates that the number of farms with computer access continues to increase, with the Western region reaching about 70%. In addition, the percent of schools incorporating computer technology serving the rural populations has also increased dramatically. Children in agricultural environments therefore are increasingly likely to have access to computers as a teaching tool both at home and at school.

Computer use in education

Jones and Paolucci (1999) define educational technology as "the use of technology to enhance the teaching and learning process" (p. 18), or the ability of such technologies to affect learning outcomes that are deemed important or appropriate. Several authors have identified the importance of context in relation to educational technology. Staples, Pugach and Himes (2005), state that new technology resources are readily "absorbed into an existing, normative ecosystem" which might include the school environment, the home or a 4-H group. An interesting and very descriptive perspective is presented by Hertzog and Klein (2005) when they refer to children as "digital natives" and parents as "digital immigrants." This view reflects the reality of both increased access and the normalization of computer use in educational technology.

Quality educational software

Polonoli (2000) presents four principles that quality educational software should incorporate. These include: 1) an adherence to learning theory, 2) employment of gaming features, 3) culturally sensitive content, and 4) the elicitation of an emotional response from the learner. All criteria are met with the current CD in the following ways: the learning theory, discussed below, incorporates both constructivist and directed instruction components. Polonoli further explicates his second principle by stating that "gaming strategies will foster more fervent pupil interaction…more intense involvement and longer contact with a learning activity." (p. 7) The gaming components in the 4-H CD include cumulative scoring, immediate quiz feedback using animated voiced characters, as well as music and certificates of accomplishment. The 4-H CD does present culturally sensitive content, once it is recognized that the

"culture" in this case is rural agricultural communities. Finally, what Polonoli means by an emotional response, is creating a "mild state of cognitive dissonance." The 4-H CD presents familiar situations that the children should recognize, but perhaps they will not be able to relate the injury scenarios (such as the grain bin story) alluded to in the CD with their own home experiences of these familiar situations.

Several authors (Polonoli, K.E., 2000; Keeler, C.M., 1996: Hertzog & Klein, 2005) also cite as a strength, the ability of the use of computers to impact multiple learning styles whether visual, kinesthetic or auditory. This aspect of the use of computers to enhance learning may be particularly important in elementary grades such as those targeted for the 4-H CD as these children may be still exploring multiple learning modalities.

THEORETICAL FOUNDATION FOR 4-H CDs

There are three areas of theory that will be discussed related to the development and use of interactive CDs to educate children and youth regarding agricultural health and safety concepts. Included in the three theoretical perspectives are: developmental theory, learning theory and the role of family in the education of children.

Developmental

A number of authors describe the value of computer technology in enhancing children's development (Seng, 1998; Hertzog & Klein, 2005). The lists have in common social development, emotional development and cognitive development: Seng (1998) adds thinking skills and physical development, Hertzog and Klein (2005) add learning creativity, language & reading, and mathematics.

The age group targeted by the 4-H CD fits with Piaget's "concrete operational stage" in addressing cognitive development. This stage, according to Piaget, includes an increase in abstract reasoning ability, and the ability to generalize from concrete experiences (Roblyer, Edwards & Havriluk, 1997). This cognitive stage fits very well with the goals of the CD. Concrete experiences are presented via video, and the objective is for the student to be able to transfer or generalize the knowledge to their own environment.

According to Charlesworth, Viggiani and Wood (2003) the most important developmental task of these middle childhood years is "the acquisition of feelings of self-competence." They go on to place this age group within Erikson's middle childhood task of industry versus inferiority: "*Industry* refers to a drive to acquire new skills and do meaningful work" (p. 206). The 4-H CD provides age appropriate guidance to learn new knowledge and skills; and helps present a new way to conceptualize their own agricultural environment and to recognize dangers and act appropriately.

Learning theory and education

According to Roblyer, Edwards and Havriluk (1997), educators have divided learning theory into two basic conceptual approaches. The first theoretical perspective is "directed instruction" and is based upon both behavioral learning theory and information processing theory. The second perspective is "constructivist" and is based upon cognitive learning theory. Roblyer et al (1997), come to the

conclusion that educators using technology needs to combine the approaches as both have strengths, and that the weaknesses of each can be compensated for by strengths of the other. “Together, these two ostensibly different views of reality may merge to form a new and powerful approach to solving some of the major problems of the educational system…” (p. 58). We believe the 4-H CD incorporates some of the key strengths of both directed instruction and the constructivist approaches.

From the constructivist theory come four key components. These include problem oriented activities, visual formats, and a “rich” environment (e.g. beyond texts and worksheets). Also out of the constructivist perspective is the goal of using methods which “emphasize student’s ability to solve real-life, practical problems” (p. 70). In this case, the CD modules help the viewer to think about and learn new ways to improve the safety of their own activities related to the work or play they may be involved in at home. It is important for learners to see the link between learning and real-life activities that they may experience within their own environment at home.

The CD also incorporates some of the key strengths of the directed instruction approach. These components include clear learning objectives and tests matched to these objectives. Also included are clear instructions that are presented in a logical order that will facilitate learning how to proceed through the CD with increasing ease and understanding.

Finally, Bradens’ (1996) Instructional Design Model identifies the evaluative steps that have been included in the development of the 4-H CD to this point. These steps include a needs assessment, multiple formative evaluation steps with revisions and pilot testing.

Parent/Family Involvement in Education

Research has shown that engaging parents with an active role in their children’s education can open new opportunities for children to succeed academically (Machen, Wilson & Notar, 2005). Fan and Chen (2001) conducted a meta-analysis which showed that parental involvement positively affects students’ academic achievement. Fan and Chen (2001) found that the vast majority of policy makers, school board administrators, teachers, and even students have agreed that parental involvement is critical for the academic success of children. The Michigan Department of Education (2001) reviewed decades of research which showed that when parents are involved, students have higher grades and graduation rates, better school attendance, increased motivation and self-esteem, decreased use of drugs and alcohol, and less behavioral problems. Particularly, parental involvement in children’s homework positively influences student outcomes because it offers modeling, reinforcement, and instruction (Hoover-Dempsey et al., 2001).

The interactive CD would provide an opportunity for parents to become more involved in the safety educational process of children growing up in an agricultural environment (Seiz & Downey, 1998). We will involve both the “Regional Panels” and the Advisory Team in developing ways to encourage students to take safety information home. The family discussions and interactions potentially triggered by the CD can create a reciprocal learning environment; the children’s learning could be enhanced by the parents’ involvement, and the parents could learn ways of communicating safety from discussions and interactions regarding the CD modules with the children. Family discussions raised by the CD might

encourage both the parents and children to think more about occupational health and safety. The parents' involvement can help enhance their own learning while simultaneously providing a positive influence on the children's learning and behavior.

SPECIFIC AIMS

The five specific aims to accomplish the proposed project objectives were:

Specific Aim 1: Evaluate the impact of an interactive computer based agricultural health and safety education intervention (4-H CD1) in three different agricultural regions of the U.S. (Northeast, Southwest, and Southeast).

Specific Aim 2: Assess how well the content of the existing 4-H CD1 meets the needs of youth and families in three different agricultural regions of the U.S.

Specific Aim 3: Identify additional health and safety teaching modules (or modifications of current modules) based on feedback from three regional panels.

Specific Aim 4: Based upon the needs identified in Specific Aim 3, develop and formatively evaluate a second agricultural health and safety educational CD (4-H CD2) to meet the needs of a broader national audience.

Specific Aim 5: Develop with the Advisory Team, a dissemination plan of the two CDs through the national 4-H, the HICAHS Translation project, and other appropriate venues. \ approval for both CDs.

METHODOLOGY

In the previous funding cycle the research team successfully developed and formatively evaluated a prototype agricultural health and safety CD for 4-H youth grades 3-6 in PHS Region VIII. The 4-H CD1 is interactive containing five teaching modules addressing safety issues related to tractors, chemical handling, animal handling, ATVs and grain handling. Each of the modules includes 2-3 video clips, safety facts and an embedded quiz with immediate reinforcement identifying correct or incorrect answers.

This project sought to evaluate the effectiveness of the CD1 on a national sample of youth in the targeted grades. Working with three Agricultural Centers in very different agricultural production regions of the country, the team used outcome evaluation research methods to test for both knowledge gain and short term behavioral change. "Concept teams" (parents, children & 4-H leaders) developed with each Center will assist the researchers to assess appropriateness of current CD for their region and to identify new topics for 4-5 additional teaching modules. A research Advisory Team made up of representatives from each participating Center, the HICAHS research team and subject matter experts will assist with all aspects of the 5-year project, including data collection, "Concept Team" development

and activities, final selection of new teaching module topics, and development and formative evaluation of 4-H CD2.

To accomplish the specific aims of this project, HICAHS partnered with three additional Agricultural Health and Safety Centers on this project to develop and test two Interactive Agricultural Health and Safety Curricula on CDs :

- North East Center for Agricultural Safety and Health Cooperstown, N.Y. ,
- South East Center for Agricultural Health and Injury Prevention Lexington, Kentucky
- South West Center for Agricultural Health, Injury Prevention and Education Tyler, Texas.

In addition, HICAHS worked with the Director of 4-H at Colorado State University to incorporate 4-H personnel around the state to assist with the development of 4-H CD1. The three additional Centers worked with their state 4-H organizations to help with evaluation of 4-H CD1 and the Development of 4- H CD2.

Aim 1. Evaluate youth outcomes of the current 4-H CD utilizing experimental design in 3 different agricultural regions of the U.S.

Figure 1, below illustrates the experimental design approach to Project Aim 1. A quasi-experimental design utilizing randomly assigned treatment and control groups was be used to test for knowledge gain. Already existing 4-H groups in **each** region were randomly assigned to treatment (n=60) and control groups (n=60) in approximately equal numbers, with an overall goal of 180 (60 per region) children in the target age group (grades 3-6) in the treatment (Group 1) and 180 (grades 3-6) in the control group (Group 2).

Sample	Pretests	Treatment	Post test	Survey
Group 1	O_1	**X**	O_2	O_3
Group 2	O_1		O_2	O_3

Figure 1. *Research Design – Aim 1*

Legend:
O_1 = Knowledge pretest
O_2 = Knowledge post test
O_3 = Parent telephone survey/behavior
X = "Treatment" – using "4-H CD"

Hypotheses: There were seven research hypotheses addressed by this phase of the proposed project assessing the impact of 4-H CD1 developed by HICAHS.

1. There will be no difference between the treatment and control groups by region based upon demographics of age; gender; years in 4-H, current living situation.

2. There will be no difference between the treatment and control groups overall based upon demographics of age; gender; years in 4-H, current living situation.
3. There will be no difference between the pre test scores of the treatment and control groups by region.
4. There will be no difference between the pre test scores of the treatment and control groups overall.
5. The treatment group will score ≤ the control group on the posttest knowledge test.
6. The parents of those children in the treatment group will report ≤ number of safe behavior incidents three months post treatment than the parents of children in the control groups.
7. The parents of those children in the treatment group will report ≤ number of "family" discussions related to agricultural health and safety information three months post treatment than the parents of the control group

4-H Samples: 4-H groups in each of the three regions of the U.S. were selected by the Regional Coordinator and randomly assigned by group to the treatment or control groups for testing 4-H CD1. The regions were chosen specifically to represent different types of agricultural production across the U.S. The target n per region is 60 youth for treatment group and 60 for control; for a total N of 360 across all three regions. The regional Centers collaborating on this project are: the Northeast Center for Agricultural Safety and Health, Cooperstown, NY; Southwest Center for Agricultural Health, Injury Prevention and Education, Tyler, TX and the Southeast Center for Agricultural Health and Injury Prevention, Lexington, KY.

Intra-group Correlations: Using all pilot data (n=231), intra-group correlations were computed and are presented in Table 2. Since the correlation estimates were very small or zero, sample size estimates are computed assuming zero within group correlation.

Table 2. *Within Group Correlations (n=231)*

Overall Quiz	ATV	AH	TS	GH	CH
0.001	0.000	0.036	0.009	0.000	0.021

ATV=All terrain vehicle, AH=animal handling, TS=tractor safety, GH=grain handling, CH=chemical handling.

Sample Size Estimation 4-H participants: For the pilot data there was an increase in the overall quiz score of approximately 15% (pre-mean=73.3%, post-mean=88.7%) in the intervention group. A similar increase would be expected in the study. The control group (pre-mean=73.5%) did not have a 'post' test. Assuming that the control group might increase from 5% to 7% from pre to post, the effect size (effect size=intervention group gain – control group gain) desired to be detected as statistically significant ($p<0.05$) was set to 8%. The pilot data standard deviation for the intervention group change was 16.5%. Sample size was thereby estimated to be 158 youth for each group for a one-tailed t-test to detect a group effect of 8%, assuming a within group standard deviation of 17%, alpha=0.05 and power=0.90. Since attrition in the pilot data from pre to post was 20%, to yield an effective sample size (harmonic mean of pre and post sample sizes) of 158, 178 youth will be needed for the pre test in each

of the two groups. Sample sizes for various other combinations of power and effect sizes are presented in Table 3.

Table 3. *Adjusted Sample Size Estimates*

Computed N Adjusted for 20% Attrition from Pre to Post					
Intervention mean – Control mean	Nominal Power	Actual Alpha (one-tailed)	Actual Power	N Total	N Adjusted for 20% Attrition
8%	0.8	0.0500	0.803	114	129
8%	**0.9**	**0.0500**	**0.903**	**158**	**178**
9%	0.8	0.0500	0.801	90	101
9%	0.9	0.0500	0.901	124	140
10%	0.8	0.0499	0.805	74	84
10%	0.9	0.0500	0.904	102	115

Parent interview sample

A second sample of parents of the children in both treatment and control 4-H groups will be randomly selected by 4-H leaders and the Regional coordinators from each region. These parents will have signed a consent form indicating their willingness to participate in a phone interview if selected. The interviews will be scheduled at their convenience approximately 3 months post intervention. The target N for this group is 60 parents, 20 per region, 10 whose children were in the treatment group and 10 whose children were in the control group. This second data collection approach is more qualitative in nature, and the sample size is based upon feasibility.

Setting

Treatment and Control groups were selected by project coordinators at three regional NIOSH Agricultural Health and Safety Centers located in New York, Texas and Kentucky. Each Center covers multiple states and each selected the states within their region and the 4-H children to participate. The children, who agreed to participate via assent and whose parents also sign consents participated in the evaluation research in their natural environment, where ever their 4-H group traditionally meets.

Measurement

There were two instruments to collect data for this phase of the proposed project.

1. A pre/post multiple choice knowledge test made up of 25 questions based upon the information presented in the five modules of the CD 1. (5 questions per module). The revised version of this instrument (based upon both validity and reliability analysis) included a page of demographic information that identified the age, gender and current living situation of participants. *Validity analysis:* The pre/post multiple choice knowledge test underwent formative evaluation question by question in each module with over 150 children in the appropriate age group. The purpose was to identify items that were not clearly understood, or those items that contained language at too high a level for the target age group. Validity was also addressed by having

subject matter experts review the questions. Changes were made to the pre/post test to improve the content validity of the instrument for the second process phase of evaluation during the last project period

2. *Reliability Analysis***:** Based upon the pilot data gathered from the process evaluation in two regional states we were able to analyze the reliability of the pre/post test instrument in order to identify those items in each subscale with low correlations with the subscale total.
3. The second instrument was a survey designed to be completed by telephone interview of a subgroup of parents of the 4-H children in both treatment and control groups in each region. The parents were randomly selected by the regional coordinator from those agreeing to participate (signed consent); they will be contacted 3-4 months after their child has completed participating in either the treatment or the control group.

This second instrument was designed by the PIs in collaboration with the Advisory Team and addressed the following questions related to health and safety behavior changes observed:

1. Has the participant (parent) observed any health or safety behavior changes in their child since the post test; both treatment and control groups? An example prompt will be used to help provide a frame of reference.
2. Has the child/youth brought up for discussion with family members any agricultural health and safety within the same time period?

Results Aim 1.

Hypotheses: There were seven research hypotheses addressed by this phase of the proposed project assessing the impact of 4-H CD1 developed by HICAHS.

1. **There will be no difference between the treatment and control groups by region based upon demographics of age; gender; years in 4-H, current living situation.**
   Hypothesis one was not confirmed, differences were found between treatment and control groups by region based upon age, and years in 4-H. No differences were found based upon gender.

2. **There will be no difference between the treatment and control groups overall based upon demographics of age; gender; years in 4-H, current living situation.**
   Hypothesis was not supported, there were significant differences identified between treatment and control groups overall based upon age, gender, and years in 4-H. These differences were fit into a general linear model to control for differences when addressing hypotheses 3, 4 and 5.

3. **There will be no difference between the pre test scores of the treatment and control groups by region.**
   Hypothesis 3 was supported. Analysis of pre test scores by region did not vary significantly when controlling for age, gender, years in 4-H.

Table 4. *Pretest score treatment and control by region*

Region	Group	Estimate	t-values	P =
NE	Control	70.1	33.15	.0001
NE	Treatment	73.1	35.82	.0001
SE	Control	67.9	16.63	.0001
SE	Treatment	67.9	39.46	.0001
SW	Control	67.05	34.08	.0001
SW	Treatment	66.2	33.68	.0001

4. **There will be no difference between the pre test scores of the treatment and control groups overall.**

   This hypothesis was also supported. The percent of test items correct was 68.4 for the control and 69.1 for the treatment group with a p value of .0001..

5. **The treatment group will score ≤ the control group on the posttest knowledge test.**
   This hypothesis was also supported. The treatment group scored 83 percent correct to the control groups 70 percent correct.

6. **The Treatment and control group scores overall will be significantly different [note: this hypothesis was added after the proposal was accepted]**
   Pre/post test scores were compared utilizing analysis of covariance taking into account any differences based upon years in pretest scores, 4-H, gender, grades and region. Overall posttest scores were significantly different between treatment and controls. See Table 5.

Table 5. *Treatment vs. Control Group Scores Overall*

	Estimate	Standard Error	DF	t value	p=
Control	69.9	1.58	304	44.13	0.0001
Treatment	82.9	1.00	304	82.62	.0001

The following figures illustrate pretest and post test scores by treatment and control, as well as scores on modules by grade.

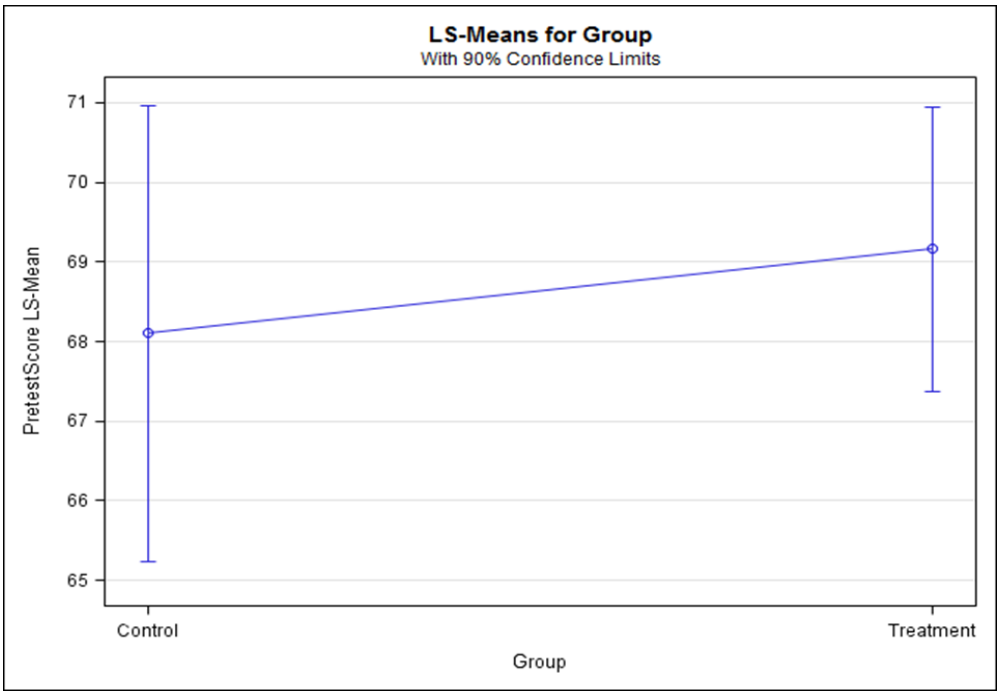


Figure 2. *Pretest Scores for by treatment and control groups.*

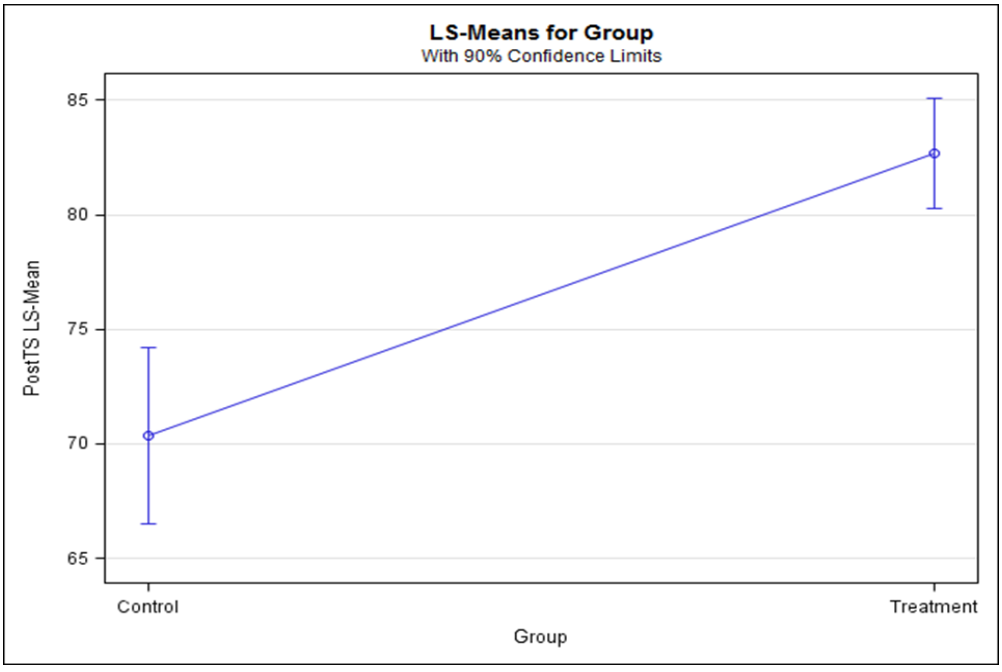
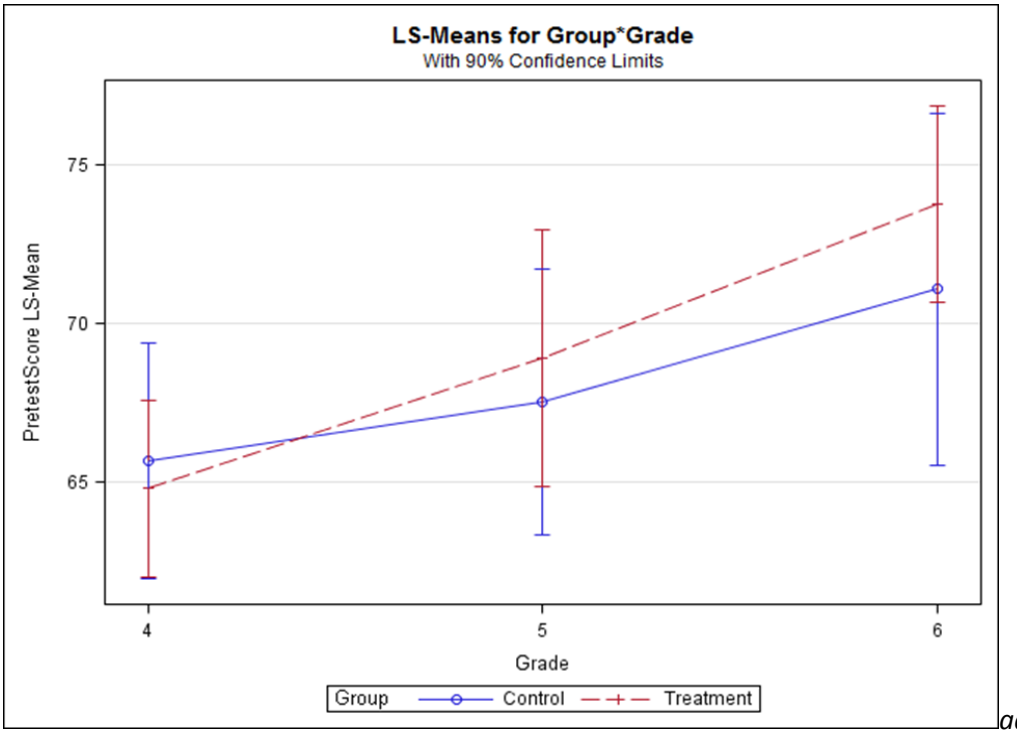


Figure 3. *Post Test for treatment and control groups*



ade

Figure 4. *Pretest scores by grade*

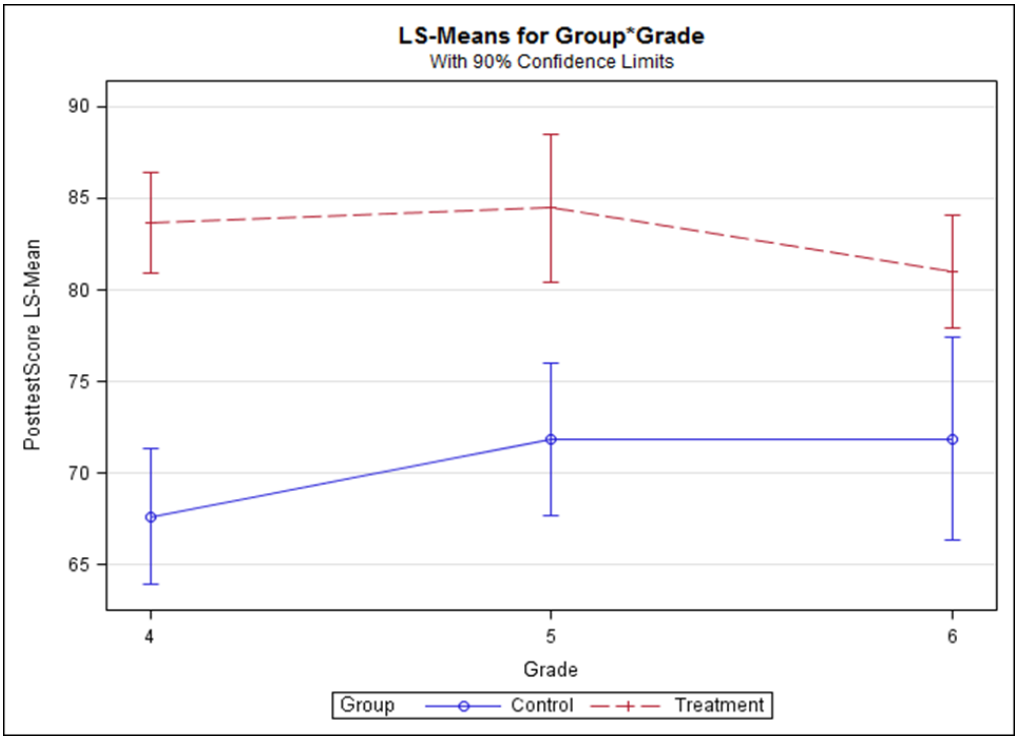


Figure 5. *Post Test scores by Grade*

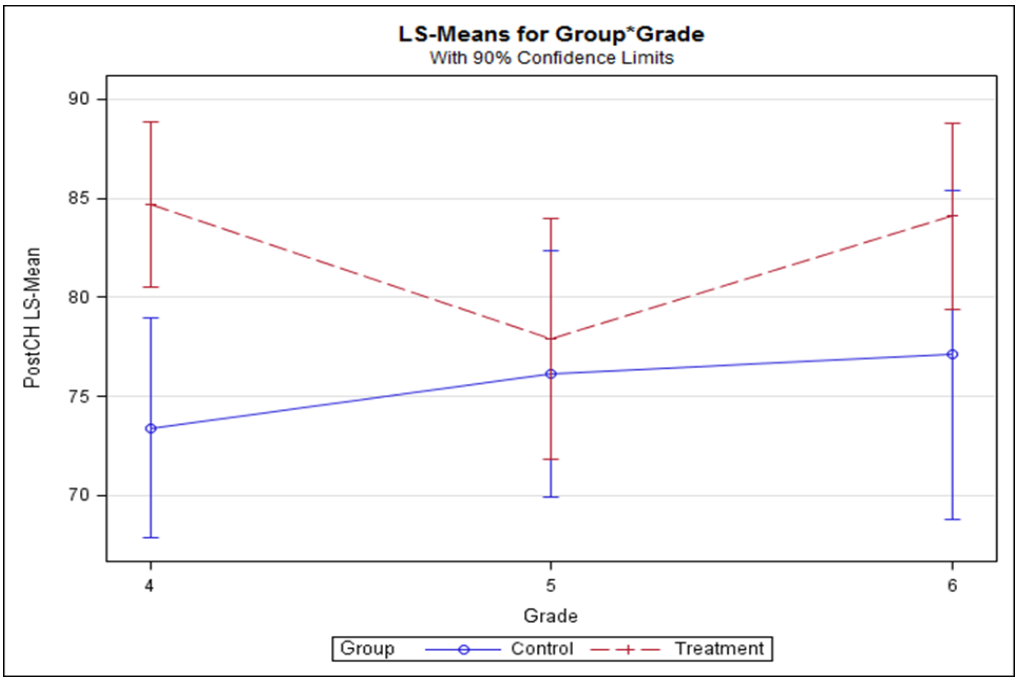


Figure 6. *Post Test of Chemical Handling by Grade*

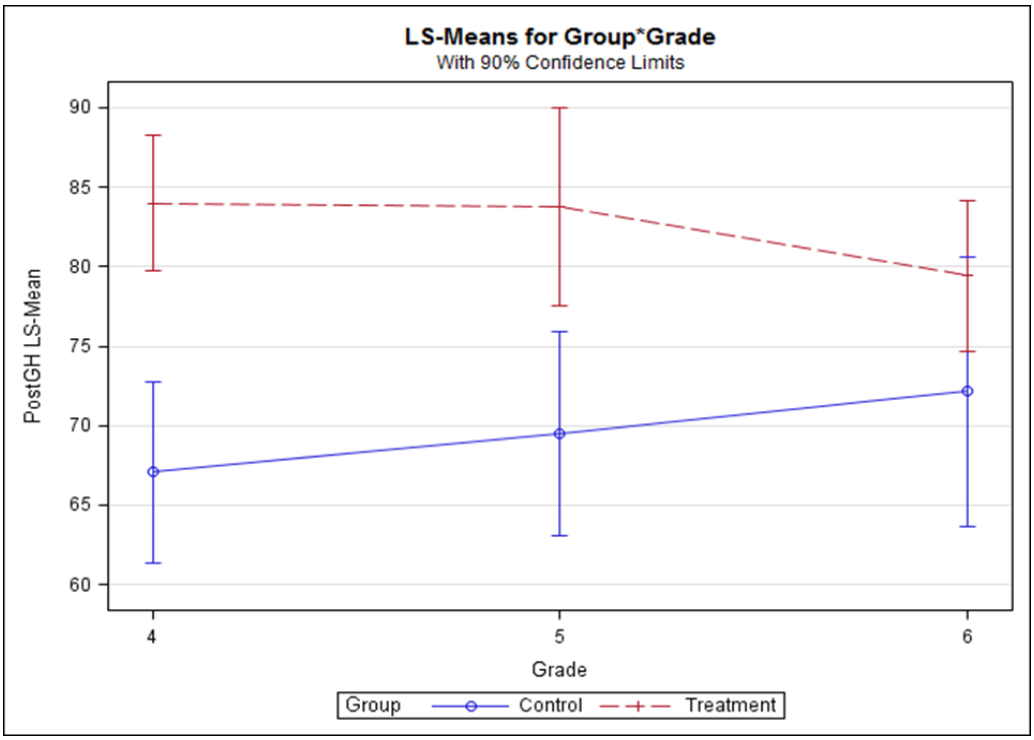


Figure 7. *Post Test of Grain Handling by Grade*

7. **The parents of those children in the treatment group will report ≤ number of safe behavior incidents three months post treatment than the parents of children in the control groups.**

   Parent surveys were conducted 3-6 months after the 4-H youth had utilized the CD curriculum and taken pre and post tests. The demographics of the parents who were interviewed by phone are illustrated in Table 6.

Table 6. *Parent Sample Demographics*

Key Variables		Treatment		Control	
		n	Percentage	*n*	Percentage
By State					
	KY	11	38	2	13
	NY	9	31	11	73
	TX	8	31	2	13
By Respondent					
	Mother	24	82	12	75
	Father	4	14	4	25
	Other	1	3	--	--
Lives on Ranch/Farm					
	Yes	13	45	5	31
	No	16	55	11	69

It is difficult to discern more than observed trends related to behavior changes due to the low sample size and the variance by region. We also discovered that it sometimes took a while for parents to identify the curriculum we were asking about, and thus they would change their responses as they went through the interview. In other words, as the interviewer talked about the modules, the parents began to recall discussions or observed behaviors that they did not identify early in the survey.

Table 7. *Treatment vs. Control Parent Reports of Positive Impact by Percentage*

	Talked About Module	Had a Family Discussion	Behavior Change
ATV			
Treatment	57.70%	44.80%	17.20%
Control	37.50%	43.80%	18.80%
Tractor Safety			
Treatment	31.00%	34.50%	6.90%
Control	12.50%	12.50%	

Table 7 illustrates cumulative parent responses to two of the modules, ATV safety and Tractor safety on both family discussions and observed behavior change. The other potential contaminating issue is that

control groups were allowed access to the 4-H CD1, once pre and posttests had been collected, thus some of the children in the control may have already viewed the CD prior to the researchers being able to contact the parents for a phone interview.

Specific Aim 2. Assess how well the content of the existing 4-H CD1 meets the needs of youth and families in three different agricultural regions of the U.S. Based upon the feedback of panels of parents, children and 4-H personnel in Texas, Kentucky and New York, the topics included in 4-H CD1 were appropriate to the three different agricultural regions in the study. In fact, several of the topics (ATV, animal handling, and chemicals) were identified by the panels as selections to include in 4-H CD2 but with more depth of information to be included.

Specific Aim 3: Identify additional health and safety teaching modules (or modifications of current modules) based on feedback from three regional panels. The three regional panels, as well as health and safety experts in each participating region were asked to identify specific health and safety modules that they would like to be included in the second CD to be produced. Through a process of content analysis of the data received, five topics were selected to include in the second CD. Three of these were requesting additional information be included in the second CD related to ATVs, Large Animal handling and showing, and Chemical Safety on the farm. In addition, farm machinery safety and a farm safety tour were selected to add to the second CD.

4-H CD2 addresses:

- Large animal handling and showing
- Machinery safety
- ATV operation
- Chemical safety
- Farm safety tour

Specific Aim 4: Based upon the needs identified in Specific Aim 3, develop and formatively evaluate a second agricultural health and safety educational CD (4-H CD2) to meet the needs of a broader national audience. Once the topics were identified, each participating Center (New York, Kentucky and Texas) took responsibility for taking video material related to one or more of the topics and forwarded them to HICAHS to begin the process of editing for the new CD. Once the video material was selected, HICAHS personnel wrote a script for each video section which was then timed to fit each video clip. Each participating Center then identified regional youth who were willing to narrate portions of the video, so it would be youth speaking to youth about the importance of agricultural health and safety. The HICAHS team also wrote quiz questions to be included with pop-up responses to immediately reinforce whether answers were correct or incorrect. The finalization of 4-H CD2 has been delayed due to the sudden and unexpected death of Dr. Liu's wife. Once the materials are received from him, the team intends to complete the project as all that remains is loading the materials onto a CD with the appropriate working coding. Formative evaluation can be accomplished in Colorado.

Specific Aim 5: **Develop with the Advisory Team, a dissemination plan of the two CDs through the national 4-H, the HICAHS Translation project, and other appropriate venues.** The 4-H CD1 has been

fairly extensively disseminated as each participating 4-H Treatment group the three collaborating regions of the country received one for pre/testing or after the post test in the case of the control groups. A HICAHS Advisory Board member has offered to assist the PI with gaining National 4-H Curriculum approval for both CDs.

RESULTS AND DISCUSSION – See information under "Methodology" above.

CONCLUSION

Several important intermediate outcomes have resulted from this project.

- The project provided a model and protocol for successful collaboration between four Agricultural Health and Safety Centers over a 4 year period.

- The project addressed specific criticisms of Agricultural Health and Safety education efforts by utilizing experimental design, multiple diverse agricultural regions, and measures of both knowledge and behavior change.

- 4-H CD1 provided a significant knowledge gain for participants in the treatment groups over control groups.

- Parents of those 4-H children who had utilized the 4-H CD1 reported more family discussions of agricultural health and safety issues and were also able to identify some specific changes in behavior that they believe resulted from the curriculum. *

- The critical importance of stakeholder participation was key to addressing regional agricultural production differences in module development for 4-H CD2.

*These parents were both treatment and control parents, as some of the control children had already used 4-H CD1 before their parents were surveyed which resulted from a timing mistake in one region.

Program Director/Principal Investigator (Last, First, Middle): Reynolds, Stephen J.

Inclusion Enrollment Report

This report format should NOT be used for data collection from study participants.

Study Title: Developing and Testing Interactive CD Health and Safety Curricula for 4-H Youth

Total Enrollment: 360 **Protocol Number:** 09-964H

Grant Number: 5U54OH008085

PART A. TOTAL ENROLLMENT REPORT: Number of Subjects Enrolled to Date (Cumulative) by Ethnicity and Race

Ethnic Category	Sex/Gender			
	Females	Males	Unknown or Not Reported	Total
Hispanic or Latino	20	22	0	42 **
Not Hispanic or Latino	168	135	0	303
Unknown (individuals not reporting ethnicity)	0	0	0	0
Ethnic Category: Total of All Subjects*	188	157	0	345 *
Racial Categories				
American Indian/Alaska Native	4	3	0	7
Asian	8	5	0	13
Native Hawaiian or Other Pacific Islander	0	0	0	0
Black or African American	35	26	0	61
White	141	123	0	264
More Than One Race	0	0	0	0
Unknown or Not Reported	0	0	0	0
Racial Categories: Total of All Subjects*	188	157	0	345 *

PART B. HISPANIC ENROLLMENT REPORT: Number of Hispanics or Latinos Enrolled to Date (Cumulative)

Racial Categories	Females	Males	Unknown or Not Reported	Total
American Indian or Alaska Native	0	0	0	0
Asian	0	0	0	0
Native Hawaiian or Other Pacific Islander	0	0	0	0
Black or African American	0	0	0	0
White	0	0	0	0
More Than One Race	0	0	0	0
Unknown or Not Reported	20	22	0	42
Racial Categories: Total of Hispanics or Latinos**	20	22	0	345 **

* These totals must agree.
** These totals must agree.

INCLUSION OF CHILDREN

Children grades 3-6 in 4-H clubs in 3 regions of the country were the target group for this education project. The project was relevant for particularly children living or visiting farms. An interactive agricultural health and safety curriculum in CD format was tested for knowledge and measures of potential behavior change. Project personnel cited literature indicating the number and severity of injuries to children in the target age group; and utilized educational and developmental theory to provide the theoretical basis for the educational format. Knowledge is a necessary precursor to behavior change and significant knowledge gain of the treatment group over the control group resulted from utilizing the 4-H CD1.

MATERIALS AVAILABLE FOR OTHER INVESTIGATORS – *Not applicable*

PUBLICATIONS

Buchan, V., Seiz, R., Danhoff, K. , Donovan, T., Gilmore, K., and Scofield, S. (Under review). Successful Regional and Inter-organizational Collaboration in Applied Research: Challenges Met, Lessons learned.

Presentations

Buchan, V. & Seiz, B. (October 2008). Lessons Learned in Conducting Rigorous Evaluation Research on Agricultural Health and Safety CD Curricula for Youth: Practical Challenges Faces, Met. . . and Remaining. Platform Presentation. 6th International Symposium Public Health and the Agricultural Rural Ecosystem. October 21, 2008, Saskatoon, Canada.

Buchan, V. (May, 2009). Health and Safety for Children: an Interactive CD. National Farm Bureau Safety Conference. Invitational Platform Presentation. Fort Collins, CO. May 27, 2009.

Buchan, V., Seiz, R. & Liu, J. (August, 2009). Developing and Testing Interactive CD Health and Safety Curricula for 4-H Youth. Peer reviewed poster presentation. NIOSH Invitational Intra/Extramural Agriculture, Forestry and Fishing Safety and Health Workshop. Cincinnati, OH. Aug. 11-12, 2009.

Buchan, V. (2005, August). "Interactive Agricultural Health and Safety CD for 4-H".Western Region 4H Program Leader's Meeting. Jackson, WY.

Translation and Dissemination Program

Education and Translation Core
John Rosecrance, 970-491-1405, John.Rosecrance@colostate.edu
2007 – 2012

Section 1

The goal of the HICAHS Translation and Dissemination Program was to enhance the effectiveness of the translation and dissemination activities of our community partners involved in agricultural safety and health. This goal was accomplished in a two-step approach: 1) providing community-initiated small grants to regional agricultural and forestry partners involved in the prevention of occupational injuries and illnesses, and 2) working with community partners to increase the effectiveness of their translation and dissemination activities. The HICAHS personnel utilized a participatory approach to engage agricultural stakeholders in a systematic process focusing on the health and safety needs of their respective agricultural community. The project focused on the integration of social marketing principles within the community-initiated projects, which was relatively new to the field of agricultural health and safety. Formative evaluation and impact assessment were used to enhance and refine the community-driven translation and dissemination processes. A number of community-initiated projects that focused on improving agricultural health and safety were successful in developing and disseminating targeted health and safety information.

SPECIFIC PROJECTS

The following community-initiated projects are examples of the scope and breadth of projects accomplished. The year noted in parentheses is the date that funding began for the project.

Colorado Farm Bureau Association (2008) – Enhancing Farm Safety through Community Participation in Hands-On Demonstrations. A primary method for teaching safety awareness in the farming community by the Farm Bureau has been through live demonstrations out of the back of a twelve-foot cargo trailer that housed the props and equipment. The use of the trailer was extensive and contributed to hands-on demonstrations to over 10,000 farmers, hired hands, and their families. The Association worked with HICAHS to double their outreach by investing in an additional trailer and by assessing audience interest in the program. HICAHS graduate students were involved in several county fair safety programs to assess the audience perception of the demonstrations.

Montana Farm Bureau (2009) - Montana Ranchers-Health and Safety Perceptions. An evaluation of safety workshops developed and presented by the Montana Farm Bureau to Montana farmers and ranchers was conducted to assess workshop effectiveness and identify improvements. The purpose of the workshop was to educate ranchers and farmers about workplace safety and to promote elements of the safety program. The workshop was presented to over 600 farm and ranch owners annually. Prior to the involvement of HICAHS there had been no evaluation of the effectiveness of the workshops. Results from the pre and post-tests revealed only marginal improvements in new knowledge. This feedback resulted in revisions of the safety program as well as changes in the delivery mode.

I-29 Corridor Dairy Workshops (2009) – Identifying Effective Educational Methods for Safety Training in the Dairy Industry. HICAHS partnered with the I-29 Dairy Consortium to sponsor five health and safety workshops for the regional dairy industry entitled “What You Need to Know About OSHA Before OSHA Needs to Know About You.” Workshops were designed to present information on employer obligations to ensure worker health and safety on dairy farms. Workshops were held at dairies in five

states (MN, IA, SD, ND, and NE) along US Interstate I-29. Sixty-seven participants attended the sessions. Participants evaluated the sessions favorably, and requested additional information in the form of future training sessions on specific safety topics. These sessions proved a successful medium to disseminate safety information to dairy owners, managers and workers, thus facilitating the translation of information into practice.

Colorado Corn Growers Association (2009) – Assessment of Barriers to Improving Safety Climate. The Colorado Corn Growers Association arranged a series of "Kitchen Table Talks" consisting of interviews and informal meetings with farmers and their families to better understand barriers to safer work practices. Two students from the local university, who were raised in the community of corn growers (insiders), were hired to travel throughout the counties represented by the association to conduct the interviews with association members. The project resulted in a list of commonly held beliefs about safety and barriers to enhancing safety for this community. Knowledge from this project led to a follow-up project to revise a safety curriculum used by the Colorado Corn Association.

Colorado Corn Growers Association (2010) - Enhancing Safety among Colorado Corn Growers. The purpose of this study was to evaluate and refine the safety communication campaign utilized by the Colorado Corn Growers Association. A needs assessment was conducted by HICAHS and Association personnel who made personal visits to 85% of the corn farm families in the Association (see above). As part of this project, safety climate was measured to assess perceptions of employees regarding the way safety was managed on small to large farms. The study evaluated the translation and dissemination of educational safety materials that focused on safety climate changes. The delivery format of the training materials was modified based on feedback from farm owners and subject matter experts.

University of Utah Extension (2010) – Safety Through Agriculture Safety Management & **Lean Six Sigma:** HICAHS supported and partnered with Utah State University Dairy Extension to offer a two-day workshop on agriculture safety management using management principles of Lean Six Sigma. The workshop was attended by Utah dairy owners, operations managers, Extension agents, dairy specialists, and other dairy stakeholders. Participants were presented with information on how to apply Lean Six Sigma strategies to address health and safety as well as economic and quality issues related to milk production. Participants evaluated each session favorably and requested future training sessions.

Montana State University Extension (2011) - Family Forest Landowner Forest Operations Safety Training. Family-owned private forest lands across Montana account for less than 18% of the total forested land, but provide for more than 30% of the annual harvested wood. The purpose of this project was to develop, conduct and evaluate a series of forestry workshops focused on safe work practices for small-land owners. This program was designed to increase awareness and enhance the use of safe work methods among private family forest landowners. Nearly 85% of the participants indicated increased motivation to use safer work methods, and 90% indicated an increased ability to work safer in forest.

Colorado Livestock Association (2011) - Safety Culture Video for Spanish Speaking Workers in Livestock Operations. A needs assessment on worker safety was conducted by Colorado Livestock Association with cattle feedlots, dairy operations, and swine producers. The assessment identified needed improvements in safety culture related to animal handling and other safety issues in livestock operations. Producers also noted the challenge of providing culturally appropriate safety materials for Spanish-speaking workers. HICAHS partnered with the Colorado Livestock Association to develop and

produce a video on animal handling safety in both English and Spanish languages. It has been widely distributed on the Internet and through mailings.

Colorado State University & Montana State University Extension ATV Use and Animal Handling Safety (2010). All-terrain vehicle (ATV) use has exploded in the U.S. to include a staggering 10 million vehicles and 16 million users (GAO 2010). ATVs are being used increasingly in agricultural operations and have been associated with injuries and deaths (Helmkamp 2011). In 2005, 870 riders died and 136,700 others received treatment for injuries at the hospital (Helmkamp 2009). Sixty-percent of all ATV-related deaths reported between 1992 – 2007 in the US occurred in agricultural operations. Costs associated with just 129 ATV-related deaths from 2003–2007 were estimated at $103.6 million (Helmkamp in press). This HICAHS project was the first in a series to address the ATV health and safety needs identified by Montana State University Extension. Colorado State University faculty partnered with MSU Extension to develop and disseminate health and safety information on using ATVs specifically in agriculture. Existing ATV Safety materials do not provide recommendations for agriculture-specific tasks. Through 3 focus groups involving a total of 21 Ag Producers these ATV uses were identified: (1) animal handling, (2) fence building and mending, (3) weed control/spraying, and (4) General transportation. Products developed from this project were disseminated in consideration of the social marketing recommendations of Product, Price, Promotion, and Place.

Montana State University Extension (2011) - ATV Safety Training for Ag Producers in Montana. This project builds upon the community-based translation project designed to provide ATV Safety training to Ag producers (see above). Two agricultural Extension agents were certified by the ATV Safety Institute (ATVSI) Curriculum through a four-day workshop for preparation to teach the RiderCourse classes to local agricultural producers. Following the certification, the Extension agents trained 8 agricultural producers (5 male, 3 female) on ATV safety training through a five-hour ATV Safety Institute Curriculum. The curriculum incorporated Ag-specific learning activities addressing the top 3 ATV uses (see above). A Pre/Post Survey was administered (90 Day follow-up) and a 3-hour focus group was held to assess the applicability of the new ag-specific training program to their operations. There was between 12-19% improvement on pre/post testing; 50% of the respondents reported that the training was beneficial, and 88% said it definitely increased their awareness of ATV safety issues and will alter their behavior. Additionally, 7 of 8 stated they would attend hands-on training in the future.

Montana State University Extension (2011) - ATV Safety Tip Sheets for Producers in Montana. This project will build from three prior focus groups held the previous year in communities throughout Montana (see two projects above). Based upon the information obtained in the three, 3-hour sessions, prototype “Tip Sheets” were developed for these three primary ATV Ag job tasks. This project convened additional Ag producers in Circle, Montana from the surrounding community area to develop and refine the “Tip Sheets”, disseminate them to the community and evaluate impacts on perceptions and behaviors of those producers using ATVs on the operations. The refined tip sheet was reviewed and evaluated by Dr. Ray Ochs at the ATV Safety Institute in Irvine, California and then resubmitted to another Montana focus group for re-evaluation and development of a dissemination plan before being evaluated 90 days post dissemination. *Project still in progress.*

Section 2

BACKGROUND

The foundation of the HICAHS Translation and Dissemination Program is a twenty-five year history of agricultural partnerships throughout the mountain and plains region. Although the focus and methods of the program are being refined continuously, the mission has always been the prevention of agricultural and forestry-related injuries. This program consists of a close working partnership between HICAHS and community partners involved in agricultural health and safety. These community partners consist of organizations that have direct access to farmers, ranchers, owners, workers and their families. Organizations include the Farm Bureau, Livestock and Dairy Associations, Corn and Wheat Growers Associations, Extensions Specialists at Land Grant Universities and their community Extension Agents, Farm Safety 4 Just Kids, insurance organizations and farming cooperatives. Many community organizations do not have the knowledge or resources to effectively translate or disseminate health and safety information to their membership. Thus, a partnership with HICAHS has the potential to greatly enhance the successfulness of community based programs.

Significance of Agriculture in Public Health Service Region

Public Health Service Region VIII includes the states of Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming. This region of the country consists of vast windswept plains, which join the foothills and gradually increased altitude culminating in the Rocky Mountains and the Western Slope. Much of the region is semi-arid with an average annual rainfall of only 12 to 15 inches. Resultant farm/ranch operations employ low intensity, lower profit margin methods that require vast acreages with more profitability. Agricultural production includes primarily ranching and dry-land farming. Within PHS Region VIII there are roughly 145,00 farms and ranches covering approximately 220 million acres.

The number one commodity in the region during the project was cattle while major grain crops included wheat, corn, and soybeans. Two additional types of production agricultural on the rise in the region are pork and dairy operations. In the U.S., agriculture produces an average of 1.4% of the gross domestic product. In the West, the average is 2.0%, but in PHS Region VIII the percent of gross state product from agriculture reaches 3.55%. The total agricultural market value in PHS Region VIII is approximately 15 billion dollars.

The diversity of agriculture and to the vast distances between communities presented a major challenge to effective dissemination of agricultural health and safety information in the high plains intermountain region. By expanding our partnership base to a variety of agricultural stakeholders, we were positioned to successfully broadly disseminate relevant agricultural health information throughout PHS Region VIII. Effective dissemination required the translation findings into user-friendly and culturally sensitive material and a system of community trusted change agents that can communicate with farmers, workers, and farm children. The change agents over the period of this project were representatives from each community such as Extension Agents (also known as Extension Educators), local farm safety coordinators, health representatives in agriculture associations such as the Montana Farm Bureau, Colorado Livestock Association and the Colorado Corn Association. These organizations represented a

critical link within our dissemination efforts. This type of innovation / dissemination model involving researchers, agricultural specialists and farmers / workers is often referred to as the "Agricultural Extension Model." The Agricultural Extension Model is considered one of the most successful in securing user's adoption of research results (Rogers, 2003). This integrated system consisting of university researchers, county Extension Educators who work as change agents with rural populations, and Extension Specialists who link researchers to the county Extension Educators is instrumental in the innovation-development and translation processes.

Agricultural Extension Model

The ultimate purpose of agricultural health and safety programs, whether laboratory research or educational modules, is to provide knowledge that is useful to end-users for the prevention of injuries and illnesses. However, even after more than twenty years of NIOSH sponsored activities focused on agricultural health and safety, challenges remain in the development of injury prevention strategies as well as in the translation, dissemination and adoption of existing prevention measures. One of the most successful models for securing user's adoption of beneficial research results is the Agricultural Extension Model (Rogers, 2003). The model contains three main components: 1) a research subsystem consisting of professors engaged in agriculture studies, 2) county extension agents who work as change agents with end-users (farmers and other rural groups at the local level), and 3) state extension specialists who link agricultural researchers to the county agents. The Agricultural Extension Model is an integrated system designed for the development, translation, dissemination, and utilization of new knowledge related to improving agriculture safety programs. There are three common approaches that have been used with the Agricultural Extension Model including: technology transfer, "farmer first," and the participatory approach (Foster, et al. 1995).

The technology transfer approach typically involves a top-down methodology where scientists determine research priorities, generate innovations they believe are important for farmers and provide the results to Extension Specialists and Educations. Information about the innovations, including likely benefits, is then passed to individual farmers on the assumption that this will encourage them to adopt the innovation or new knowledge (Chambers, et al. 1989). In practice, farmers often do not adopt the new technologies and work methods for a variety of reasons. The research-driven nature of the top-down approach can result in products and practices that do not fulfill a genuine need (Frank and Chamala, 1992).

The *farmer first* approach contrasts strongly with the technology transfer model. It acknowledges that farmers often have sound local knowledge and good reasons for their behavior, which may not be understood by scientists (Chambers, et al. 1989; Frank and Chamala, 1992). The farmer's experience with academic research provides a basis on which scientists can learn from and with farmers to set research priorities. The main objective of the farmer first approach is to empower farmers to learn and create better situations for themselves rather than being passive recipients of new technology (Chambers, et al. 1989). Researchers do not drive the research, development and extension process; they interact with and assist farmers. The process is "bottom-up" with emphasis on bringing about changes that farmers want. An important limitation of the farmer first approach is that significant off-

farm political and economic forces, which inevitably shape farmer priorities and decision-making, can be overlooked.

The third Extension approach, which was taken in this translation project, was the *participatory approach* based on multiple stakeholder cooperation and participation. This approach arises from the recognition by many agricultural researchers, extension personnel, and farmers of the need to view agricultural problems as complex issues that require input from a wide variety of stakeholders (Wilson, 1992). The emphasis of the participatory approach is on involving key stakeholders in a cooperative and flexible process that facilitates the implementation of activities to achieve practical improvements. Many participatory techniques exist, including focus groups and structured workshops. A participatory approach to research in agricultural health and safety is likely to be more effective and successful in the utilization of new knowledge than merely technology transfer or farmer first approaches (Wilson, 1992).

The traditional Agricultural Extension Model reflects a rational, linear conception of the process of knowledge utilization; the focus of this model is to get the word out, with the assumption that good ideas will be used by those who hear about them. A number of researchers have noted that, while the traditional Extension Model has been successful in the dissemination and utilization of new knowledge related to agricultural production technology, the model has not been particularly effective in other subject areas (Rogers, 2003). The understandings about effective dissemination and knowledge utilization, emerging from the recent literature, reveals that the process is complex, transactional, and heavily dependent on the potential user's pre-existing knowledge, beliefs, and experiences. The focus on the *user* of research has come to the forefront during a period when the target audiences for agricultural health and safety research have broadened and thus the need to direct more attention to manufacturers, agricultural associations, insurance companies, health care providers, and to farmers, field workers, and their families.

SPECIFIC AIMS

The goal of the proposed program was to enhance the translation, dissemination, and utilization of new knowledge related to agricultural health and safety in PHS Region VIII. Knowledge generated from community initiated projects was translated into user-specific media and then disseminated by utilizing a participatory approach with an extensive network of established agricultural partnerships.

The “Agricultural Extension Model,” which is considered one of the most successful in securing users’ adoption of research results (Rogers, 2003), will serve as the framework of this project. To enhance effective dissemination of agricultural health and safety materials, a participatory Agricultural Extension Model will be adapted to a variety of organizations involved in agricultural health and safety. The HICAHS personnel will work directly with key agricultural partners (Cooperative Extension, agricultural associations, insurance companies, migrant health services, Farm Safety 4 Just Kids, Easter Seals) that have direct access to end-users such as owners, ranch hands, farm families and children, disabled farmers, and seasonal and migrant farm workers. The investigators will work closely with the agricultural community to develop projects that address the specific health and safety needs in their region.

The following were the **specific aims** of this project.

Specific Aim 1: Provide agricultural community-initiated small grants (ACISG) that assist in the refinement or expansion of existing health and safety education / translation programs in PHS Region VIII.

Specific Aim 2: Enhance the translation and dissemination of knowledge developed from the ACISG program, assistive technology modules, and HICAHS research projects to relevant agricultural stakeholders.

Specific Aim 3: Assess the dissemination and knowledge utilization of end-users targeted by the community-initiated small grants program.

The specific aims of the education / translation project supported several of the focus areas outlined by the U.S. Department of Health and Human Services in **Healthy People 2010** (http://www.healthypeople.gov). The focus areas of Healthy People 2010 addressed included *Occupational Safety and Health, Injury Prevention, Educational Community-Based Programs, and Health Communication.* Healthy People 2010 identified the need for multifaceted health promotion and community involvement activities that are developed and delivered at the local level. This work stressed participatory involvement of multiple stakeholders as a fundamental method for planning, implementing, and evaluating educational and community-based programs. The project addressed multiple Healthy People 2010 target areas through intensive participation of the agricultural community. Additionally, this work addressed issues related to "Special Populations at Risk" in the original priorities outlined in the National Occupational Research Agenda (NORA) (http://www.cdc.gov/NORA). The work performed also addressed the occupational health of populations that are frequently under-represented in traditional occupational health outreach (i.e., undocumented and migrant farm workers, as well as seasonal farm workers that tend to be Hispanic / Latino. In the "second decade of NORA," the National Institute for Occupational Safety and Health took a "Sector-based Approach" which includes the Agriculture Industry. The specific aims were directly related to achieving the goals established in Healthy People 2010 and in the National Occupational Research Agenda.

METHODOLOGY

Specific Aim 1: Provide Agricultural Community-Initiated Small Grants (ACISG) that assist in the refinement or expansion of existing health and safety translation / education programs in PHS Region VIII.

The objective of Specific Aim 1 was to provide community partners additional resources to develop, refine, or expand agricultural-related health and safety projects. The average size award was $10,000 and given to 2 to 3 community organizations each year. Awards were made on an annual basis and scheduled (announcement of program, proposal evaluation, award made) per the Center's funding cycle.

Each applicant utilized the HICAHS Small Grants Project Application to provide a description of their proposed projects. The project description included:

1. Overview of Project
    - statement of problem, significance and need,
    - goal and objectives,
    - population served (race, gender, socioeconomic status, age, anticipated number of individuals to be served),
    - expected results, dissemination and evaluation plans,
    - timetable for project implementation and completion of objectives.
2. Project Budget – budget sheet will be provided, written budget justification to describe expenses.
3. Organization – Applicant will be asked to describe their organization and his/her expertise in that organization related to the project.

The small grants were reviewed by a committee consisting of no less than three HICAHS associates. Applications were reviewed and scored on the following areas:

1. Compatibility with the HICAHS mission
2. Significance of the problem with demonstrated regional need
3. Project methods and procedures
4. Feasibility of project and identified work plan
5. Definable outcomes
6. Dissemination and evaluation plan
7. Impact in the community / region

Based on experiences from the HICAHS Regionalization program and the likelihood that the majority of community partners do not have experience in grant writing, the HICAHS personnel provided assistance and feedback in the application process. Thus, as necessary, HICAHS personnel worked with community partners in the development and writing of proposals for the ACISG program.

Specific Aim 2: Enhance the translation and dissemination of knowledge learned from the ACISG program, assistive technology education modules, and HICAHS research projects to relevant agricultural stakeholders in PHS Region VIII.

The objectives of Aim 2 were to 1) Work in collaboration with community grant recipients to translate reports and results into products targeted to agricultural end-users and 2) Disseminate research and educational products from the ACISG program, to end-users through our established network of agricultural partnerships.

The foundation of our dissemination efforts was based on the existing structure of partnerships developed over the last 15 years of the HICAHS activities. These partnerships have allowed us to disseminate new health and safety information to agricultural and rural populations throughout all States in PHS Region VIII. Our dissemination program is based on the participatory Agricultural

Extension Model of university based agricultural researchers and specialists (HICAHS), community change agents (agricultural health and safety stakeholders), and end-users (e.g. farmers and ranchers, farm families and children, disabled farmers, and seasonal and migrant farmworkers) (Figure 2). It is clear from current research and past experience that the critical factors in effective dissemination are the relationships between the change agent (our agricultural partners) and the end-user (farmers / workers), and that the new knowledge is "wanted" by the end-user. The participatory process involving community initiated projects will provide valuable feedback on the specific needs and readiness of the community. Our vast network of agricultural partners and stakeholders enables us to target our dissemination efforts to the needs of communities within the six States in PHS Region VIII.

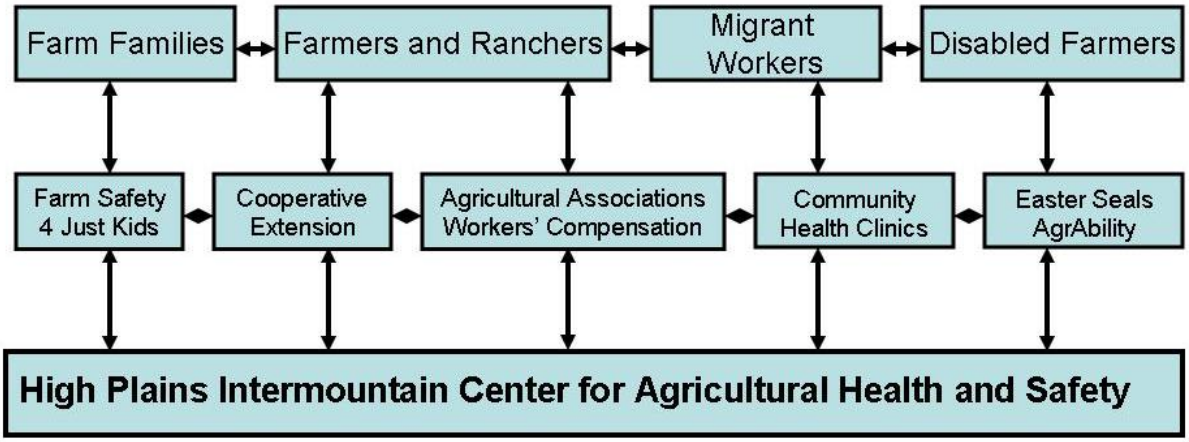


Figure 1. *HICAHS participatory model depicting our network of partnerships involved in the translation, dissemination, and utilization of new knowledge related to agricultural health and safety.*

Translation. The purpose of translation in the context of agricultural health and safety research was to transfer what was developed by community partners into useful products, practices, and information that can be utilized by the end-user in the agricultural community. The focus on the *user* of research has come to the forefront during a period when the target audiences for agricultural health and safety research has broadened to include more attention to manufacturers, agricultural associations, insurance companies, health care providers, as well as farmers, field workers, and their families.

Specific Aim 3: Assess the dissemination and knowledge utilization of end-users targeted by the community-initiated small grants program, assistive technology education modules, and HICAHS research projects.

The objectives of Aim 3 were to 1) Use current Center Program Monitoring tools to track dissemination of products produced through the ACISG program, assistive technology educational modules, and HICAHS research and 2) Assess knowledge utilization of the ACISG program.

Overall Project Evaluation

The HICAHS used a data-based program monitoring process for the evaluation of all Center projects. The description, aims and objectives of each Center project is entered into ACCESS; additional data on variables such as target groups, r2p application, type of agriculture, project activities, collaborations, and products are collected and entered throughout the fiscal year. The information may be queried for Center Administration management purposes, and to track progress on each project's objectives. The monitoring data also become part of the NIOSH Agricultural Center Initiative Evaluation Project funded by CDC. For a fuller description of this approach to Center evaluation please refer to the Administrative Core portion of the proposal.

RESULTS AND DISCUSSION

The following community-initiated projects are examples of the scope and breadth of projects accomplished.

Colorado Farm Bureau Association (2008) – Enhancing Farm Safety through Community Participation in Hands-On Demonstrations. A primary method for teaching safety awareness in the farming community by the Farm Bureau has been through live demonstrations out of the back of a twelve-foot cargo trailer that housed the props and equipment. The use of the trailer was extensive and contributed to hands-on demonstrations to over 10,000 farmers, hired hands, and their families. The Association worked with HICAHS to double their outreach by investing in an additional trailer and by assessing audience interest in the program. HICAHS graduate students were involved in several county fair safety programs to assess the audience perception of the demonstrations.

Montana Farm Bureau (2009) - Montana Ranchers-Health and Safety Perceptions. An evaluation of safety workshops developed and presented by the Montana Farm Bureau to Montana farmers and ranchers was conducted to assess workshop effectiveness and identify improvements. The purpose of the workshop was to educate ranchers and farmers about workplace safety and to promote elements of the safety program. The workshop was presented to over 600 farm and ranch owners annually. Prior to the involvement of HICAHS there had been no evaluation of the effectiveness of the workshops. Results from the pre and post-tests revealed only marginal improvements in new knowledge. This feedback resulted in revisions of the safety program as well as changes in the delivery mode. Feedback from participants was helpful in identifying more meaningful delivery methods and content. Participants suggested several modifications including the use of personal stories, real-world examples, use of video illustrating hazardous equipment and tasks, and use of injury rates or workers' compensation data to assist in the prioritization of hazards.

I-29 Corridor Dairy Workshops (2009) – Identifying Effective Educational Methods for Safety Training in the Dairy Industry. HICAHS partnered with the I-29 Dairy Consortium to sponsor five health and safety workshops for the regional dairy industry entitled "What You Need to Know About OSHA Before OSHA Needs to Know About You." Workshops were designed to present information on employer obligations to ensure worker health and safety on dairy farms. Workshops were held at dairies in five states (MN, IA, SD, ND, and NE) along US Interstate I-29. Sixty-seven participants attended the sessions.

Participants evaluated the sessions favorably, and requested additional information in the form of future training sessions on specific safety topics. These sessions proved a successful medium to disseminate safety information to dairy owners, managers and workers, thus facilitating the translation of information into practice. Participants represented 35 dairies and 574 employees from the five states. Pre and post tests were administered to participants to assess training effectiveness. Mean score on the pre-test was 3.07 out of 10 questions. Mean score on the post-test was 7.02 out of the same 10 questions, equating to a 44% improvement. Participants evaluated the sessions favorably, and requested additional information in the form of future training sessions on specific safety topics.

Colorado Corn Growers Association (2009) – Assessment of Barriers to Improving Safety Climate. The Colorado Corn Association arranged a series of "Kitchen Table Talks" consisting of interviews and informal meetings with farmers and their families to better understand barriers to safer work practices. Two students from the local university, who were raised in the community of corn growers (insiders), were hired to travel throughout the counties represented by the association to conduct the interviews with association members. The project resulted in a list of commonly held beliefs about safety and barriers to enhancing safety for this community. Knowledge from this project led to a follow-up project to revise a safety curriculum used by the Colorado Corn Association.

Colorado Corn Growers Association (2010) - Enhancing Safety among Colorado Corn Growers. The purpose of this study was to evaluate and refine the safety communication campaign utilized by the Colorado Corn Growers Association. A needs assessment was conducted by HICAHS and Association personnel who made personal visits to 85% of the corn farm families in the Association (see above). As part of this project, safety climate was measured to assess perceptions of employees regarding the way safety was managed on small to large farms. The study evaluated the translation and dissemination of educational safety materials that focused on safety climate changes. The delivery format of the training materials was modified based on feedback from farm owners and subject matter experts.

University of Utah Extension (2010) – Safety Through Agriculture Safety Management & **Lean Six Sigma:** HICAHS supported and partnered with Utah State University Dairy Extension to offer a two-day workshop on agriculture safety management using management principles of Lean Six Sigma. The workshop was attended by Utah dairy owners, operations managers, Extension agents, dairy specialists, and other dairy stakeholders. Participants were presented with information on how to apply Lean Six Sigma strategies to address health and safety as well as economic and quality issues related to milk production. Participants evaluated each session favorably and requested future training sessions.

Montana State University Extension (2011) - Family Forest Landowner Forest Operations Safety Training. Family-owned private forest lands across Montana account for less than 18% of the total forested land, but provide for more than 30% of the annual harvested wood. The purpose of this project was to develop, conduct and evaluate a series of forestry workshops focused on safe work practices for small-land owners. This program was designed to increase awareness and enhance the use of safe work methods among private family forest landowners. Nearly 85% of the participants indicated increased motivation to use safer work methods, and 90% indicated an increased ability to work safer in forest. Each workshop presented chainsaw safety, safe tree felling, limbing and bucking techniques. This

program was designed to increase awareness and enhance the use of safe work methods among private family forest landowners.

Pre, post and follow-up assessments of the workshops indicated an:

- 80% increase in awareness of chainsaw hazards,
- 18% increase in confidence in using a chainsaw safely,
- 85% increase in tree felling hazard awareness,
- 85% of the participants indicated increased motivation to use safer work methods, and 90% indicated an increased ability to work safer in forest.

Intermediate Outcomes

Development of a forest harvesting and operations guide for small landowners that incorporates the OSHA Logging e-Tools.

Development of a standardized training program on forestry safety for small landowners and digital videos of harvesting and other safe forestry methods posted on several websites.

Colorado Livestock Association (2011) - Safety Culture Video for Spanish Speaking Workers in Livestock Operations. Animal handling injuries are a significant problem, being more costly and resulting in more time off work than other agricultural injuries. A strong and compelling need exists to develop cost-effective interventions to reduce of animal handling as well as other work-related injuries in livestock operations. In 2011, the HICAHS partnered with the Colorado Livestock Association to develop more effective safety training materials for English and Spanish speaking workers. A needs assessment on worker safety for agricultural operations was conducted by Colorado Livestock Association with cattle feedlots, dairy operations, and swine producers in the state of Colorado. The assessment identified needed improvements in safety culture related to animal handling and other safety issues in livestock operations. Producers also noted the challenge of providing culturally appropriate safety materials for Spanish-speaking workers.

Intervention: Creating Safety Culture in Livestock Operations DVD

Based on input from livestock owners, workers, and HICAHS personnel, the livestock association developed and produced a video on DVD aimed at enhancing safety culture in livestock operations. The target audience consisted of owners and workers at dairies, feedlots, ranches, and swine operations.

Specific attention was aimed at addressing the cultural aspects of Spanish-speaking workers.

Intermediate Outcomes

Creating Safety Culture in Livestock Operations video (9-minutes) produced in English and Spanish. Distributed to more than 250 (as of 1/2012) livestock and dairy producers in the Mountain West states.

Video (Creating Safety Culture in Livestock Operations) posted (4/2012) on YouTube for broad dissemination.

INCLUSION ENROLLMENT REPORT – Not applicable

INCLUSION OF CHILDREN – Not applicable

MATERIALS AVAILABLE FOR OTHER INVESTIGATORS – See descriptions of products under "Publications" below.

PUBLICATIONS

Douphrate, D. Special Issue: Dairy Farm Safety and OSHA—Approaches for Effective Management and Worker Training. New Mexico State University Dairy Extension Newsletter, September 2011, Volume 2, Number 4 & 5.

Douphrate, D. Dairy Farm Safety and OSHA—Approaches for Effective Management and Worker Training. Utah State University Dairy Extension Newsletter, June 2011, Volume 34, Number 3.

Rosecrance, J., Chen, P., O'Keefe, G., Lamm, D., Borges, D., & Ermann, E. (August 2010) FarmInsure Worker's Comp Safety Information Packet – Safety Behavior Checklist (Spanish)

Rosecrance, J., Chen, P., O'Keefe, G., Lamm, D., Borges, D., & Ermann, E. (August 2010) FarmInsure Worker's Comp Safety Information Packet – Emergency Information Cards (Spanish)

Rosecrance, J., Chen, P., O'Keefe, G., Lamm, D., Borges, D., & Ermann, E. (August 2010) FarmInsure Worker's Comp Safety Information Packet – Safety Video (Spanish)

Rosecrance, J. & Chen, P. (2010). SMART strategy: Partnering with the Colorado Corn Grower's Association. AgConnections, Volume 5.

Douphrate, D. & Rosecrance, J. (2010). What You Need to Know About OSHA Before OSHA Needs to Know About You.

Products

Creating Safety Culture in Livestock Operations video (9-minutes) produced in English and Spanish. Distributed to more than 250 (as of 1/2012) livestock and dairy producers in the Mountain West states and posted on YouTube: http://www.youtube.com/watch?v=LSZMrAp8xT4

Presentations

Motteram, R. English version of video "Creating Safety Culture in Livestock Operations" presented at three spring safety association sponsored safety meetings in Burlington, Sterling and Pueblo, Colorado. 2012

Douphrate, D. Dairy farm safety and OSHA: Approaches for effective management and worker training. Dairy Calf and Heiffer Conference, April 5-6, 2011, Lake Geneva, WI.

Douphrate, D, Fry, M. Incorporating Lean Six Sigma into Occupational Health and Safety. Webinar, American Conference of Governmental Industrial Hygienists, March 1, 2011.

Douphrate, D. What You Need to Know About OSHA Before OSHA Needs to Know About You. I-29 Dairy Consortium Safety Workshop. July, 2010, Pipestone, MN.

Douphrate, D. What You Need to Know About OSHA Before OSHA Needs to Know About You. I-29 Dairy Consortium Safety Workshop. July, 2010, Brookings, SD.

Douphrate, D. What You Need to Know About OSHA Before OSHA Needs to Know About You. I-29 Dairy Consortium Safety Workshop. July, 2010, Milbank, SD.

Douphrate, D. What You Need to Know About OSHA Before OSHA Needs to Know About You. I-29 Dairy Consortium Safety Workshop. July, 2010, Sioux Center, IA.

Douphrate, D. What You Need to Know About OSHA Before OSHA Needs to Know About You. I-29 Dairy Consortium Safety Workshop. July, 2010, Firth, NE.

Douphrate, D. Agriculture Safety Management Using Lean Six Sigma. Utah Dairy Extension & Utah State University Workshops. September 28-29, 2009.

LITERATURE CITED

Buttolph D. 1992. A new look at adaptation. Knowledge: Creation, Diffusion, Utilization, 13 (4): 460-470

Chambers R, Pacey A, Thrupp L. 1989. Farmer First: Farmer Innovation and Agricultural Research. London: Intermediate Technology Publications

Crandall DP. 1989. Implementation aspects of dissemination. Knowledge: Creation, Diffusion, Utilization, 11: 79–106.

Dunn W. 1983. Measuring Knowledge Use. Knowledge: Creation, Diffusion, Utilization, 5(1): 120-133.

Friedman MA, & Farag ZE. 1991. Gaps in the dissemination / knowledge utilization base. Knowledge: Creation, Diffusion, Utilization, 12(3): 266-288.

GAO. 2010. ALL-TERRAIN VEHICLES How They Are Used, Crashes, and Sales of Adult-Sized Vehicles for Children's Use. Government Accountability Office. Washington, DC. Document GAO-10-418.

Helmkamp JC, Biddle EA, Marsh SM, Campbell CR. Economic Burden of All-terrain Vehicle Related Adult Deaths in the U.S. Workplace, 2003-2006. Journal of Agricultural Safety and Health (in press)

Helmkamp, Marsh, & Aiken. 2011. Occupational All-Terrain Vehicle Deaths among Workers 18 Year and Older in the United States, 1992-2007. Journal of Agricultural Safety and Health, 17, 147-155.

Helmkamp, JC & Carter, MW. 2009. ATV Deaths among Older Adults in West Virginia: Evidence Suggesting that "60" is the New 40! Southern Medical Journal, 102:465-469. PubMed ID: 19373159

Rogers EM. 2003. Diffusion of Innovations, Fifth edition. New York, NY: Free Press.

Wilson J. 1992. Changing agriculture: An introduction to systems thinking. Kenthurst: Kangaroo Press.

Closeout Document 2: The Final Financial Status Report

This document to be submitted by the Office of Sponsored Programs at Colorado State University.

Closeout Document 3: The Final Invention Statement and Certification

This document to be submitted by the Office of Sponsored Programs at Colorado State University.

Closeout Document 4: Equipment Inventory Listing

The equipment inventory listing begins on the following page.

CDC Procurement & Grants Office - Branch V
Equipment Inventory Listing

Report Date:	08/01/2012	Grant Number:	5U50OH008085-07
Project Title:	*HICAHS	Project Period:	09/15/2007 - 06/14/2012
Grantee Name:	Colorado State University	Project Officer:	William Allen Robison
Grants Management Officer:	Peter E. Grandillo Jr.	Grants Specialist:	Maryann P. Monroe

*High Plains Intermountain Center for Agriculture Health and Safety

Description of Item: i.e. pH Meter	Mfr.[1] i.e. Fischer	Serial Number	Quantity	Condition[2]	Location[3]	Purchase Cost	Date Received [mm/dd/yyyy]
VWR SYM ULT Freezer	VWR Intl	BE06Q1E0100	1	Excellent	350 W. Lake Str	$10,205.89	05/08/2012
Model# DW861628H		B2C2G0041			Fort Collins, CO		
					ERHS Lab 107		
Physiological Monitoring	NexGen	530,531,532,	1	Good	350 W.Lake Str	$16,130.00	08/29/2011
System - SXT Series Kit	Ergonomics	533,534,535,			Fort Collins CO		
		134,135			ERHS Lab 125		
		475/476/477/478/479/480					

[1]Mfr. (Manufacturer)
[2]Condition: (Excellent) (Good) (Fair) (Poor) (Inoperable)
[3]Location: complete physical address

For Government Use Only, not to be completed by the Grantee
Property Administrator & PO Disposition Recommendation and Instructions:

Description of Item	Disposition[1]	Address[2]
[Copy from above]	_____Transfer Title _____Retain and Compensate Awarding Agency _____ Return to Program Office _____Other (explain)	Attn: [Project Officer] CDC / NIOSH 1600 Clifton Road, NE MS E-74 Atlanta, GA 30329-4018
[Copy from above]	_____Transfer Title _____Retain and Compensate Awarding Agency _____ Return to Program Office _____Other (explain)	

[1]Check the appropriate disposition
[2]CDC Warehouse is the central receiving point for delivery of all non-hazardous and non-perishable supplies and equipment, CDC –AM–2004-03, update 2010

CDC Procurement & Grants Office - Branch V
Equipment Inventory Listing

Report Date:	08/01/2012	Grant Number:	5U50OH008085-07
Project Title:	*HICAHS	Project Period:	09/15/2007 - 06/14/2012
Grantee Name:	Colorado State University	Project Officer:	William Allen Robison
Grants Management Officer:	Peter E. Grandillo Jr.	Grants Specialist:	Maryann P. Monroe

*High Plains Intermountain Center for Agriculture Health and Safety

Description of Item: i.e. pH Meter	Mfr.[1] i.e. Fischer	Serial Number	Quantity	Condition[2]	Location[3]	Purchase Cost	Date Received [mm/dd/yyyy]
Benchtop Freeze-Dry System	Labconco	100322406V	1	Good	1380 Centre Ave Fort Collins, CO Physio Lab 139	$9,311.02	05/19/2010

[1]Mfr. (Manufacturer)
[2]Condition: (Excellent) (Good) (Fair) (Poor) (Inoperable)
[3]Location: complete physical address

For Government Use Only, not to be completed by the Grantee
Property Administrator & PO Disposition Recommendation and Instructions:

Description of Item	Disposition[1]	Address[2]
[Copy from above]	_____Transfer Title _____Retain and Compensate Awarding Agency _____ Return to Program Office _____Other (explain)	Attn: [Project Officer] CDC / NIOSH 1600 Clifton Road, NE MS E-74 Atlanta, GA 30329-4018
[Copy from above]	_____Transfer Title _____Retain and Compensate Awarding Agency _____ Return to Program Office _____Other (explain)	

[1]Check the appropriate disposition
[2]CDC Warehouse is the central receiving point for delivery of all non-hazardous and non-perishable supplies and equipment, CDC –AM–2004-03, update 2010

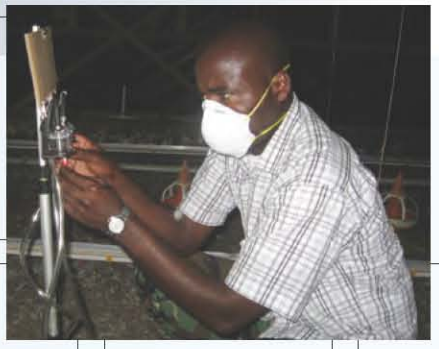
Appendices

HICAHS 2007-2012 Closeout Report

Appendix 1: ACE Reports

The Agricultural Center Evaluation (ACE) Reports from 2006-2010 can be found online at http://www.hicahs.colostate.edu/ace.html. These reports reviewed the activities of *all* the NIOSH-sponsored Agricultural Centers nationwide. The project was led by Victoria Buchan, Deputy Director of HICAHS. A copy of the Executive Summary of the latest ACE Report (2010) begins on the following page.

- 2006
- 2007
- 2008
- 2009
- 2009 Executive Summary
- 2010
- 2010 Executive Summary



Agriculture, Forestry, Fishing, Safety & Health

NIOSH Agricultural Center Initiative
Evaluation Project
January 2011

Prepared by
High Plains Intermountain Center for Agricultural Health and Safety

Great Plains Center for Agricultural Health
The University of Iowa, Iowa City, IA
Director: Fredric Gerr, MD
http://www.public-health.uiowa.edu/gpcah/
319-335-4212

High Plains Intermountain Center for Agricultural Health & Safety
Colorado State University, Fort Collins, CO
Director: Stephen J. Reynolds, PhD, CIH
http://www.hicahs.colostate.edu/
970-491-1912

Northeast Center for Agricultural Safety & Health
Cooperstown, NY
Director: John May, MD
http://www.nycamh.com/
607-547-6023 X-224

Pacific Northwest Agricultural Safety and Health Center
University of Washington, Seattle, WA
Director: Richard Fenske, PhD, MPH
http://depts.washington.edu/pnash
800-330-0827

Southeast Center for Agricultural Health and Injury Prevention
University of Kentucky, Lexington, KY
Director: Robert McKnight, MPH, ScD
http://ukcph.org/scahip
252-744-1000

Southwest Center for Agricultural Health, Injury Prevention, & Education
The University of Texas Health Center at Tyler, TX
Director: Jeffrey L. Levin, MD, MSPH
http://www.swagcenter.org/sitesearch.htm
903-877-5896

Western Center for Agricultural Health & Safety
University of California, Davis, DA
Director: Marc Schenker, MD, MPH
http://agcenter.ucdavis.edu/
530-752-4050

National Institute for Occupational Safety & Health
Atlanta, GA
Director: John Howard, MD
http://www.cdc.gov/niosh/homepage.html

HHS/CDC 5 U50 OH008085-06/S

Special thanks to Marcy Harrington (Pacific Northwest Center) for report cover design and Teresa Donovan (Southeast Center) for assistance with report indexing and editing.

Agricultural Centers: A History

Based upon statistics available, the Agricultural Occupational Sector (which now includes farming, ranching, forestry, logging, and fishing) continues to rank among the most hazardous industries in the United States. Particularly in modern farming and ranching, the owner/operators of these outfits may be a family, an industrialized operation, or an association of those components who are all at risk for occupational injury or disease. Workers in this sector have continually had higher fatality and injury rates than U.S. workers in all other sectors. Until the early 1990s there was no organized approach to reduce the occupational injury and disease for this agricultural sector.

In 1990, the National Institute for Occupational Safety and Health responded to Public Law 101-517 and developed a funding program to establish extramural centers for Agricultural Disease and Injury Research, Education, and Prevention. Over the next twelve years, Centers were established in diverse regions across the country via a competitive application process. In 1995 an external evaluation was completed of the Centers and has become known as the Kennedy Report. In response to this report, one Center proposed the establishment of a team consisting of representatives from each Center to design and develop a multisite approach to the evaluation of all the Centers as an Initiative: The Agricultural Center Evaluation (ACE) Project.

Representatives from each Center met during a series of workshops between the years 1997—1999 to develop evaluation research questions and define indicators to measure the work of the Centers overall. The lead Center then developed a database that allowed each Center to collect their own data in a standardized and consistent manner. The lead Center is responsible for the aggregation of all Centers' data into one database. The first pilot report was published in 1999 and reports have continued almost every year since with interruptions due to funding issues. There are several keys to the longevity and success of the ACE team that deserve acknowledgment.

- The continued support of NIOSH as the team has developed and revised their approach
- The multidisciplinary nature of the team which provides expertise in a variety of disciplines and topics which are useful to the whole
- A collaborative spirit that began the process and has continued with each year and report.

V. Buchan, PI & K. Danhoff

with

D. Perez

High Plains Intermountain Center for Agricultural Health & Safety

NIOSH Agricultural Center Initiative Evaluation Project Fiscal Year 2010

EXECUTIVE SUMMARY

NIOSH Agricultural Center Initiative Evaluation Report - FY 2010

As previously outlined, the Agricultural Health and Safety Center Initiative began with the development of two Centers in 1990 funded by the National Institute for Occupational Safety and Health (NIOSH). Due to the vast regional differences in agriculture production and practices across the United States, NIOSH chose to add additional Centers roughly corresponding to Public Health Service Regions. In FY 2010, the Initiative consisted of seven Agricultural Centers mandated to undertake research, develop prevention and education programs and provide consultation to constituents across the United States in an expanded North American Industry Classification System (NAICS), occupational sub code 11, Agriculture, Forestry, Fishing and Hunting.

The mission of the Initiative is to reduce injury and disease in three of the most hazardous occupations in the United States, agriculture, forestry and fishing. This mission is to be accomplished by addressing the following objectives:

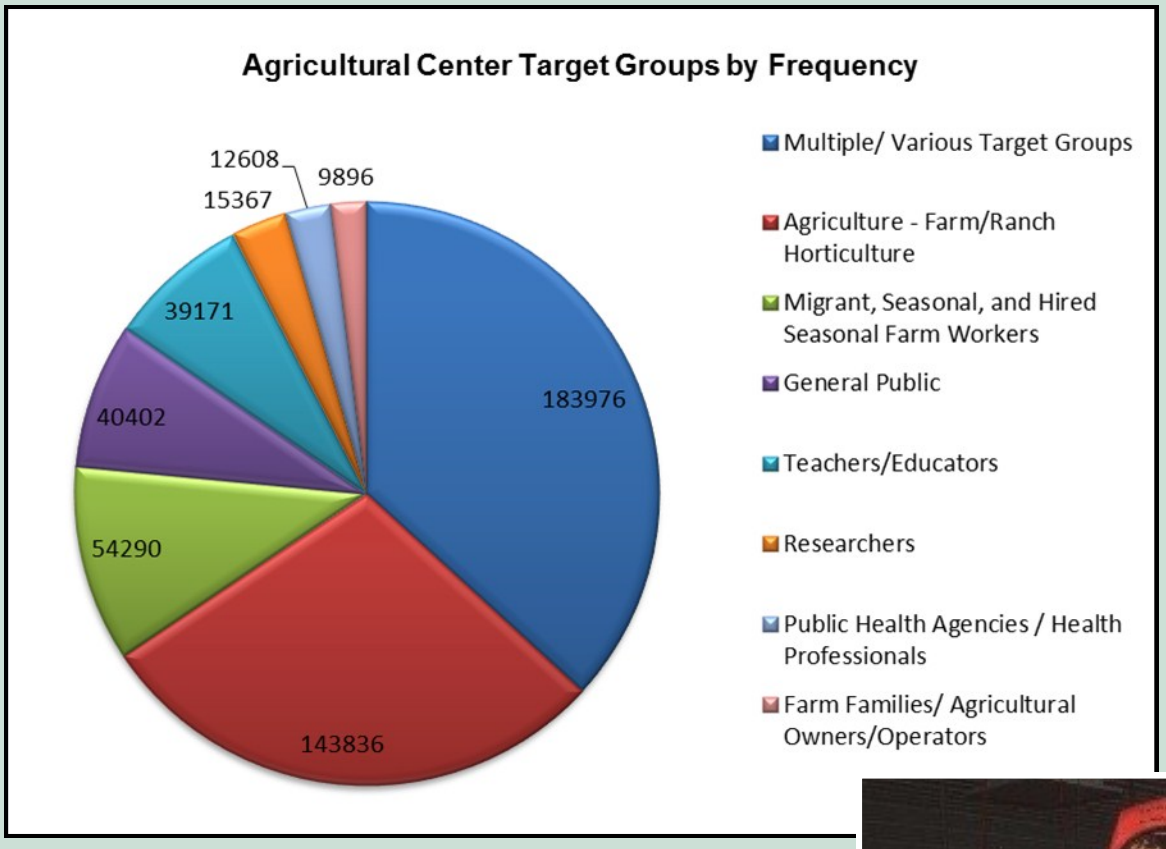
1. Conduct research related to the prevention of occupational disease and injury among producers, workers and their families.
2. Develop, implement and evaluate educational and outreach programs for promoting health and safety for production agriculture/forestry/fishing including farmers, workers and their families. This would include providing consultation and/or training to researchers, health and safety professionals, graduate/ professional students, and agricultural extension agents and others in a position to improve the health and safety of workers.
3. Develop, implement and evaluate model programs for the prevention of illness and injury among agriculture/forestry/fishing producers, workers and their families.
4. Develop linkages and communication with other governmental and non-governmental bodies involved in health and safety with special emphasis on communications with other agricultural/forestry/fishing health and safety programs (PAR-06-057).

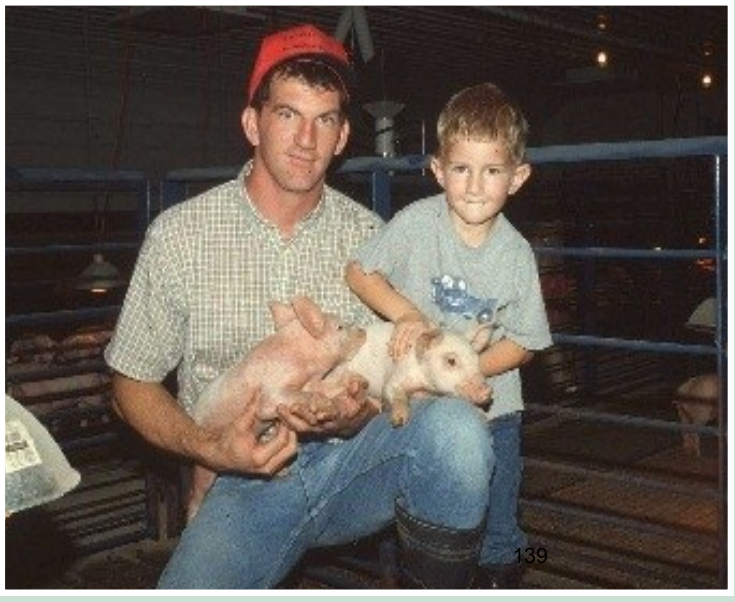
Initiative accomplishments FY 2010 – Program monitoring

Seven Centers provided data on 134 projects into a copy of the ACCESS™ database which was forwarded to HICAHS for aggregating and reporting. The FY 2010 Initiative data combines the productivity of all Centers to provide the necessary results to address eleven evaluation questions; the results of three of these questions are presented here, the reader is encouraged to review the full report for the remaining responses and discussion related to these outcome measures.

What were the target populations or audience contacts by specific activities by the Center Initiative during FY 2010?

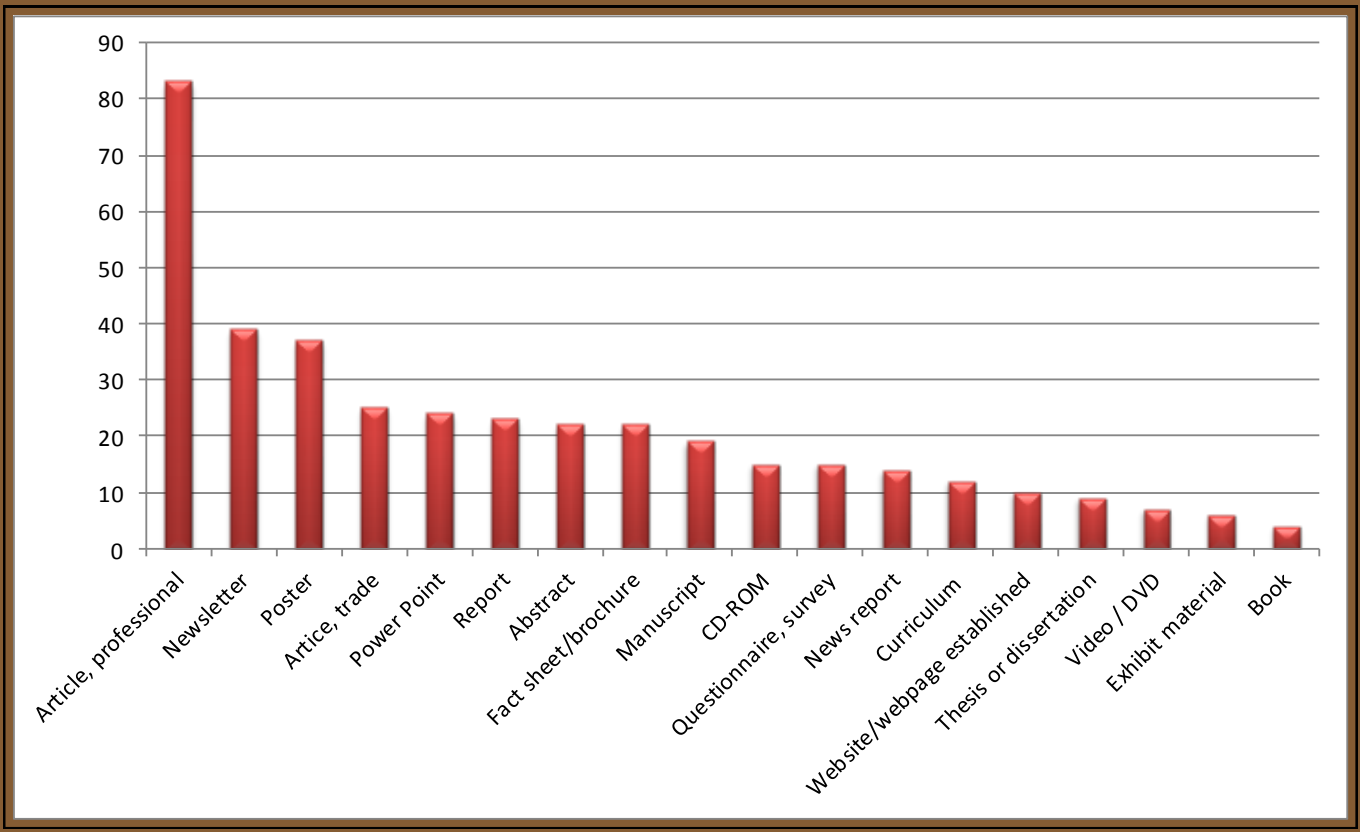
The Agricultural Center Initiative had a broad range of target groups during FY 2010. Just over 500,000 contacts were reported and the top five reported target groups account for 90% of the total contact counts. The activities of the Initiative have been divided into direct and indirect (product distribution) contact with constituents. Of the 122,439 direct activities reported the top ten included media interviews, material distribution, presentations at conferences, outreach education and training. Indirect contacts totaled 378,739 and the reported products included published articles, newsletters, curriculum, CD-ROMs and power point presentations for distribution. The vast majority of all efforts targeted either agricultural owners and operators or more than one group within the agricultural community.





What products by type were produced by the Center Initiative during FY 2010?

A total of 389 products were developed during the 2010 monitoring period. The majority of the efforts reported (63%) were attempts to disseminate information and educational materials. Based upon the variety of product types, it is reasonable to expect that the information and education produced by the Center Initiative is reaching a variety of audiences.



Number of products produced by category (N=389)

Which NORA goals were addressed by Center research during FY 2010?

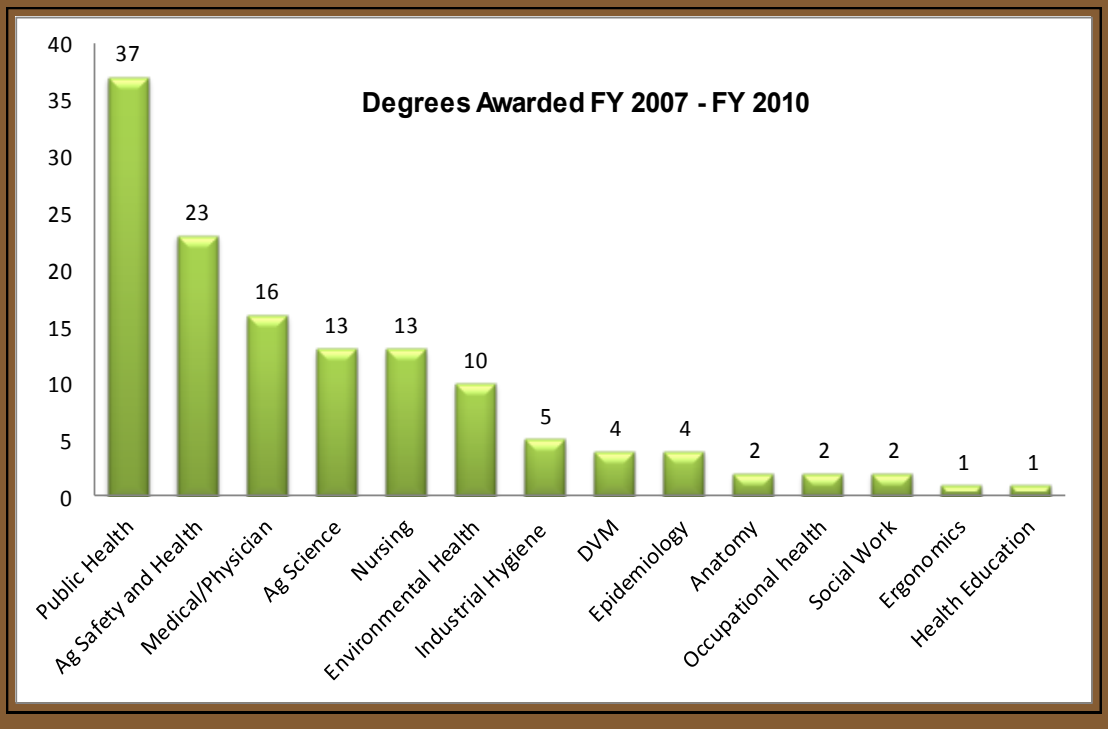
For the last two reporting years, the ACE team has reported research projects under the NORA II categorizations. FY 2010 saw at least one project addressing all nine NORA II strategic goals. Strategic goal 3 – outreach, communications, and partnerships – had the most reported projects with 57. Strategic goal 2 – vulnerable workers – had the second most projects reported with 51.

Aggregate report for current funding cycle FY 2007-2010

The second section of the report provides an overview of the work of the Center Initiative for the years 2007 through 2010, the first four years of the current five year funding cycle. The information provided responds to a selection of the overall aggregate evaluation questions to illustrate the cumulative accomplishments of Center personnel related to research, outreach, products, and additions to the knowledge base related to agriculture/forestry/fishing health and safety.

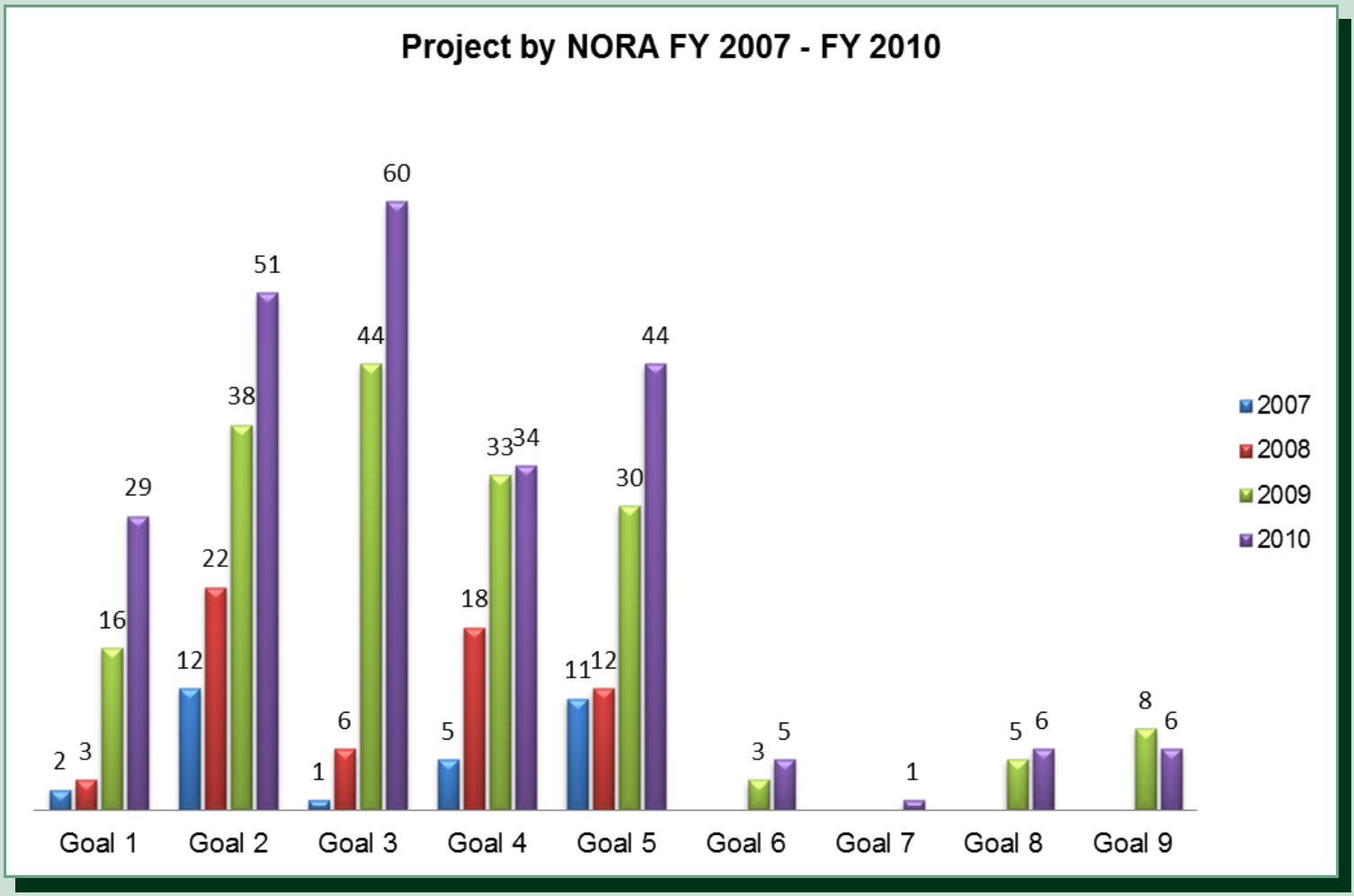
For what disciplines were degrees awarded by Centers between FYs 2007-2010?

The Center Initiative clearly responds to the needs related to agricultural/forestry/fishing for occupational health and safety by providing educational opportunities for multiple disciplines that can continue to provide research, outreach and services to this occupational sector. Over the past four year period 133 students have graduated in a variety of disciplines that have been supported the Center Initiative.



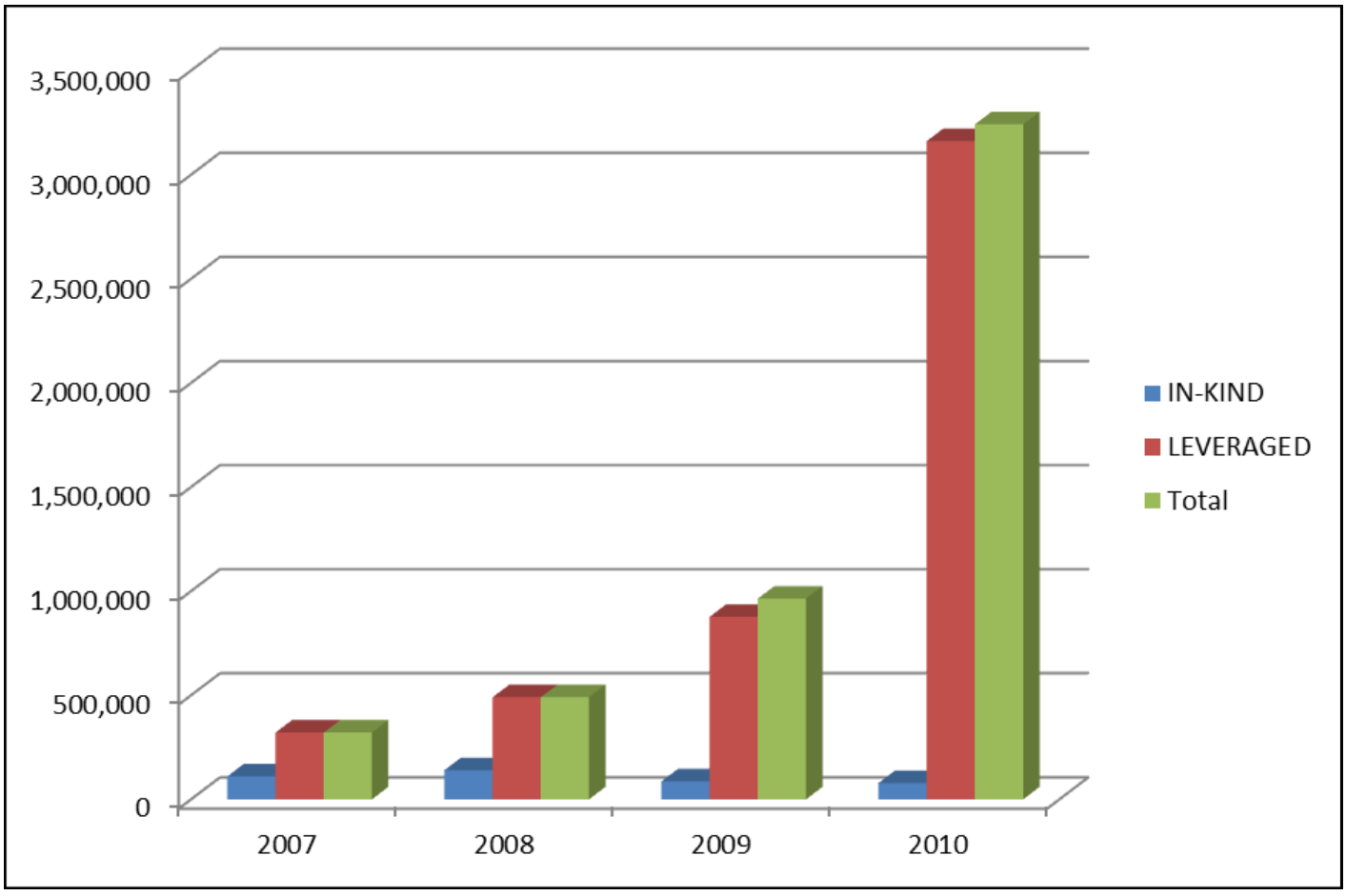
How many research (including pilot/feasibility) projects by NORA II goals were supported by the Center Initiative during FYs 2007-2010?

It is important to identify the move from NORA I to NORA II as a framework within which research projects can be categorized. When the sector based framework was adopted at the end of 2008, the ACE team responded by re-categorizing those projects that had been funded since 2007. In this report a special effort was made to re-categorize all feasibility/pilot projects funded by the Centers. All nine strategic goals are addressed by at least one project; a considerable accomplishment as Forestry and Fishing (Goals 6-9) were not part of the charge to the Centers when the funding cycle began.



What was the reported monetary value leveraged (beyond NIOSH support) by the Center Initiative (in dollars and in-kind) between 2007 and 2010?

In FYs 2007 and 2008, just under a million dollars were leveraged each year by the Initiative. Just over $2,000,000 dollars were leveraged in 2009 and fiscal year 2010 saw the most leveraged dollars with just over $3.1 million. A total of $5,122,347 has been reported leveraged over the four year span of this report, adding considerable additional funding from sources other than NIOSH to support the work of the Centers.



Project Success Stories—Research to Practice

This year's ACE report again includes a section presenting a project r2p (Research to practice) "success story" from each Center. These short reports represent multiple approaches to translation of projects to practice accomplished through the efforts of Initiative personnel.

Discussion

The 2010 fiscal year report represents the work and accomplishments of the staff, collaborators, and partners of the seven reporting Agricultural Centers undertaking research, prevention and education on behalf of those working in agricultural, forestry and fishing occupations across the United States.

NIOSH provided supplemental funding support to each participating Center to acknowledge the time and effort that individual team members put into the ACE data collection process; and the Centers are most appreciative of the funding provided.

The Centers which make up the Agriculture/Forestry/Fishing Initiative provided data in the ACCESS™ database to HICAHS for aggregation. A number of limitations to this monitoring process are presented in the report and represent some of the methodological limitations of all multisite evaluation efforts.

Summary and Recommendations

The ACE team has now completed four full years of program monitoring under the current funding cycle. The results presented in the report describe a broad range of activities across diverse regions of the country during fiscal year 2010 as well as cumulative accomplishments over the current funding cycle.

The ACE project began as a response to an external evaluation review of the Center Initiative (Kennedy 1995). The National Academy of Science evaluation completed in 2008 also encouraged the Centers to work together with NIOSH to approach evaluation collaboratively. The ACE team, with support from NIOSH, has provided a multisite approach to monitoring and documenting the research activities, products, outreach, and translation efforts of Initiative projects.

- The primary recommendation of this ACE report is to build upon the experience, knowledge and collaboration the ACE process has provided and continue to pursue a multi-site approach to evaluation with the new funding cycle which begins with fiscal year 2012 (9/15/11-9/14/16).

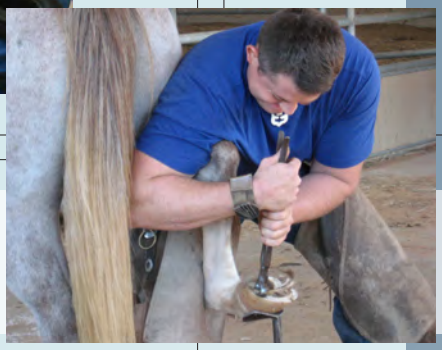
Back Row (left to right): Susan Ackerman, Allen Robison, Sandy Freeland, Karen Gilmore, Teresa Donovan, Sara Shepherd, Patricia Ramstad/Front Row (left to right): Marcy Harrington, Vicky Buchan, Diana Perez, Kristin Danhoff

Ag Center Evaluators

Patricia Ramstad and Murray Madsen Great Plains Center for Agricultural Health The University of Iowa, Iowa City, IA (319) 335-4481 patricia-ramstad@uiowa.edu	**Teresa Donovan** Southeast Center for Agricultural Health & Injury Prevention University of Kentucky, Lexington, KY (859) 323-4602 tdono2@email.uky.edu
Vicky Buchan, PI, Kristin Danhoff & Diana Perez High Plains Intermountain Center for Agricultural Health & Safety (Lead Center) Colorado State University, Fort Collins, CO (970) 491-1912 victoria.buchan@colostate.edu	**Karen Gilmore and Sara Shepherd** Southwest Center for Agricultural Health, Injury Prevention, & Education The University of Texas Health Center at Tyler Tyler, TX (903) 877-5896 karen.gilmore@uthct.edu
Sue Ackerman Northeast Center for Agricultural Safety & Health Cooperstown, NY (607) 547-6023 ext. 224 sackerman@nycamh.com	**Sandy Freeland** Western Center for Agricultural Health & Safety Davis, CA (530) 754-8678 slfreeland@ucdavis.edu
Marcy Harrington Pacific Northwest Agricultural Safety and Health Center University of Washington, Seattle, WA (206) 685-8962 marcyw@u.washington.edu	**W. Allen Robison** National Institute for Occupational Safety and Health (Sponsor) Atlanta, GA

A special Thanks to Kari Wolf for graphic design assistance.

Drs. Purvchwitz and Conway, NEC



Appendix 2: HICAHS PRODUCTS 2007-2012

HICAHS PUBLICATIONS - ALL 148

Journal Articles 148

Conference Presentations 154

Webinars, Continuing Education, Lectures, Multimedia 161

Trade Publications 162

Reports 163

Standards 163

Testimony 163

Student Theses 164

Conference Leadership 165

HICAHS PUBLICATIONS BY SELECTED PROJECTS 167

HICAHS Dairy Initiatives 167

HICAHS Pilot Program 175

HICAHS PUBLICATIONS - ALL

Journal Articles

Adams, C., Riggs, P., & Volckens, J. (2009). Development of a method for personal, spatiotemporal exposure assessment. Journal of Environmental Monitoring, 11(7), 1331-1339.

Anthony, T. R., Landázuri, A. C., Van Dyke, M., & Volckens, J. (2010). Design and Computational Fluid Dynamics Investigation of a Personal, High Flow Inhalable Sampler. Annals of Occupational Hygiene, 54(4), 427-442. doi: 10.1093/annhyg/meq029

Asti, L., Canan, B., Heaney, C., Ashida, S., Renick, K. M., Xiang, H., Stallones, L., Bean, T., Jepsen, SD., Wilkins III, J. R. (2011). Compliance with the North American guidelines for children's agricultural tasks among youth working with large animals. Journal of Agrimedicine, 16(3), 174-193.

Benton-Vitz, K., & Volckens, J. (2008). Evaluation of the pDR-1200 Real-Time Aerosol Monitor. Journal of Occupational and Environmental Hygiene, 5(6), 353-359. doi: 10.1080/15459620802009919

Beseler, C., & Stallones, L. (2010). Safety knowledge, safety behaviors, depression and injuries in Colorado farm residents. American Journal of Industrial Medicine, 53(1), 47-54.

Beseler, C., & Stallones, L. (2011). An item response theory analysis of safety knowledge in Colorado farm residents. Journal of Occupational & Environmental Medicine, 53(4), 388-395.

Beseler, C., Stallones, L., Hoppin, J. A., Alavanja, M., Blair, A., Keefe, T., & Kamel, F. (2008). Depression and pesticide exposures among private pesticide applicators enrolled in the Agricultural Health Study. Environmental Health Perspectives, 116(12), 1713-1719.

Beseler, C. L., & Stallones, L. (2008). A Cohort Study of Pesticide Poisoning and Depression in Colorado Farm Residents. Annals of Epidemiology, 18(10), 768-774. doi: 10.1016/j.annepidem.2008.05.004

Beseler, C. L., & Stallones, L. (2009). Pesticide poisoning and respiratory disorders in Colorado farm residents. Journal of Agricultural Safety and Health, 15(4), 327-334.

Bowling, M.B., Belk, K.E., Nightingale, K.K., Goodridge, L.D., Scanga, J.A., Sofos, J.N., Tatum, J.D., & Smith, G.C. (2007). Central Nervous System Tissue in Meat Products: An Evaluation of Risk, Prevention Strategies, and Testing Procedures, Advances in Food Nutrition, 53, 39-64.

Buchan, V., Seiz, R., Danhoff, K. , Donovan, T., Gilmore, K., and Scofield, S. (Under review). Successful Regional and Inter-organizational Collaboration in Applied Research: Challenges Met, Lessons learned.

Burch, J. B., Svendsen, E., Siegel, P. D., Wagner, S. E., von Essen, S., Keefe, T., Mehaffy, J., Martinez, A.S., Bradford, M., Baker, L., Cranmer, B., Saito, R., Tessari, J., Prinz, L., Andersen, C., Christensen, O., Koehncke, N., Reynolds, S. J. (2009). Endotoxin Exposure and Inflammation Markers Among Agricultural Workers in Colorado and Nebraska. Journal of Toxicology and Environmental Health, Part A: Current Issues, 73(1), 5 - 22.

Canan, B., Asti, L., Heaney, C., Ashida, S., Renick, K., Stallones, L., . . . Wilkins III, J. R. (2011). Compliance with NAGCAT Work Practices Recommendations for Youth Cleaning Service Alleys in Stall Barns. Journal of Agricultural Safety and Health, 17(2), 127-146.

Choudhry, A., Reynolds, S. J., Mehaffy, J., Levin, J. L., Gilmore, K., Douphrate, D., & Nonnenmann, M. W. (2012). Evaluation of parlor washing as an intervention for decreasing occupational exposure to organic dust and endotoxin among dairy parlor workers--a pilot study. Journal of Occupational & Environmental Health, In Press.

Cigularov, K. P., Chen, P., & Stallones, L. (2009). Effects of farm safety climate and farm safety locus of control on error communication: perspectives from young farm workers. Work and Stress, 23, 297-312.

Clark, P., Koehler, K. A., & Volckens, J. (2009). An improved model for particle deposition in porous foams. Journal of Aerosol Science, 40(7), 563-572. doi: 10.1016/j.jaerosci.2009.02.005

Comer, R., Ayers, P., & Liu, J. (2007). Evaluation of engineering plastic for rollover protective structure (ROPS) mounting. Journal of Agricultural Safety and Health, 13(2), 137-.

N Comstock, M Towle, A Warner, SJ Reynolds, L Durso, C Campbell, M Kiefer, SA. Bosch. Outbreak of Shiga Toxin—Producing *Escherichia coli* O111 Infections Associated With a Correctional Facility Dairy—Colorado, 2010, JAMA 2012; 308 (5): 447 – 449.

Comstock, N., Towle, M., Warner, A., Reynolds, S. J., Durso, L., Campbell, C., Kiefer, M., Bosch, S. A. (2012). Epidemiologic and occupational investigation of an Escherichia coli O111 outbreak associated with a correctional facility dairy--Colorado, 2010. Morbidity and Mortality Weekly Report (March 9, 2012).

Cragin LA, Kessner JS, Bachand AM, Boyd Barr D, Meadows JW, Krieg EF, Reif JS. (2011). Menstrual cycle characteristics and reproductive hormone levels in women exposed to atrazine in drinking water. Environmental Research, 111(8), 1293-301.

Curwin, B. D., Hein, M. J., Sanderson, W. T., Striley, C., Heederik, D., Kromhout, H., . . . Alavanja, M. C. (2007). Pesticide dose estimates for children of Iowa farmers and non-farmers. Environmental Research, 105(3), 307-315. doi: 10.1016/j.envres.2007.06.001

Dartt, A., Rosecrance, J., Gerr, F., Chen, P., Anton, D., & Merlino, L. (2009). Reliability of assessing upper limb postures among workers performing manufacturing tasks. Applied Ergonomics, 40(3), 371-378. doi: 10.1016/j.apergo.2008.11.008

Dooley, G. P., Hanneman, W. H., Carbone, D. L., Legare, M. E., Andersen, M. E., & Tessari, J. D. (2007). Development of an Immunochemical Detection Method for Atrazine-Induced Albumin Adducts. Chemical Research in Toxicology, 20(7), 1061-1066. doi: 10.1021/tx700083v

Douphrate D, Nonnenman M, Fethke N, Rosecrance J. (in preparation). Full-shift exposure measurement of muscle forces among large herd dairy parlor workers: a feasibility study. To be submitted to International Journal of Industrial Ergonomics.

Douphrate D, Rosecrance J, Gimeno D, Nonnenmann M, and Reynolds S, (in preparation). Injury risk analysis in large herd dairy parlors. To be submitted to American Journal of Industrial Medicine.

Douphrate, D. I., Fethke, N. B., Nonnenmann, M. W., Rosecrance, J. C., & Reynolds, S. J. (2012). Full shift arm inclinometry among dairy parlor workers: A feasibility study in a challenging work environment. Applied Ergonomics, 43(3), 604-613. doi: 10.1016/j.apergo.2011.09.007

Douphrate, D. I., Nonnenmann, M. W., & Rosecrance, J. C. (2009). Ergonomics in Industrialized Dairy Operations. Journal of Agromedicine, 14(4), 406 - 412. doi: 10.1080/10599240903260444

Douphrate, D. I., Rosecrance, J. C., Reynolds, S. J., Stallones, L., & Gilkey, D. P. (2009). Tractor-Related Injuries: An Analysis of Workers' Compensation Data. Journal of Agromedicine, 14(2), 190-197. doi: 10.1080/10599240902773215

Douphrate, D. I., Rosecrance, J. C., Stallones, L., Reynolds, S. J., & Gilkey, D. P. (2009). Livestock-handling injuries in agriculture: An analysis of Colorado workers' compensation data. American Journal of Industrial Medicine, 52(5), 391-407. doi: 10.1002/ajim.20686

J Garcia, DH Bennett, DJ Tancredi, MB Schenker, DC Mitchell, S Reynolds, FM Mitloehner. Occupational exposure to particulate matter and endotoxin for California dairy workers *International Journal of Hygiene and Environmental Health, In Press, Corrected Proof, Available online 12 May 2012*

Gilkey, D., Randall, E., Hansen, C., Patil, A., Rosecrance, J., & Douphrate, D. (2011). Musculoskeletal Symptoms And Ergonomic Risk Factors Among Veterinary Ultrasonographers. Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 55(1), 720-723. doi: 10.1177/1071181311551149

Goodridge, L. D. (2010). Designing Phage Therapeutics. Current Pharmaceutical Biotechnology, 11:15-27.

Harris, J. R., Winn, G. L., Ayers, P. D., & McKenzie Jr, E. A. (2011). Predicting the performance of cost-effective rollover protective structure designs. Safety Science, 49(8–9), 1252-1261. doi: 10.1016/j.ssci.2011.04.011

Kirychuk, S. P., Reynolds, S. J., Koehncke, N., Nakatsu, J., & Mehaffy, J. (2009). Comparison of Endotoxin and Particle Bounce in Marple Cascade Samplers With and Without Impaction Grease. Journal of Agromedicine, 14(2), 242 - 249. doi: 10.1080/10599240902845062

Kirychuk, S. P., Reynolds, S. J., Koehncke, N. K., Lawson, J., Willson, P., Senthilselvan, A., . . . Dosman, J. A. (2010). Endotoxin and Dust at Respirable and Nonrespirable Particle Sizes are not Consistent Between Cage- and Floor-Housed Poultry Operations. Annals of Occupational Hygiene, 54(7), 824-832. doi: 10.1093/annhyg/meq047

Koehler, K. A., Anthony, T. R., van Dyke, M., & Volckens, J. (2011). A Rotating Bluff-Body Disc for Reduced Variability in Wind Tunnel Aerosol Studies. Annals of Occupational Hygiene, 55(1), 86-96. doi: 10.1093/annhyg/meq078

Koehler, K. A., Anthony, T. R., Van Dyke, M., & Volckens, J. (2012). Solid versus Liquid Particle Sampling Efficiency of Three Personal Aerosol Samplers when Facing the Wind. Annals of Occupational Hygiene, 56(2), 194-206. doi: 10.1093/annhyg/mer077

Koehler, K. A., Clark, P., & Volckens, J. (2009). Development of a Sampler for Total Aerosol Deposition in the Human Respiratory Tract. Annals of Occupational Hygiene, 53(7), 731-738. doi: 10.1093/annhyg/mep053

O'Shaughnessy PO, Lo J, Golla V, Nakatsu J, Tillery MI, Reynolds SJ (2007). Comparison of Aerosol Samplers Relative to the Inhalable and Respirable Collection Criteria. JOEH 4,237-245.

Patil, A., Rosecrance, J., Douphrate, D., & Gilkey, D. (2012). Prevalence of carpal tunnel syndrome among dairy workers. American Journal of Industrial Medicine, 55(2), 127-135. doi: 10.1002/ajim.21995

Plummer, L. E., Pinkerton, K. E., Reynolds, S., Meschke, S., Mitloehner, F., Bennett, D., Schenker, M. B. (2009). Aerosols in the Agricultural Setting. Journal of Agromedicine, 14(4), 413 - 416. doi: 10.1080/10599240903260527

Poole JA, Gleason AM, Bauer C, West WW, Alexis N, van Rooijen N, Reynolds SJ, Romberger DJ, Kielian T. $CD11c^{+}/CD11b^{+}$ Cells are Critical for Organic Dust-Elicited Murine Lung Inflammation. American Journal of Respiratory Cell Molecular Biology In Press 2012.

Poole, J. A., Dooley, G. P., Saito, R., Burrell, A. M., Bailey, K. L., Romberger, D. J., Mehaffy, J., Reynolds, S. J. (2010). Muramic Acid, Endotoxin, 3-Hydroxy Fatty Acids, and Ergosterol Content Explain Monocyte and Epithelial Cell Inflammatory Responses to Agricultural Dusts. Journal of Toxicology and Environmental Health, Part A: Current Issues, 73(10), 684 - 700. doi: 10.1080/15287390903578539

Poole, J. A., Kielian, T., Wyatt, T. A., Gleason, A. M., Stone, J., Palm, K., . . . Romberger, D. J. (2011). Organic dust augments nucleotide-binding oligomerization domain expression via an NF-κB pathway to negatively regulate inflammatory responses. American Journal of Physiology - Lung Cellular and Molecular Physiology, 301(3), L296-L306. doi: 10.1152/ajplung.00086.2011

Poole, J. A., & Romberger, D. J. (2012). Immunological and inflammatory responses to organic dust in agriculture. Current Opinion in Allergy and Clinical Immunology, 12(2), 126-132 110.1097/ACI.1090b1013e3283511d3283510e.

Poole, J. A., Wyatt, T. A., Kielian, T., Oldenburg, P., Gleason, A., Bauer, A., . . . Romberger, D. J. (2011). Toll-like receptor (TLR2) Regulates Organic Dust-Induced Airway Inflammation. The Journal of allergy and clinical immunology, 127(2), AB137.

Randall, E., Hansen, C., Gilkey, D., Patil, A., Bachand, A., Rosecrance, J., & Douphrate, D. (2012). Evaluation of ergonomic risk factors among veterinary sonographers. Journal of Veterinary Radiology and Ultrasound, In Press.

Reynolds, S., Clark, M. L., Koehncke, N., Von Essen, S., Prinz, L., Keefe, T., Mehaffy, J., Bradford, M., Cranmer, B., Davidson, ME., Yang, IV., Burch, J. B. (2012). Pulmonary function reductions among potentially susceptible subgroups of agricultural workers in Colorado and Nebraska. JOEM 2012: 54(5)632-641.DOI: 10.1097/JOM.0b013e31824d2e1c

Reynolds, S. J., Nakatsu, J., Tillery, M., Keefe, T., Mehaffy, J., Thorne, P. S., Donham, K., Nonnenmann, M., Golla, V., O'shaughnessy, P. (2009). Field and Wind Tunnel Comparison of Four Aerosol Samplers Using Agricultural Dusts. Annals of Occupational Hygiene, 53(6), 585-594. doi: 10.1093/annhyg/mep021

Reynolds, S. J., Tadevosyan, A., Fuortes, L., Merchant, J. A., Stromquist, A. M., Burmeister, L. F., . . . Kelly, K. M. (2008). Keokuk County Rural Health Study: Self-Reported Use of Agricultural Chemicals and Protective Equipment. Journal of Agromedicine, 12(3), 45 - 55. doi: 10.1080/10599240801887850

Reynolds, S., Burch, J., Wagner, S., Svendsen, E., Siegel, P., von Essen, S., Koehncke, N. (2009). Endotoxin Exposure, Inflammation Markers, and Pulmonary Function among Agricultural Workers in Colorado and Nebraska. Paper presented at the U.S.A AIOH 27th Conference Canberra 2009, New and Emerging Issues.

Saito, R., Cranmer, B. K., Tessari, J. D., Larsson, L., Mehaffy, J. M., Keefe, T. J., & Reynolds, S. J. (2009). Recombinant Factor C (rFC) Assay and Gas Chromatography/Mass Spectrometry (GC/MS) Analysis of Endotoxin Variability in Four Agricultural Dusts. Annals of Occupational Hygiene, 53(7), 713-722. doi: 10.1093/annhyg/mep052

Stallones, L., Acosta, M. S. V., Sample, P., Bigelow, P., & Rosales, M. (2009). Perspectives on Safety and Health Among Migrant and Seasonal Farmworkers in the United States and México: A Qualitative Field Study. The Journal of Rural Health, 25(2), 219-225. doi: 10.1111/j.1748-0361.2009.00221.x

Stallones, L., & Gunderson, P. D. (2008). News clippings offer intriguing injury prevention possibilities [invited editorial]. Journal of Agromedicine, 12(3), 1-2.

Tadevosyan, A., Reynolds, S., Kelly, K., Fuortes, L., Mairapetyan, A., Tadevosyan, N., . . . Beglaryan, S. (2007). Organochlorine Pesticide Residues in Breast Milk in Armenia. Journal of Pre-Clinical and Clinical Research, 1(1), 84-88.

Thayer, D., Koehler, K. A., Marchese, A., & Volckens, J. (2011). A Personal, Thermophoretic Sampler for Airborne Nanoparticles. Aerosol Science and Technology, 45(6), 744-750. doi: 10.1080/02786826.2011.558943

Thomas, K. W., Dosemeci, M., Hoppin, J. A., Sheldon, L. S., Croghan, C. W., Gordon, S. M., . . . Alavanja, M. C. (2009). Urinary biomarker, dermal, and air measurement results for 2,4-D and chlorpyrifos farm

applicators in the Agricultural Health Study. J Expos Sci Environ Epidemiol, 20(2), 119-134. doi: 10.1038/jes.2009.6

Thorne, P. S., Perry, S. S., Saito, R., O'Shaughnessy, P. T., Mehaffy, J., Metwali, N., . . . Reynolds, S. J. (2010). Evaluation of the Limulus Amebocyte Lysate and Recombinant Factor C Assays for Assessment of Airborne Endotoxin. Appl. Environ. Microbiol., 76(15), 4988-4995. doi: 10.1128/aem.00527-10

Volckens, J., Dailey, L., Walters, G., & Devlin, R. B. (2009). Direct Particle-to-Cell Deposition of Coarse Ambient Particulate Matter Increases the Production of Inflammatory Mediators from Cultured Human Airway Epithelial Cells. Environmental Science & Technology, 43(12), 4595-4599. doi: 10.1021/es900698a

Wang, X., Ayers, P., & Womac, A. (2009). Static simulation and analysis of mower's ROPS behavior in finite element method. Journal of Agricultural Safety and Health, 15(4), 335-351.

Wang, X., Ayers, P., Womac, A., & Depauw, R. (2007). Sensitivity analysis and validation of continuous roll prediction model for front drive mowers. Applied Engineering in Agriculture, 23(4), 455-461.

Wilkins III, J. R., & Stallones, L. (2007). Using participant event monitoring in a cohort study of unintentional injury among children and adloescents. American Journal of Public Health, 97(2), 283-290.

Willford, J. & Goodridge, L.D**.** (2008). An Integrated Assay for Rapid Detection of Escherichia coli O157:H7 on Beef Samples. Food Protection Trends, 28, 468-472.

Willford, J., Mills, K., & Goodridge, L. D. (2009). Evaluation of Three Commercially Available ELISA Kits for Detection of Shiga Toxin Producing Escherichia coli. Journal of Food Protection, 72, 741-747.

Willford, J., Manley, W., Rebelein, T., & Goodridge, L. D. (2007). Pulsed field, ribotype and integron analysis of multidrug resistant isolates of Salmonella enterica serovar Newport. Food Research International, 40(8), 975-981. doi: 10.1016/j.foodres.2007.05.012

Yang, Y.Y, Borch, T., Young, R.B., Goodridge, L.D., & Davis, J. G. (2010). Degradation Kinetics of Testosterone by Manure-Borne Bacteria: Influence of Temperature, pH, Glucose Amendments, and Dissolved Oxygen, Journal of Environmental Quality, 39, 1153-1160.

Yang, H., Byelashov, O.A., Geornaras, I., Goodridge, L.D., Nightingale, K.K., Belk, K.E., Smith, G.C., & Sofos, J.N. (2010). Presence of antibiotic-resistant commensal bacteria in samples from agricultural, city, and national park environments evaluated by standard culture and real-time PCR methods. Canadian Journal of Microbiology, 56(9), 761-770.

Conference Presentations

Beseler, C., & Stallones, L. (2010, September 12-14). An Item Response Theory (IRT) analysis of safety knowledge in Colorado farm residents. Presented at the American College of Epidemiology Annual Meeting, San Francisco, CA.

Beseler, C., & Stallones, L. (2008, June 9-13). Smoking interacts with pesticide poisoning to reduce lung fuction in Colorado farm residents. Presented at the Epidemiology International Conference Occupational Health-Neurotoxicology Environmental Occupational Health Joint Conference, San Jose, Costa Rica.

Buchan, V., Seiz, R. & Liu, J. (August, 2009). Developing and Testing Interactive CD Health and Safety Curricula for 4-H Youth. Peer reviewed poster presentation. NIOSH Invitational Intra/Extramural Agriculture, Forestry and Fishing Safety and Health Workshop. Cincinnati, OH. Aug. 11-12, 2009.

Buchan, V. (May, 2009). Health and Safety for Children: an Interactive CD. National Farm Bureau Safety Conference. Invitational Platform Presentation. Fort Collins, CO. May 27, 2009.

Buchan, V. & Seiz, B. (October 2008). Lessons Learned in Conducting Rigorous Evaluation Research on Agricultural Health and Safety CD Curricula for Youth: Practical Challenges Faces, Met. . . and Remaining. Platform Presentation. 6th International Symposium Public Health and the Agricultural Rural Ecosystem. October 21, 2008, Saskatoon, Canada.

Buchan, V. (2005, August). "Interactive Agricultural Health and Safety CD for 4-H".Western Region 4H Program Leader's Meeting. Jackson, WY.

Clark, M. L., Bachand, A., Heiderscheidt, J. M., Diaz-Sanchez, D., Luna, B., Volckens, J., . . . Neas, L. (2011, September 13-16). Impact of an indoor cook stove intervention on measures of systemic inflammation. Presented at the ISEE, Barcelona, Spain.

Clark, M. L., Reynolds, S. J., Davidson, M., Keefe, T., Mehaffy, J., Bradford, J., . . . Poole, J. A. (2011, September). Endotoxin exposure, TLR4 mutations, smoking and work-related behaviors: pulmonary function deficits among potentially susceptible subgroups of agricultural workers in Colorado and Nebraska. Presented at the ISEE.

Dartt, A., & Rosecrance, J. (2008). Field evaluation of ergonomically designed hand tools. Presented at the NORA Symposium 2008: Public Market for Ideas and Partnership, Denver, CO.

Dartt, J., & Gilkey, D. (2009, January 16-17). Safety training evaluation: Montana State Fund Ag Safety Workshop. Presented at the American College of Occupational and Environmental Medicine, Denver, CO.

Davidson, M., Clark, M. L., Keefe, T., Mehaffy, J., Bradford, M., Roman-Muniz, N., . . . Reynolds, S. J. (2012, August 27-29). Similar exposure group (task) based analysis of bioaerosol exposures in dairies. Presented at the Nordic Meeting on Agricultural Occupational Health and Safety, Ystad, Sweden.

Douphrate, D. (2007, August 27-30). Sprain and strain musculoskeletal disorders among Colorado agriculture workers: an analysis of workers compensation claims data. Presented at the 6th International Scientific Conference on Prevention of Work-Related Musculoskeletal Disorders, Boston, MA.

Douphrate, D. (2009, September 24-25). How can we use workers' compensation data for occupational injury research? Presented at the Second Annual Western States Occupational Network (WestON) Conference, Denver, CO.

Douphrate, D. (2011, April 5-6). Dairy farm safety and OSHA--Approaches for effective management and worker training. Presented at the Dairy Calf & Heifer Association Annual Conference, Lake Geneva, Wisconsin.

Douphrate, D. (2011, December 7-8). Incorporating workers safety into daily farm management activities. Presented at the 2011 Dairy Summit, Wisconsin Dells, WI.

Douphrate, D., Kolstrup, C., Rosecrance, J., Reynolds, S., Lundqvist, P., Pinske, S., & Stal, M. (2010, August 29-September 3). European and US dairy production: challenges of work-related musculoskeletal disorder prevention. Presented at the Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders, Angers, France.

Douphrate, D., Nonnenmann, M. W., Reynolds, S. J., Levin, J. L., Buchan, V., & Rosecrance, J. (2010, January 26-28, 2010). The High Plains and Mountain Region Dairy Health and Safety Workshop: A participatory Approach to Identify Research and Outreach Needs in the Dairy Industry. Presented at the Agriculture and Safety Health Council of America, Dallas, TX.

Douphrate, D., & Rosecrance, J. (2007, November 3-7). Agriculture injuries in Colorado: an analysis of workers' compensation claims. Presented at the American Public Health Association 135th Annual Meeting and Expo, Washington, DC.

Douphrate, D., & Rosecrance, J. (2008, April 17-18). The analysis of agriculture injuries using workers' compensation data. Presented at the 6th Annual Regional National Occupational Research Agenda Young Investigators Symposium, Salt Lake City, UT.

Douphrate, D., & Rosecrance, J. (2008, November 11-13). Livestock-handling injuries in Colorado agriculture. Presented at the New Paths Conference: Health and Safety in Western Agriculture, Cle Elum, WA.

Douphrate, D., & Rosecrance, J. (2009, June 11-12). Ergonomics needs assessment of large-herd dairy parlor operations. Presented at the Proceedings of the 21st Annual International Occupational Ergonomics and Safety Conference, Dallas, TX.

Douphrate, D., & Rosecrance, J. (2009, June 11-12). Ergonomics needs assessment of large-herd dairy parlor operations. Presented at the 21st Annual International Occupational Ergonomics and Safety Conference, Dallas, TX.

Douphrate, D., & Rosecrance, J. (2010, September 16-18). Industrialization of dairy operations: Ergonomic implications. Presented at the International Conference of Work Safety and Risk Prevention in Agro-food and Forest Systems, Ragusa Ibla Campus, Italy.

Douphrate, D., & Rosecrance, J. (2010, September 16-18). Industrialization of dairy operations: Ergonomic implications. Presented at the International Conference of Work Safety and Risk Prevention in Agro-food and Forest Systems, Ragusa Ibla Campus, Italy.

Douphrate, D., & Rosecrance, J. (2010, September 16-18). Livestock handling injuries in the United States. Presented at the International Conference of Work Safety and Risk Prevention in Agro-food and Forest Systems, Ragusa Ibla Campus, Italy.

Douphrate, D., Rosecrance, J., Fethke, N., & Nonnenmann, M. W. (2010, August 29-September 3). Full-shift upper extremity direct exposure assessment of US dairy parlor workers. Presented at the Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders, Angers, France.

Douphrate, D., Rosecrance, J., Kolstrup, C., Pinske, S., & Stal, M. (2010). Musculoskeletal disorders and ergonomic challenges in modern dairy production: European and US perspectives. Presented at the Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders, Angers, France.

Douphrate, D., Rosecrance, J., & Reynolds, S. (2008, October 19-23). Dairy farm injuries: an analysis of workers' compensation data. Presented at the Sixth International Symposium on Public Health and the Agricultural Rural Ecosystem, Saskatoon, SK, Canada.

Douphrate, D., Rosecrance, J., & Reynolds, S. (2008, October). Tractor-related injuries on farms: An analysis of worker's compensation data. Presented at the Public Health and the Agricultural Rural Ecosystem, Saskatchewan, Saskatoon, Canada.

Douphrate, D., Rosecrance, J., & Reynolds, S. (2008, October). What can worker's compensation data tell us about livestock handling injuries in agriculture? Presented at the Public Health and the Agricultural Rural Ecosystem, Saskatchewan, Saskatoon, Canada.

Douphrate, D., Rosecrance, J., Reynolds, S., Rosas-Goulart, C., & Roman-Muniz, N. (2009, August 11-19). NIOSH protecting workers in agriculture: an example of immediate r2p in an ergonomic research project in large herd dairies. Presented at the NIOSH Invitational Intra/Extramural Agriculture, Forestry and Fishing Safety and Health Workshop, Cincinnati, OH.

Douphrate, D., Rosecrance, J., & Reynolds, S. J. (2011, August 22-24). Musculoskeletal Symptoms and Physical Exposures among US Large-Herd Milking Parlor Workers. Presented at the Irish Meeting on Agricultural Occupational Safety and Health, Dublin, Ireland.

Douphrate, D., Rosecrance, J., Stallones, L., Reynolds, S., & Gilkey, D. (2008). The use of workers' compensation data to investigate livestock handling injuries in agriculture. Presented at the NORA Symposium 2008: Public Market for Ideas and Partnership, Denver, CO.

Douphrate, D., Rosecrance, J., Stallones, L., Reynolds, S., & Gilkey, D. (2008, July 29). The use of workers' compensation data to investigate tractor-related injuries in agriculture. Presented at the National Occupational Research Agenda Symposium, Denver, CO.

Douphrate D, Fethke N Hagevoort R, Nonnenmann M, Mixco A, Tellechea-Sanchec T, Rosecrance J, Reynolds S (2012, September 3-6). Ergonomic exposures of posture and muscle activity among US large-herd dairy parlor workers. International Conference on Safety, Health and Welfare in Agriculture and Agro-food Systems--SHWA 2012, Ragusa Ibla Campus- Italy.

Douphrate D, Fethke N Hagevoort R, Nonnenmann M, Mixco A, Tellechea-Sanchec T, Rosecrance J, Reynolds S (2012, August 27-29). Ergonomic exposures of posture and muscle activity among US large-herd dairy parlor workers. Presented at the Nordic Meeting on Agricultural Occupational Health and Safety, Ystad, Sweden.

Funk, S., Reynolds, S. J., Volckens, J., Dowd, S., & Nonnenmann, M. W. (2011, May 16-19). Evaluation of seasonal ventilation changes and their effect on ambient dust, endotoxin and bioaerosol concentrations in a dairy parlor. Presented at the American Industrial Hygiene Conference and Exposition, Portland, OR.

Gilkey, D. (2009, June 11). Enhancing translation and dissemination through agricultural partnerships. Presented at the Colorado Corn Association Annual Board Meeting, Greeley, CO.

Gilkey, D. (2009, May 26-28). Enhancing translation and dissemination through agricultural partnerhsips. Presented at the Farm Bureau Safety and Health Network Conference, Hilton Hotel, Fort Collins, CO.

Kirychuk, S., Reynolds, S., Koehncke, N., Lawson, J. A., Senthilselvan, A., Marciniuk, D., & Dosman, J. (2009, May 17). Respiratory symptoms and levels of endotoxin and dust are not consistent between cage and floor-housed poultry operations. Presented at the American Thoracic Society, San Diego, CA.

Kolstrup, C., Douphrate, D., Pinzke, S., Stål, M., Lundqvist, P., Rosecrance, J., & Reynolds, S. J. (2010, August 29-September 3). Musculoskeletal Symptoms Among U.S. and Swedish Dairy Workers. Presented at the Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders, Angers, France.

Liu, J., & Ayers, P. (2007). Feasibility and efficacy of use of ROPS on ATV in farm. Presented at the 2007 ASABE Conference, Minneapolis, MN.

Merryweather, A., Pate, M. (2011, August 7-11). Self-Reported Tractors Operator Falls, Ergonomics and Musculoskeletal Pain. Presented at the ASABE Annual International Meeting, Louisville, KY.

Merryweather, A., Pate, M. (2011, August 7-11).Tractor Mounting/Dismounting Biomechanics Related to Falls. Presented at the ASAB Annual International Meeting, Louisville, KY.

Mitchell, D., Schenker, M. B., Armitage, T., Bennett, D., Tancredi, D., Eastman, C., . . . Mitloehner, F. (2011, September 7-9). Are respiratory decrements associated with exposure to particles including

endotoxins on large California dairies? Presented at the EPICOH International Conference on Epidemiology in Occupational Health, Oxford, UK.

Motteram, R. English version of video “Creating Safety Culture in Livestock Operations” presented at three spring safety association sponsored safety meetings in Burlington, Sterling and Pueblo, Colorado. 2012

Nonnenmann, M. W., Choudhry, A., Mehaffy, J., Douphrate, D., Levin, J. L., Gilmore, K., & Reynolds, S. J. (2012, August 27-29). Evaluation of a parlor washing system to reduce exposure to inhalable aerosols during dairy parlor work--A pilot study. Presented at the Nordic Meeting on Agricultural Occupational Health and Safety, Ystad, Sweden.

Pate, M. (2011, June 26-30, 2011). Estimation of the Frequency, Severity and Primary Causative Factors Associated with Injuries and Fatalities involving Confined Spaces in Agriculture. Presented at the ISASH, Boise, Idaho.

Pate, M. (2011). Farm Owner/Operators' Perceptions of Risk Associated with Confined Spaces in Agriculture. Presented at the ASABE Annual International Meeting, Louisville, KY.

Patil, A., Gilkey, D. P., Rosecrance, J., & Douphrate, D. (2010). Risk exposure assessment of dairy parlor workers. Presented at the Proceedings of the Human Factors and Ergonomics Society, 54th Annual Meeting.

Quijano, L. (2011). Seasonal and migrant farmworker stress; mental and physical health implications. Presented at the HICAHS dairy Board Meeting. Fort Collins, CO.

Rautiainen, R., Sprince, N. L., Donham, K., Ohsfeldt, R., Burmeister, L. F., Reynolds, S., & Zwerling, C. (2008). Lost time from injuries and occupational diseases in agriculture in Finland. Presented at the National Institute for Farm Safety Conference.

Reynolds, S., Burch, J., Wagner, S., Svendsen, E., Siegel, P., von Essen, S., . . . Koehncke, N. (2009, January 17). Endotoxin Exposure, Immune Markers, and Pulmonary Function in Agricultural Workers in Colorado and Nebraska. Presented at the Rocky Mountain American college of Occupational and Environmental medicine Conference, Denver, CO.

Reynolds, S., Burch, J., Wagner, S., Svendsen, E., Siegel, P., von Essen, S., Koehncke, N. (2009). Endotoxin Exposure, Inflammation Markers, and Pulmonary Function among Agricultural Workers in Colorado and Nebraska. Presented at the U.S.A AIOH 27th Conference Canberra 2009, New and Emerging Issues.

Reynolds, S., Liu, J., Anyaegbunam, C., Cole, H., Purschwitz, M., Galvin, K., & Ayers, P. (2008, July 29). NIOSH Agricultural Centers--National Agricultural Tractor Safety Initiative. Presented at the NORA Symposium 2008: Public Market for Ideas and Partnerships, Denver, CO.

Reynolds, S. J. (2008, November 13). Panel: Bioaerosols in Dairy Barns. Presented at the New Paths, Health and Safety in Western Agriculture, Cel Elum, WA.

Reynolds, S. J. (2008, September 25-26). Roundtable discussion on NIOSH Ag Centers and ERCs. Presented at the Western States Occupational Network (WestON), Denver, CO.

Reynolds, S. J. (2009, May 27). HICAHS overview. Presented at the Farm Bureau Safety and Health Network Conference, Fort Collins, CO.

Reynolds, S. J. (2009, May 27). Prospective study of occupational lung diseases and endotoxin exposure in new dairy workers. Presented at the Farm Bureau Safety and Health Network Conference, Fort Collins, CO.

Reynolds, S. J. (2009, May 27). Summary of NIOSH National Agricultural Tractor Safety Initiative. Presented at the Farm Bureau Safety and Health Network Conference, Fort Collins, CO.

Reynolds, S. J. (2011, May 4). What's hanging in dairy; avoiding udder disaster: High Plains Intermountain Dairy Health and Safety Initiatives-Projects and Partnerships. Presented at the NFMC, Marshfield, WI.

Reynolds, S. J., Campbell, C., Towle, M., Warner, A., Kiefer, M., Ray, B., & Comstock, N. (2011, June). Investigation of an Escherichia coli O111 outbreak at a state-run correctional facility dairy facility. Presented at the National Symposium on Agriculture, Forestry and Fishing Health and Safety, Boise, ID.

Reynolds, S. J., Clark, M. L., Davidson, M., Keefe, T., Mehaffy, J., Bradford, J., . . . Poole, J. A. (2011, June). Agricultural dust exposures and pulmonary function among grain elevator, cattle feedlot, dairy, and corn farm workers in Colorado and Nebraska. Presented at the National Symposium on Agriculture, Forestry and Fishing Health and Safety, Boise, ID.

Reynolds, S. J., Clark, M. L., Davidson, M., Keefe, T., Mehaffy, J., Bradford, J., . . . Poole, J. A. (2011, August 22-24). Exposure to endotoxin, muramic acid, ergosterol and effects on pulmonary function among western dairy workers. Presented at the Irish Meeting on Agricultural Occupational Safety and Health, Dublin, Ireland.

Reynolds, S. J., Clark, M. L., Davidson, M., Keefe, T., Mehaffy, J., Bradford, M., . . . Reynolds, S. J. (2012, August 27-29). Exposures to organic aerosols and effects on pulmonary function among western US dairy workers. Presented at the Nordic Meeting on Agricultural Occupational Health and Safety, Ystad, Sweden.

Reynolds, et. al. (2010). Incorporating occupational health into a public health investigation of an Escherichia coli O111 outbreak associated with a correctional dairy facility. Western Regional Epidemiology Network Conference. Ashland, OR.

Reynolds, S. J., Cranmer, B., Keefe, T., Mehaffy, J., Martinez, A. S., Bradford, M., . . . Von Essen, S. (2009). Endotoxin exposure and respiratory outcomes among dairy, cattle feedlot, and grain elevator workers in Colorado and Nebraska. Paper presented at the Thomas L. Petty Lung Conference 52nd Annual Meeting "The Environment and the Lung: Detection, Prevention, and Mechanisms of Disease".

Reynolds, S. J., Cranmer, B., Keefe, T., Mehaffy, J., Serrano Martinez, A., Bradford, M., . . . Von Essen, S. (2008, October 19). Endotoxin exposure and respiratory outcomes among dairy, cattle feedlot, and grain elevator workers in Colorado and Nebraska. Paper presented at the Public Health and the Agricultural Rural Ecosystem, Saskatchewan, Saskatoon, Canada.

Reynolds, S. J., Saito, R., Mehaffy, J., Cranmer, B., Tessari, J., Keefe, T., . . . Koehncke, N. (2008, October 20). Variability of Endotoxin in Agricultural Environments. Presented at the Public Health and the Agricultural Rural Ecosystem, Saskatchewan, Saskatoon, Canada.

Reynolds, S.J. et. al. (2011). Integrating Occupational Health with Mainstream Public Health: Investigation of an Escherichia Coli O111 Outbreak, Colorado 2010. Council of State and Territorial Epidemiologists (CSTE) Annual Conference, Pittsburgh, PA.

Reynolds, S.J., Davidson, M.E. (2011). Biofuels: An emerging occupational health and safety issue. Presented at the MAP ERC Energy Summit. Denver, CO, April 14.

Reynolds, S.J. (2009). Endotoxin exposure, inflammation markers, and pulmonary function among agricultural workers in Colorado and Nebraska. Presented at the Australian Institute of Occupational Hygienists. Canberra, Australia, December 7.

Rosecrance, J., & Douphrate, D. (2008, November 11-13). Ergonomics and dairy operations. Presented at the New Paths Conference: Health and Safety in Western Agriculture, Cel Elum, WA.

Rosecrance, J., & Douphrate, D. (2010, September 16-18). Hand and wrist disorders among US poultry processing workers. Presented at the International Conference of Work Safety and Risk Prevention in Agri-food and Forest Systems, Ragusa Ibla Campus, Italy.

Rosecrance, J., Douphrate, D., Gilkey, D. P., Reynolds, S., Wallace, W., & Gober, J. (2009, November 5-9). The industrialization of agricultural operations: Injuries among dairy workers. Presented at the APA and NIOSH Work and Stress Conference, San Juan, Puerto Rico.

Rosecrance, J., Douphrate, D., & Patil, A. (2010, August 29- September 3). Carpal tunnel syndrome among US dairy parlor workers. Presented at the Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders, Angers, France.

Saito, R., Mehaffy, J., Cranmer, B., Tessari, J., Keefe, T., Von Essen, S., . . . Reynolds, S. (2008, June 4). Determinants of exposure to dust and endotoxins in four agricultural environments. Presented at the AIHCE, Minneapolis, MN.

Schwatka, N., Ermann, E., Hoffmeister, K., & Rosecrance, J. (2010). Safety climate in agriculture. Presented at the Proceedings of the Human Factors and Ergonomics Society, 54th Annual Meeting.

Stallones, L. (2010, August 13). History of injury prevention in the US and the role of regional injury prevention research centers. Presented at the digital Human Research Center, National Institute of Advanced Industrial Science and Technology, Tokyo, Japan.

Stallones, L., & Beseler, C. (2008, June 9-13). Cohort study of the association between pesticide poisoning and depression. Presented at the Epidemiology International Conference Occupational Health-Neurotoxicology Environmental Occupational Health Joint Conference, San Jose, Costa Rica.

Stallones, L., & Xiang, H. (2008, June 9-13). Work-related injuries among US immigrant workers. Presented at the Epidemiology International Conference Occupational Health-Neurotoxicology Environmental Occupational Health Joint Conference, San Jose, Costa Rica.

Steneroden, K., Hill, A., Knight, A., Reynolds, S. J., & Salman, M. (2011). Infectious and zoonotic disease control strategies in Western US animal shelters: An epidemiological approach and its application. Presented at the International Symposium on Veterinary Epidemiology and Economics.

Webinars, Continuing Education, Lectures, Multimedia

Campbell, C., Comstock, N., Keifer, M., Ray, B., Reynolds, S. J., Towle, M., & Warner, A. (November 9, 2011). Epidemiologic and occupational investigation of an Escherichia coli O111 outbreak associated with a correctional facility dairy--Colorado 2010 [Webinar]: Agrisafe.

Creating Safety Culture in Livestock Operations video (9-minutes) produced by the HICAHS and the Colorado Livestock Association in English and Spanish. Distributed to more than 250 (as of 1/2012) livestock and dairy producers in the Mountain West states and posted on YouTube: http://www.youtube.com/watch?v=LSZMrAp8xT4

Douphrate, D., & Fry, M. (March 1, 2011). Incorporating Lean Six Sigma into Occupational Health and Safety [Webinar]: American Conference of Governmental Industrial Hygienists.

Hagevoort, G.R., et. al. (2011). Considering Human and Animal Safety: Dairy Safety Training for Dairy Producers [DVD. English and Spanish]. HICAHS Translation Project.

Hagevoort, G.R., et. al. (January, 2012). Creating Safety Culture in Livestock Operations [DVD. English and Spanish]. Uploaded to YouTube April, 2012. Presented in Burlington, Sterling, and Pueblo, CO.

Reynolds, S. J. (December 10, 2009). Overview of HICAHS an Endotoxin Exposure, Inflammation Markers, and Pulmonary Function among Agricultural Workers in Colorado and Nebraska, U.S.A. [Seminar]. University of Western Sydney, Sydney, Australia.

Reynolds, S. J. (May 12, 2008). Agricultural dusts and respiratory disease [Webinar]: University of Texas Health Sciences Center at Tyler, Innovative Training Experiences for Occupational Medicine Residents in Non-Urban and Agricultural Settings.

Reynolds, S. J. (May 12, 2008). Endotoxin exposure and genetic factors in organic dust lung disease [Webinar]: University of Texas Health Sciences Center at Tyler, Innovative Training Experiences for Occupational Medicine Residents in Non-Urban and Agricultural Settings.

Reynolds, S.J. (December 6, 2009). Endotoxin Sampling and Analysis [Professional Development Course, 3.5 hours]. Australian Institute for Occupational Hygiene. Canberra, Australia.

Reynolds, S.J. (November 2, 2011). Master Class. Aarhus Universitet, Aarhus, Denmark.

Reynolds, S.J. (February 26, 2008). Public Health in Armenia. CSU International Brown Bag. Fort Collins, CO.

Reynolds, S.J. (February 22, 2008). CDPHE Agricultural Air Quality Technical Workgroup. Denver, CO.

Reynolds, S.J. (February 19, 2008). Colorado Livestock Association: Improving Communication Between CLA and CSU. Fort Collins, CO.

Reynolds, S.J. (November 3, 2007). Environmental Exposures. Bighorn Fellows Reunion, Colorado State University. Fort Collins, CO.

Reynolds, S.J. (February 22, 2007). Health and Safety Risk Management. Colorado Agriculture Big and Small. Greeley, CO.

Reynolds, S.J. (February 13, 2007). Agricultural Health and Safety. Rural Health Grand Rounds, University of Colorado School of Medicine. Denver, CO.

Reynolds, S.J. (February 12, 2007). HICAHS. Fu Chen Catholic University (Taiwan) Visitors, CSU. Fort Collins, CO.

Trade Publications

Douphrate, D. (2011, June). Dairy Farm Safety and OSHA--Approaches for Effective Management and Worker Training, Utah State University Dairy Extension Newsletter.

Douphrate, D. (2011, September). Special Issue: Dairy Farm Safety and OSHA--Approaches for Effective Management and Worker Training, New Mexico State University Dairy Extension Newsletter.

Douphrate, D. (2011, September). Special Issue: Dairy Farm Safety and OSHA--Approaches for Effective Management and Worker Training, New Mexico State University Dairy Extension Newsletter.

Douphrate, D., Rosecrance, J., Reynolds, S. J., Buchan, V., & Cole, H. (March, 2010). Tractor mounting and dismounting injuries: a common but under-addressed problem in agriculture, AgConnections.

Douphrate, D. & Rosecrance, J. (2010) What you need to know about OSHA before OSHA needs to know about you.

Rosecrance, J. & Chen, P. (2010). SMART strategy: Partnering with the Colorado Corn Grower's Association. AgConnections, Volume 5.

Rosecrance, J., Chen, P., O'Keefe., Lamm, D., Borges, D., Ermann, E. (2010). FarmInsure Worker's Comp Safety Information Packet—Safety Video (Spanish).

Rosecrance, J., Chen, P., O'Keefe., Lamm, D., Borges, D., Ermann, E. (2010). FarmInsure Worker's Comp Safety Information Packet—Safety Behavior Checklist (Spanish).

Rosecrance, J., Chen, P., O'Keefe., Lamm, D., Borges, D., Ermann, E. (2010). FarmInsure Worker's Comp Safety Information Packet—Emergency Information Cards (Spanish).

Reports

Campbell, C., Kiefer, M., & Reynolds, S. J. (2010). Occupational Investigation of an Escherichia coli O111 outbreak at the Colorado Department of Corrections Four Mile Correctional Facility: National Institute for Occupational Safety and Health Western States Office and the High Plains Intermountain Center for Agricultural Health and Safety at Colorado State University.

Reynolds, S. J., & et al. (2007). National Agricultural Tractor Safety Initiative: Final Progress Report and Recommendations.

ACE Reports

Buchan, V. & Danhoff, K. (January, 2011). *The NIOSH Agricultural Center Initiative Evaluation Project Fiscal Year 2010 Report.* HICAHS, Colorado State University. Fort Collins, CO.

Buchan, V. & Holmquist-Johnson, H. (January, 2010). *NIOSH Agricultural Center Initiative Evaluation Project fiscal year 2009 report.* HICAHS, Colorado State University. Fort Collins, CO.

Buchan, V. & Holmquist-Johnson, H. (January, 2009). *NIOSH Agricultural Center Initiative Evaluation Project fiscal year 2008 report.* HICAHS, Colorado State University. Fort Collins, CO.

Buchan, V. & Holmquist-Johnson, H. (January, 2008). *NIOSH Agricultural Center Initiative Evaluation Project fiscal year 2007 report.* HICAHS, Colorado State University. Fort Collins, CO.

Buchan, V. & Holmquist-Johnson, H. (January, 2007). *The NIOSH Agricultural Center Initiative Evaluation Project Fiscal Year 2006 Report.* (Contract # 212-200409852). HICAHS, Colorado State University. Fort Collins, CO.

Standards

ANSI/ASABE. (2011). Ventilating Manure Storages to Reduce Entry Risk (S607 OCT2010).

Testimony

Reynolds, S.J. (2008). Invited testimony regarding Occupational Health and Agricultural Health and Safety. Robert Wood Johnson Commission to Build a Healthier America, field hearing on "Workplace Wellness Initiatives, Occupational Health and Safety and Conditions and Benefits of Work." December 10.

Student Theses

*Basinas, I. (2011). Dust and Endotoxin Exposure in Animal Farming Population. Formulating the Basis for a Model-based Exposure Assessment Approach. PhD, Aarhus Universitet, Aarhus, Denmark.

Busaker, A. (2008). An Epidemiologic Evaluation of Risk Factors Associated with Asthma Severity and Phenotypes. PhD, Colorado State University, Fort Collins, CO.

Cragin, L. A. (2009). Menstrual Cycle Characteristics in Women Exposed to Atrazine in Drinking Water. PhD, Colorado State University, Fort Collins, CO.

Dartt, A. (2010). Ergonomic exposure assessment: a study of rater reliability, method reliability, and sampling strategy. PhD, Colorado State University.

Dauphin, J. (2007). Farm Safety in Lincoln County Oklahoma. MS, Colorado State University, Fort Collins, CO.

Douphrate, D. (2008). Analysis of agriculture injuries using workers' compensation data. PhD, Colorado State University, Fort Collins, CO.

Funk, S. (2011). Evaluation of seasonal ventilation changes and their effect on ambient dust, endotoxin and bioaerosol concentrations in a dairy parlor. MS, Colorado State University, Fort Collins, CO.

Hsuan, Y. (2008). The relationship between suicides and agricultural usage of organophosphate insecticides in Colorado, 1997-2002 MS, Colorado State University, Fort Collins, CO.

Kirychuk, S. (2008). Particulate distribution and relationship to endotoxin in poultry production operations. PhD, University of Saskatchewan.

*Leff, M. (2008). An exploration of depressive symptoms and drinking patterns among Colorado farm residents and the impact of these on farm-work injury. PhD, Colorado State University.

Lester, B. (2007). Comparison of Occupational and Environmental Exposures at Colorado Dairies PhD, Colorado State University, Fort Collins, CO.

Luna, B. (2009). Endotoxin air sampling : a comparison between the Recombinant Factor C (rFC) and Limulus Amebocyte Lysate (LAL) endotoxin assays MS, Colorado State University, Fort Collins, CO.

Marcillac. (2007). Characterization and quantification of air emissions from dairies PhD, Colorado State University, Fort Collins, CO.

Ndonga, M. (2012). A Portable Spectrometer for Measuring Inhalable Aerosol Size Distributions. A Portable Spectrometer for Measuring Inhalable Aerosol Size Distributions. MS, Colorado State University, Fort Collins, CO.

Paulson, Rob. (In Progress). MS, Colorado State University, Fort Collins, CO.

Robinson, Douglas. (2012). Evaluation of Bacterial Sampling Methods for Use with the Bacterial Tag-Encoded Flexible (FLX) Amplicon Pyrosequencing (bTEFAP) Technique: A Standardized Approach. In progress. MS, Colorado State University, Fort Collins, CO.

*Rosales, M. (2008). Life in the field: Migrant farm workers perceptions of work related injuries. PhD, Colorado State University, Fort Collins, CO.

Saito, R. (2008). Analyses and exposure assessment of bacterial endotoxin in agricultural environments PhD, Colorado State University, Fort Collins, CO.

Sorrentino, J. (2011). A comparison of the Limulus amebocyte lysate (LAL) and recombinant Factor C (rFC) endotoxin bioassays: Characterization of aerosols and settled dust on a sheep farm. MS, Colorado State University, Fort Collins, CO.

Steneroden, K. (2009). A holistic approach to veterinary public health in animal shelters and other sites PhD, Colorado State University, Fort Collins, CO.

* These students were not funded by HICAHS, but they did conduct an agricultural project while their supervisor was working in HICAHS. All other projects were supported in part or whole through HICAHS funding.

Conference Leadership

HICAHS (January 24, 2012). Organizer and Host. Advisory Board Meeting. Fort Collins, CO.

Reynolds, S. J. (2012). Pre-Conference Workshop Organizer--Agricultural Health and Safety with Emphasis on Dairy, September 29-30. 11th World Conference on Injury Prevention and Safety Promotion, Wellington, NZ. October 1-4.

HICAHS (2011). Founder and Organizer. HICAHS International Dairy Research Consortium. Fort Collins, CO.

HICAHS (2011). Organizer and Host. Dairy Advisory Board Meeting. Fort Collins, CO.

WestOn Conferece (September 23, 2011). Denver, CO.

Reynolds, S.J. (2011, August 22-25). Organizer, session moderator, International Dairy Initiative meetings organizer. Irish Meeting on Agricultural Occupational Health and Safety.

Reynolds, S.J. (July 11-13, 2011). Conference organizer and moderator. HICAHS Internaitonal Dairy Research Consortium—Inaugural Meeting.

Reynolds, S.J. (2010, May 22-27). Chair, ACGIH—Opening Session. American Industrial Hygiene Conference and Exhibition.

HICAHS (December 8, 2010). Organizer and Host. Advisory Board Meeting. Fort Collins, CO.

Rosecrance, J. (2010). Organizer and Host. ERC Interdisciplinary Forum on Measurement Systems for Occupational Health and Safety Research. Colorado State University and University of Iowa. Fort Collins, CO.

Douphrate, D. (2010). What you need to know about OSHA before OSHA needs to know about you [workshop]. HICAHS, I-29 Dairy Consortium Safety Workshop, MN, IA, SD, NE.

Reynolds, S.J. (2009-2010). Member of ASHCA Membership and Strategic Planning Committee and ASHCA-NIOSH Joint Conference Committee., Be Safe, Be Profitable: Protecting Workers in Agriculture. Dallas, TX, January 26-28, 2010.

Reynolds, S.J. (2009-2010). Member of ASHCA Membership and Strategic Planning Committee and ASHCA-NIOSH Joint Conference Committee. Practical Safety and Health Risk Management in Production Agriculture, January 7, 2011.

HICAHS (2009). Founder and Organizer. Dairy Advisory Board Meeting. Fort Collins, CO.

Douprate, D. (2009, October 15-16). Agriculture Health and Safety Management using Lean Six Sigma, Utah State University and Utah Dairy Extension, Logan, UT.

HICAHS (2009, October 15-16). High Plains and Mountain Region Dairy Health & Safety Workshop Denver, CO.

HICAHS (April 20, 2009). Organizer and Host. Advisory Board Meeting. Fort Collins, CO.

Douphrate, D. (2009, September 28-29). High Plains and Mountain Region Dairy Health & Safety Workshop Denver, CO, October 15-16.

Rosecrance, J. (2009). Founder & Organizer. ERC Interdisciplinary Forum on Measurement Systems for Occupational Health and Safety Research. Colorado State University and University of Iowa. Iowa City, IA.

Reynolds, S.J. (2008, October 19-23). Organizing committee member. Public Health and the Agricultural Rural Ecosystem. Saskatoon, Saskatchewan, Canada.

HICAHS (February 20, 2008). Organizer and Host. Advisory Board Meeting. Fort Collins, CO.

HICAHS PUBLICATIONS BY SELECTED PROJECTS

HICAHS Dairy Initiatives

Journal Articles

Burch, J. B., Svendsen, E., Siegel, P. D., Wagner, S. E., von Essen, S., Keefe, T., Mehaffy, J., Martinez, A.S., Bradford, M., Baker, L., Cranmer, B., Saito, R., Tessari, J., Prinz, L., Andersen, C., Christensen, O., Koehncke, N., Reynolds, S. J. (2009). Endotoxin Exposure and Inflammation Markers Among Agricultural Workers in Colorado and Nebraska. Journal of Toxicology and Environmental Health, Part A: Current Issues, 73(1), 5 - 22.

Choudhry, A., Reynolds, S. J., Mehaffy, J., Levin, J. L., Gilmore, K., Douphrate, D., & Nonnenmann, M. W. (2012). Evaluation of parlor washing as an intervention for decreasing occupational exposure to organic dust and endotoxin among dairy parlor workers--a pilot study. Journal of Occupational & Environmental Health, In Press.

Comstock, N., Towle, M., Warner, A., Reynolds, S. J., Durso, L., Campbell, C., Kiefer, M., Bosch, S. A. (2012). Epidemiologic and occupational investigation of an Escherichia coli O111 outbreak associated with a correctional facility dairy--Colorado, 2010. Morbidity and Mortality Weekly Report (March 9, 2012).

Douphrate, D. I., Fethke, N. B., Nonnenmann, M. W., Rosecrance, J. C., & Reynolds, S. J. (2012). Full shift arm inclinometry among dairy parlor workers: A feasibility study in a challenging work environment. Applied Ergonomics, 43(3), 604-613. doi: 10.1016/j.apergo.2011.09.007

Douphrate, D. I., Rosecrance, J. C., Stallones, L., Reynolds, S. J., & Gilkey, D. P. (2009). Livestock-handling injuries in agriculture: An analysis of Colorado workers' compensation data. American Journal of Industrial Medicine, 52(5), 391-407. doi: 10.1002/ajim.20686

Douphrate, D. I., Nonnenmann, M. W., & Rosecrance, J. C. (2009). Ergonomics in Industrialized Dairy Operations. Journal of Agromedicine, 14(4), 406 - 412. doi: 10.1080/10599240903260444

O'Shaughnessy PO, Lo J, Golla V, Nakatsu J, Tillery MI, Reynolds SJ: Comparison of Aerosol Samplers Relative to the Inhalable and Respirable Collection Criteria. JOEH 4:237-245, 2007.

Patil, A., Rosecrance, J., Douphrate, D., & Gilkey, D. (2012). Prevalence of carpal tunnel syndrome among dairy workers. American Journal of Industrial Medicine, 55(2), 127-135. doi: 10.1002/ajim.21995

Poole, J. A., Dooley, G. P., Saito, R., Burrell, A. M., Bailey, K. L., Romberger, D. J., Mehaffy, J., Reynolds, S. J. (2010). Muramic Acid, Endotoxin, 3-Hydroxy Fatty Acids, and Ergosterol Content Explain Monocyte and Epithelial Cell Inflammatory Responses to Agricultural Dusts. Journal of Toxicology and Environmental Health, Part A: Current Issues, 73(10), 684 - 700. doi: 10.1080/15287390903578539

Plummer, L. E., Pinkerton, K. E., Reynolds, S., Meschke, S., Mitloehner, F., Bennett, D., Schenker, M. B. (2009). Aerosols in the Agricultural Setting. Journal of Agromedicine, 14(4), 413 - 416. doi: 10.1080/10599240903260527

Reynolds, S., Clark, M. L., Koehncke, N., Von Essen, S., Prinz, L., Keefe, T., Mehaffy, J., Bradford, M., Cranmer, B., Davidson, ME., Yang, IV., Burch, J. B. (2012). Pulmonary function reductions among potentially susceptible subgroups of agricultural workers in Colorado and Nebraska. Journal of Occupational & Environmental Medicine, In Press.

Reynolds, S. J., Nakatsu, J., Tillery, M., Keefe, T., Mehaffy, J., Thorne, P. S., Donham, K., Nonnenmann, M., Golla, V., O'shaughnessy, P. (2009). Field and Wind Tunnel Comparison of Four Aerosol Samplers Using Agricultural Dusts. Annals of Occupational Hygiene, 53(6), 585-594. doi: 10.1093/annhyg/mep021

Saito, R., Cranmer, B. K., Tessari, J. D., Larsson, L., Mehaffy, J. M., Keefe, T. J., & Reynolds, S. J. (2009). Recombinant Factor C (rFC) Assay and Gas Chromatography/Mass Spectrometry (GC/MS) Analysis of Endotoxin Variability in Four Agricultural Dusts. Annals of Occupational Hygiene, 53(7), 713-722. doi: 10.1093/annhyg/mep052

Thorne PS, Perry SS, Saito R, O'Shaughnessy PT, Mehaffy J, Metwali N, Keefe T, Donham KJ, Reynolds SJ. Evaluation of the Limulus Amebocyte Lysate and Recombinant Factor C Assays for Assessment of Airborne Endotoxin. AEM August 2010, 76(15) 4988-4995.

Conferences /Presentations

Douphrate D, Fethke N Hagevoort R, Nonnenmann M, Mixco A, Tellechea-Sanchec T, Rosecrance J, Reynolds S (2012, September 3-6). Ergonomic exposures of posture and muscle activity among US large-herd dairy parlor workers. International Conference on Safety, Health and Welfare in Agriculture and Agro-food Systems--SHWA 2012, Ragusa Ibla Campus- Italy.

Douphrate D, Fethke N Hagevoort R, Nonnenmann M, Mixco A, Tellechea-Sanchec T, Rosecrance J, Reynolds S (2012, August 27-29). Ergonomic exposures of posture and muscle activity among US large-herd dairy parlor workers. Presented at the Nordic Meeting on Agricultural Occupational Health and Safety, Ystad, Sweden.

Davidson, M., Clark, M. L., Keefe, T., Mehaffy, J., Bradford, M., Roman-Muniz, N., . . . Reynolds, S. J. (2012, August 27-29). Similar exposure group (task) based analysis of bioaerosol exposures in dairies. Presented at the Nordic Meeting on Agricultural Occupational Health and Safety, Ystad, Sweden.

Douphrate, D. (2011, April 5-6). Dairy farm safety and OSHA--Approaches for effective management and worker training. Presented at the Dairy Calf & Heifer Association Annual Conference, Lake Geneva, Wisconsin.

Douphrate, D. (2011, December 7-8). Incorporating workers safety into daily farm management activities. Presented at the 2011 Dairy Summit, Wisconsin Dells, WI.

Douphrate, D., Kolstrup, C., Rosecrance, J., Reynolds, S., Lundqvist, P., Pinske, S., & Stal, M. (2010, August 29-September 3). European and US dairy production: challenges of work-related musculoskeletal disorder prevention. Presented at the Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders, Angers, France.

Douphrate, D., Nonnenmann, M. W., Reynolds, S. J., Levin, J. L., Buchan, V., & Rosecrance, J. (2010, January 26-28, 2010). The High Plains and Mountain Region Dairy Health and Safety Workshop: A participatory Approach to Identify Research and Outreach Needs in the Dairy Industry. Presented at the Agriculture and Safety Health Council of America, Dallas, TX.

Douphrate, D., & Rosecrance, J. (2009, June 11-12). Ergonomics needs assessment of large-herd dairy parlor operations. Presented at the Proceedings of the 21st Annual International Occupational Ergonomics and Safety Conference, Dallas, TX.

Douphrate, D., & Rosecrance, J. (2009, June 11-12). Ergonomics needs assessment of large-herd dairy parlor operations. Presented at the 21st Annual International Occupational Ergonomics and Safety Conference, Dallas, TX.

Douphrate, D., & Rosecrance, J. (2010, September 16-18). Livestock handling injuries in the United States. Presented at the International Conference of Work Safety and Risk Prevention in Agro-food and Forest Systems, Ragusa Ibla Campus, Italy.

Douphrate, D., & Rosecrance, J. (2010, September 16-18). Industrialization of dairy operations: Ergonomic implications. Presented at the International Conference of Work Safety and Risk Prevention in Agro-food and Forest Systems, Ragusa Ibla Campus, Italy.

Douphrate, D., Rosecrance, J., Fethke, N., & Nonnenmann, M. W. (2010, August 29-September 3). Full-shift upper extremity direct exposure assessment of US dairy parlor workers. Presented at the Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders, Angers, France.

Douphrate, D., Rosecrance, J., Kolstrup, C., Pinske, S., & Stal, M. (2010). Musculoskeletal disorders and ergonomic challenges in modern dairy production: European and US perspectives. Presented at the Seventh Internaitonal Conference on Prevention of Work-Related Musculoskeletal Disorders, Angers, France.

Douphrate, D., Rosecrance, J., & Reynolds, S. (2008, October 19-23). Dairy farm injuries: an analysis of workers' compensation data. Presented at the Sixth International Symposium on Public Health and the Agricultural Rural Ecosystem, Saskatoon, SK, Canada.

Douphrate, D., & Rosecrance, J. (2008, November 11-13). Livestock-handling injuries in Colorado agriculture. Presented at the New Paths Conference: Health and Safety in Western Agriculture, Cle Elum, WA.

Douphrate, D., Rosecrance, J., Stallones, L., Reynolds, S., & Gilkey, D. (2008). The use of workers' compensation data to investigate livestock handling injuries in agriculture. Presented at the NORA Symposium 2008: Public Market for Ideas and Partnership, Denver, CO.

Funk, S., Reynolds, S. J., Volckens, J., Dowd, S., & Nonnenmann, M. W. (2011, May 16-19). Evaluation of seasonal ventilation changes and their effect on ambient dust, endotoxin and bioaerosol concentrations in a dairy parlor. Presented at the American Industrial Hygiene Conference and Exposition, Portland, OR.

Kolstrup, C., Douphrate, D., Pinzke, S., Stål, M., Lundqvist, P., Rosecrance, J., & Reynolds, S. J. (2010, August 29-September 3). Musculoskeletal Symptoms Among U.S. and Swedish Dairy Workers. Presented at the Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders, Angers, France.

Mitchell, D., Schenker, M. B., Armitage, T., Bennett, D., Tancredi, D., Eastman, C., . . . Mitloehner, F. (2011, September 7-9). Are respiratory decrements associated with exposure to particles including endotoxins on large California dairies? Presented at the EPICOH International Conference on Epidemiology in Occupational Health, Oxford, UK.

Nonnenmann, M. W., Choudhry, A., Mehaffy, J., Douphrate, D., Levin, J. L., Gilmore, K., & Reynolds, S. J. (2012, August 27-29). Evaluation of a parlor washing system to reduce exposure to inhalable aerosols during dairy parlor work--A pilot study. Presented at the Nordic Meeting on Agricultural Occupational Health and Safety, Ystad, Sweden.

Patil, A., Gilkey, D. P., Rosecrance, J., & Douphrate, D. (2010). Risk exposure assessment of dairy parlor workers. Presented at the Proceedings of the Human Factors and Ergonomics Society, 54th Annual Meeting.

Quijano, L. (2011). Seasonal and migrant farmworker stress; mental and physical health implications. Presented at the HICAHS dairy Board Meeting. Fort Collins, CO.

Reynolds, S. J. (2008, November 13). Panel: Bioaerosols in Dairy Barns. Presented at the New Paths, Health and Safety in Western Agriculture, Cel Elum, WA.

Reynolds, S. J. (2009, May 27). Prospective study of occupational lung diseases and endotoxin exposure in new dairy workers. Presented at the Farm Bureau Safety and Health Network Conference, Fort Collins, CO.

Reynolds, S., Burch, J., Wagner, S., Svendsen, E., Siegel, P., von Essen, S., . . . Koehncke, N. (2009). Endotoxin Exposure, Inflammation Markers, and Pulmonary Function among Agricultural Workers in Colorado and Nebraska [Keynote]. Presented at the U.S.A AIOH 27th Conference Canberra 2009, New and Emerging Issues.

Reynolds, et. al. (2010). Incorporating occupational health into a public health investigation of an Escherichia coli O111 outbreak associated with a correctional dairy facility. Western Regional Epidemiology Network Conference. Ashland, OR.

Reynolds, S. J. (2011, May 4). What's hanging in dairy; avoiding udder disaster: High Plains Intermountain Dairy Health and Safety Initiatives-Projects and Partnerships. Presented at the NFMC, Marshfield, WI.

Reynolds, S. J., Campbell, C., Towle, M., Warner, A., Kiefer, M., Ray, B., & Comstock, N. (2011, June). Investigation of an Escherichia coli O111 outbreak at a state-run correctional facility dairy facility. Presented at the National Symposium on Agriculture, Forestry and Fishing Health and Safety, Boise, ID.

Reynolds, S.J. et. al. (2011). Integrating Occupational Health with Mainstream Public Health: Investigation of an Escherichia Coli O111 Outbreak, Colorado 2010. Council of State and Territorial Epidemiologists (CSTE) Annual Conference, Pittsburgh, PA.

Reynolds, S. J., Clark, M. L., Davidson, M., Keefe, T., Mehaffy, J., Bradford, J., . . . Poole, J. A. (2011, June). Agricultural dust exposures and pulmonary function among grain elevator, cattle feedlot, dairy, and corn farm workers in Colorado and Nebraska. Presented at the National Symposium on Agriculture, Forestry and Fishing Health and Safety, Boise, ID.

Reynolds, S. J., Clark, M. L., Davidson, M., Keefe, T., Mehaffy, J., Bradford, J., . . . Poole, J. A. (2011, August 22-24). Exposure to endotoxin, muramic acid, ergosterol and effects on pulmonary function among western dairy workers. Presented at the Irish Meeting on Agricultural Occupational Safety and Health, Dublin, Ireland.

Reynolds, S. J., Clark, M. L., Davidson, M., Keefe, T., Mehaffy, J., Bradford, M., . . . Reynolds, S. J. (2012, August 27-29). Exposures to organic aerosols and effects on pulmonary function among western US dairy workers. Presented at the Nordic Meeting on Agricultural Occupational Health and Safety, Ystad, Sweden.

Reynolds, S. J. (2008, September 25-26). Roundtable discussion on NIOSH Ag Centers and ERCs. Presented at the Western States Occupational Network (WestON), Denver, CO.

Reynolds, S. J., Cranmer, B., Keefe, T., Mehaffy, J., Martinez, A. S., Bradford, M., . . . Von Essen, S. (2009). Endotoxin exposure and respiratory outcomes among dairy, cattle feedlot, and grain elevator workers in Colorado and Nebraska. Presented at the Thomas L. Petty Lung Conference 52nd Annual Meeting "The Environment and the Lung: Detection, Prevention, and Mechanisms of Disease".

Reynolds, S. J., Cranmer, B., Keefe, T., Mehaffy, J., Serrano Martinez, A., Bradford, M., . . . Von Essen, S. (2008, October 19). Endotoxin exposure and respiratory outcomes among dairy, cattle feedlot, and grain elevator workers in Colorado and Nebraska. Presented at the Public Health and the Agricultural Rural Ecosystem, Saskatchewan, Saskatoon, Canada.

Rosecrance, J., & Douphrate, D. (2008, November 11-13). Ergonomics and dairy operations. Presented at the New Paths Conference: Health and Safety in Western Agriculture, Cle Elum, WA.

Rosecrance, J., Douphrate, D., Gilkey, D. P., Reynolds, S., Wallace, W., & Gober, J. (2009, November 5-9). The industrialization of agricultural operations: Injuries among dairy workers. Presented at the APA and NIOSH Work and Stress Conference, San Juan, Puerto Rico.

Rosecrance, J., Douphrate, D., & Patil, A. (2010, August 29- September 3). Carpal tunnel syndrome among US dairy parlor workers. Presented at the Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders, Angers, France.

Seminars/Webinars/CE/Lectures/multimedia

Campbell, C., Comstock, N., Keifer, M., Ray, B., Reynolds, S. J., Towle, M., & Warner, A. (November 9, 2011). Epidemiologic and occupational investigation of an Escherichia coli O111 outbreak associated with a correctional facility dairy--Colorado 2010 [Webinar]: Agrisafe.

Reynolds, S.J. (December 6, 2009). Endotoxin Sampling and Analysis [Professional Development Course, 3.5 hours]. Australian Institute for Occupational Hygiene. Canberra, Australia.

Reynolds, S. J. (December 10, 2009). Overview of HICAHS an Endotoxin Exposure, Inflammation Markers, and Pulmonary Function among Agricultural Workers in Colorado and Nebraska, U.S.A. [Seminar]. University of Western Sydney, Sydney, Australia.

Reynolds, S. J. (May 12, 2008). Agricultural dusts and respiratory disease [Webinar]: University of Texas Health Sciences Center at Tyler, Innovative Training Experiences for Occupational Medicine Residents in Non-Urban and Agricultural Settings.Reynolds,

Reynolds, S.J. (February 19, 2008). Colorado Livestock Association: Improving Communication Between CLA and CSU. Fort Collins, CO.

Newsletters/trade publications

Douphrate, D. (2011, June). Dairy Farm Safety and OSHA--Approaches for Effective Management and Worker Training, Utah State University Dairy Extension Newsletter, Volume 2, Number 4 & 5.

Douphrate, D. (2011, September). Special Issue: Dairy Farm Safety and OSHA--Approaches for Effective Management and Worker Training, New Mexico State University Dairy Extension Newsletter, Volume 34, Number 3.

Douphrate, D. & Rosecrance, J. (2010) What you need to know about OSHA before OSHA needs to know about you.

Rosecrance, J. & Chen, P. (2010). SMART strategy: Partnering with the Colorado Corn Grower's Association. AgConnections, Volume 5.

Rosecrance, J., Chen, P., O'Keefe., Lamm, D., Borges, D., Ermann, E. (2010). FarmInsure Worker's Comp Safety Information Packet—Safety Video (Spanish).

Rosecrance, J., Chen, P., O'Keefe., Lamm, D., Borges, D., Ermann, E. (2010). FarmInsure Worker's Comp Safety Information Packet—Safety Behavior Checklist (Spanish).

Rosecrance, J., Chen, P., O'Keefe., Lamm, D., Borges, D., Ermann, E. (2010). FarmInsure Worker's Comp Safety Information Packet—Emergency Information Cards (Spanish).

Conference Leadership

Douphrate, D., et.al (2009). High Plains and Mountain Region Dairy Health & Safety Workshop Denver, CO, October 15-16.

Douprate, D. (2009, October 15-16). Agriculture Health and Safety Management using Lean Six Sigma, Utah State University and Utah Dairy Extension, Logan, UT.

Reynolds, S.J. (2011). Organizer, session moderator, International Dairy Initiative meetings organizer. Irish Meeting on Agricultural Occupational Health and Safety. August 22-25.

Reynolds, S. J. (2012). Pre-Conference Workshop Organizer--Agricultural Health and Safety with Emphasis on Dairy, September 29-30. Paper presented at the 11th World Conference on Injury Prevention and Safety Promotion, Wellington, NZ. October 1-4.

Reynolds, S.J. et al (July 11-13, 2011). Conference organizer and moderator. HICAHS International Dairy Research Consortium—Inaugural Meeting.

HICAHS (July 2011). Founder and Organizer. HICAHS International Dairy Research Consortium. Fort Collins, CO.

HICAHS (2009). Founder and Organizer. Dairy Advisory Board Meeting. Fort Collins, CO.

HICAHS (2011). Organizer and Host. Dairy Advisory Board Meeting. Fort Collins, CO.

Douphrate, D. (2010). What you need to know about OSHA before OSHA needs to know about you [workshop]. HICAHS, I-29 Dairy Consortium Safety Workshop, MN, IA, SD, NE.

Reports

Campbell, C., Kiefer, M., & Reynolds, S. J. (2010). Occupational Investigation of an Escherichia coli O111 outbreak at the Colorado Department of Corrections Four Mile Correctional Facility: National Institute for Occupational Safety and Health Western States Office and the High Plains Intermountain Center for Agricultural Health and Safety at Colorado State University.

Standards

ANSI/ASABE. (2011). Ventilating Manure Storages to Reduce Entry Risk (S607 OCT2010). Reynolds contributed

Educational Materials/DVD

Hagevoort, G.R., et. al. (2011). Considering Human and Animal Safety: Dairy Safety Training for Dairy Producers [DVD. English and Spanish]. HICAHS Translation Project.

Hagevoort, G.R., et. al. (January, 2012). Creating Safety Culture in Livestock Operations [DVD. English and Spanish]. Uploaded to YouTube April, 2012. Presented in Burlington, Sterling, and Pueblo, CO.

Motteram, R, Bend, R. (2012) Safety Culture for Livestock Employees." [DVD. English and Spanish]. HICAHS Translation Project. YouTube Video, uploaded English and Spanish versions April, 2012.

Graduate Students Trained – MS and PhD

Marcus Cusanelli, 2006, MS (Environmental and Radiological Health Sciences)
Evaluation of the Cyranose 320 Electronic Nose for Odor Identification at Dairy Farms
Reynolds Chair

Brad Lester, 2007 PhD (Environmental and Radiological Health Sciences)
Comparison of Occupational and Environmental Exposures at Colorado Dairies
Reynolds Chair

Nichole Marcillac, 2007, PhD (Animal Sciences)
Characterization and quantification of air emissions from dairies
Reynolds Committee Member

Rena Saito, 2008 PhD (Environmental and Radiological Health Sciences)
Analyses and exposure assessment of bacterial endotoxin in agricultural environments
Reynolds Chair

David Douphrate, 2008 PhD (Environmental and Radiological Health Sciences -Ergonomics)
Analysis of agriculture injuries using workers' compensation data
Rosecrance Chair Reynolds, Stallones Committee Members

Luna Bevine 2009 MS (Environmental and Radiological Health Sciences)
Endotoxin air sampling : a comparison between the Recombinant Factor C (rFC) and Limulus Amebocyte Lysate (LAL) endotoxin assays
Reynolds Chair

Sara Funk, 2011 MS (Environmental and Radiological Health Sciences)
Evaluation of seasonal ventilation changes and their effect on ambient dust, endotoxin and bioaerosol concentrations in a dairy parlor
Reynolds Chair

Ioannis Basins PhD 2011 (Aarhus Universitet, Aarhus Denmark)
Dust and Endotoxin Exposure in Animal Farming Population. Formulating the Basis for a Model-based Exposure Assessment Approach
Reynolds Opponent

Mwangi Ndonga 2012, MS (Environmental and Radiological Health Sciences)
A Portable Spectrometer for Measuring Inhalable Aerosol Size Distributions
Volckens Chair

Douglas Robinson, 2012, MS (Environmental and Radiological Health Sciences)
Evaluation of Bacterial Sampling Methods for Use with the Bacterial Tag-Encoded Flexible (FLX) Amplicon Pyrosequencing (bTEFAP) Technique: A Standardized Approach.
Reynolds Chair

HICAHS Pilot Program

Publications

Lori Cragin

Cragin LA, Kessner JS, Bachand AM, Boyd Barr D, Meadows JW, Krieg EF, Reif JS. (2011). Menstrual cycle characteristics and reproductive hormone levels in women exposed to atrazine in drinking water. Environmental Research, 111(8), 1293-301.

Cragin, LA (2009). Menstrual cycle characteristics in women exposed to atrazine in drinking water. Colorado State University). ProQuest Dissertations and Theses, Retrieved from http://search.proquest.com/docview/304862562?accountid=10223

David Douphrate

Douphrate, D. I., Fethke, N. B., Nonnenmann, M. W., Rosecrance, J. C., & Reynolds, S. J. (2012). Full shift arm inclinometry among dairy parlor workers: A feasibility study in a challenging work environment. Applied Ergonomics, 43(3), 604-613. doi: 10.1016/j.apergo.2011.09.007

Lawrence Goodridge

Goodridge, L. D. (2010). Designing Phage Therapeutics. Current Pharmaceutical Biotechnology, 11, 15-27.

Yang, H., Byelashov, O.A., Geornaras, I., **Goodridge, L.D**., Nightingale, K.K., Belk, K.E., Smith, G.C., & Sofos, J.N. (2010). Presence of antibiotic-resistant commensal bacteria in samples from agricultural, city, and national park environments evaluated by standard culture and real-time PCR methods. Canadian Journal of Microbiology, 56(9), 761-770.

Yang, Y.Y, Borch, T., Young, R.B., **Goodridge, L.D**., & Davis, J. G. (2010). Degradation Kinetics of Testosterone by Manure-Borne Bacteria: Influence of Temperature, pH, Glucose Amendments, and Dissolved Oxygen, Journal of Environmental Quality, 39, 1153-1160.

Willford, J., Mills, K., & **Goodridge, L. D.** (2009). Evaluation of Three Commercially Available ELISA Kits for Detection of Shiga Toxin Producing Escherichia coli. Journal of Food Protection, 72, 741-747.

Willford, J. & **Goodridge, L.D.** (2008). An Integrated Assay for Rapid Detection of Escherichia coli O157:H7 on Beef Samples. Food Protection Trends, 28, 468-472.

Bowling, M.B., Belk, K.E., Nightingale, K.K., **Goodridge, L.D**., Scanga, J.A., Sofos, J.N., Tatum, J.D., & Smith, G.C. (2007). Central Nervous System Tissue in Meat Products: An Evaluation of Risk, Prevention Strategies, and Testing Procedures, Advances in Food Nutrition, 53, 39-64.

William Hanneman

Hanneman, W.H., Tjalkens,R.B., Legare,M.E., Ritz, L. and Dooley, G.P. (to be published in 2012). The atrazine metabolite diaminochlorotriazine suppresses LH release from murine LβT2 cells by suppressing GnRH-induced intracellular calcium transients. Toxicological Sciences.

Andrew Merryweather

Merryweather, A., Pate, M., Vemparala, S. (2011).Tractor Mounting/Dismounting Biomechanics Related to Falls. Paper presented at the ASABE Annual International Meeting, Louisville, KY, August 7-11. Retrieved from http://elibrary.asabe.org/azdez.asp?JID=5&AID=37421&CID=loui2011&T=2

Merryweather, A., Pate, M., Vemparala, S. (2011). Self-Reported Tractors Operator Falls, Ergonomics and Musculoskeletal Pain. Paper presented at the ASABE Annual International Meeting, Louisville, KY, August 7-11. Retrieved from http://elibrary.asabe.org/azdez.asp?JID=5&AID=37790&CID=loui2011&T=2

Michael Pate

Pate, M. L. & Merryweather, A. S. (In-press 2012). Utah farm owner/operators' safety practices and risk awareness regarding confined space work in agriculture. Journal of Agricultural Safety and Health.

Jill Poole

Poole, J. A., & Romberger, D. J. (2012). Immunological and inflammatory responses to organic dust in agriculture. Current Opinion in Allergy and Clinical Immunology, 12(2), 126-132 doi: 110.1097/ACI.1090b1013e3283511d3283510e.

Poole, J. A., Wyatt, T. A., Kielian, T., Oldenburg, P., Gleason, A., Bauer, A., Golden, G., West, W.W., Sisson, J., Romberger, D. J. (2011). Toll-like receptor (TLR2) Regulates Organic Dust-Induced Airway Inflammation. The Journal of allergy and clinical immunology, 127(2), AB137.

Poole, J. A., Kielian, T., Wyatt, T. A., Gleason, A. M., Stone, J., Palm, K., West, W.W., Romberger, D. J. (2011). Organic dust augments nucleotide-binding oligomerization domain expression via an NF-κB pathway to negatively regulate inflammatory responses. American Journal of Physiology - Lung Cellular and Molecular Physiology, 301(3), L296-L306. doi: 10.1152/ajplung.00086.2011

Poole, J. A., Dooley, G. P., **Saito, R**., Burrell, A. M., Bailey, K. L., Romberger, D. J., Mehaffy, J., Reynolds, S. J. (2010). Muramic Acid, Endotoxin, 3-Hydroxy Fatty Acids, and Ergosterol Content Explain Monocyte and Epithelial Cell Inflammatory Responses to Agricultural Dusts. Journal of Toxicology and Environmental Health, Part A: Current Issues, 73(10), 684 - 700. doi: 10.1080/15287390903578539

Presentations

David Douphrate

Douphrate, D., Rosecrance, J., & Reynolds, S. J. (2011, August 22-24). Musculoskeletal Symptoms and Physical Exposures among US Large-Herd Milking Parlor Workers. Presented at the Irish Meeting on Agricultural Occupational Safety and Health, Dublin, Ireland.

Douphrate, D., Rosecrance, J., Kolstrup, C., Pinske, S., & Stal, M. (2010, August 29-September 3). Musculoskeletal disorders and ergonomic challenges in modern dairy production: European and US perspectives. Presented at the Seventh Internaitonal Conference on Prevention of Work-Related Musculoskeletal Disorders, Angers, France.

Douphrate, D., Kolstrup, C., Rosecrance, J., Reynolds, S., Lundqvist, P., Pinske, S., & Stal, M. (2010, August 29-September 3). European and US dairy production: challenges of work-related musculoskeletal disorder prevention. Presented at the Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders, Angers, France.

Douphrate, D., Rosecrance, J., Fethke, N., & Nonnenmann, M. W. (2010, August 29-September 3). Full-shift upper extremity direct exposure assessment of US dairy parlor workers. Presented at the Seventh International Conference on Prevention of Work-Related Musculoskeletal Disorders, Angers, France.

Lawrence Goodridge

Goodridge, L.D. (2011). Rapid Detection of Bacteria Isolated from Agricultural Dust Samples: A Comparison of Methods. American Society for Microbiology 111th General Meeting, New Orleans, Louisiana.

Goodridge, L.D. and Chase, J. (2006). A Bacteriophage Cocktail Decreases Escherichia coli O157:H7 Counts in Dairy Calves. 1st Texas/Evergreen Phage/Virus Genomics and Ecology Meeting, Kingsville, Texas.

Chase, J. and **Goodridge, L.D.** (2006). Preparation of Endotoxin-free Bacteriophages for Use as Food Grade Antimicrobial. International Association for Food Protection, 93rd Annual Meeting, Calgary, Alberta, Canada.

Chase,J. Kalchayanand, N., and **Goodridge, L. D.** (2006). Bacteriophage Therapy Reduces Escherichia coli O157:H7 Counts in the Bovine Gastrointestinal Tract. 6th International Symposium on Shiga Toxin (Verocytotoxin) Producing E. coli Infections, Melbourne, Australia.

Chase, J. Kalchayanand, N., and **Goodridge, L. D.** (2005). Use of Bacteriophage Therapy to Reduce Escherichia coli O157:H7 Concentrations in an Anaerobic Digestor that Simulates the Bovine Gastrointestinal Tract. Institute of Food Technologists Annual Meeting and Food Expo, New Orleans, Louisiana.

Chase,J., and **Goodridge, L. D.** (2005). Intelligent Design of a Phage Cocktail to Reduce Shedding of E. coli O157:H7 in Cattle. 16th Evergreen International Phage Biology meeting, Olympia, Washington.

Goodridge, L.D. (2005). Applied uses of bacteriophages in food microbiology and safety. First Joint Meeting of the Rocky Mountain Virology Club and Rocky Mountain Branch, ASM. Pingree Park, Colorado.

Goodridge, L.D. (2005). Evaluation of a Bacteriophage Cocktail to Reduce Escherichia coli 0157:H7 Shedding in Beef Cattle. Environmental and Radiological Health Sciences Graduate Seminar Series. Colorado State University, Fort Collins, Colorado.

Andrew Merryweather

Merryweather, A., Pate, M., Vemparala, S. (2011).Tractor Mounting/Dismounting Biomechanics Related to Falls. Paper presented at the ASABE Annual International Meeting, Louisville, KY, August 7-11.

Merryweather, A., Pate, M., Vemparala, S. (2011). Self-Reported Tractors Operator Falls, Ergonomics and Musculoskeletal Pain. Paper presented at the ASABE Annual International Meeting, Louisville, KY, August 7-11.

Michael Pate

Pate, M. (2012, March). Increasing risk awareness of confined spaces in production agriculture. Presented at the Utah State University Extension Annual Conference, Logan, UT.

Pate, M. (2011, June 26-30). Estimation of the Frequency, Severity and Primary Causative Factors Associated with Injuries and Fatalities involving Confined Spaces in Agriculture. Presented at the ISASH, Boise, Idaho.

Pate, M. (2011). Farm Owner/Operators' Perceptions of Risk Associated with Confined Spaces in Agriculture. Presented at the ASABE Annual International Meeting, Louisville, KY.

Louise Quijano

Quijano, L. (2011). Seasonal and migrant farmworker stress; mental and physical health implications. Presented at the HICAHS dairy Board Meeting. Fort Collins, CO.

Appendix 3: Selection of minutes from various HICAHS meetings 2007-2012

Appendix 3.1: 2008 HICAHS Advisory Board 180
Appendix 3.2: 2009 High Plains & Mountain Region Dairy Health & Safety Workshop 195
Appendix 3.3: 2011 HICAHS Dairy Advisory Board 205
Appendix 3.4: 2011 HICAHS International Dairy Research Consortium (Colorado) 224
Appendix 3.5: 2011 HICAHS International Dairy Research Consortium (Ireland & Sweden) 231

HI-CAHS Advisory Committee Meeting
February 20. 2008
Fort Collins, CO

INTRODUCTIONS

Dr. Steve Reynolds welcomed the Advisory Committee members and HICAHS personnel in attendance, and circulated the meeting Agenda. He emphasized his hopes to establish how the Advisory Committee could be best organized and utilized in the future.

The following Advisory Committee members were in attendance: Paul Gunderson (former Ag Center Director), Dan Fahrenholtz (Greeley MD), Del Chase (Ag Studies Coordinator at Lamar Community College), Jeffrey Levin (Southwest Ag Center Director), Bob Ellis (CSU Professor), Doug Steele (Director of Montana Extension Services), Eric Esswein (Public Health Officer associated with the Denver and Cincinnati NIOSH offices), Mitch Anderson (Ag Land, Inc.), Nancy Schleining (Director of Member Services for Colorado Livestock Association), and Clyde Serna and Tom Levy (Pinnacol Colorado Workers' Compensation Carrier).

In addition, the following HICAHS personnel attended the meeting: Darla Borges, Vicky Buchan, Roy Buchan (former HICAHS Director), Bob Seiz, Juhua Liu, Helen Holmquist-Johnson, Rena Saito, John Mehaffy, Bill Hanneman, Bill Wailes, David Douphrate, Garrett O'Keefe, John Rosecrance and Angi Buchanan. Available for a portion of the meeting were: Peter Chen, Dave Gilkey, and Dennis Lamm.

NIOSH UPDATE

Steve Reynolds reviewed the Agenda briefly, and updated the group on NIOSH ag programs status. The current contact and head of extra-mural ag programs at NIOSH is Allen Robison. NIOSH is struggling with funding, with only $9 million of budgeting allocated to ag being distributed to NIOSH and 17% of the ag support going to the CDC as indirect. Ag Center Directors have questioned where the additional ag funding has been consumed. Due to the reduced monetary allocation, only 10% of grants applied for have been funded, rather than the previous 20%.

This lack of funding has affected the ability to pursue activities outside the Centers. The NIOSH Education Research Centers (ERCs) and Ag centers are congressionally mandated and therefore somewhat protected from these budget cuts. However, fewer HICAHS proposed projects have been funded, and two project reviews have been contested, but no response has been received from NIOSH about these challenges. NIOSH has expanded its presence in the west with a satellite office in Denver.

Eric Esswein elaborated that NIOSH and the Public Health Department are increasing health hazard evaluations in the west with a new direction being promoted by the latest NIOSH Director. The unique needs regarding worker health and safety in the

west has been recognized, including issues in Washington and Alaska, such as mining and gas concerns. Max Keifer is managing the NIOSH Denver office and internal NIOSH ag programs, and contact with the remainder of NIOSH has been structured through him. At the newly formed Denver office, more hiring is underway. The current team of six senior members is currently in a state of flux, with additional hiring being done to respond to the 450 requests for services received last year.

Advantages

Steve sees many possibilities for building partnerships among developing occupation health programs in Colorado, in the areas of industrial hygiene, occupational medicine , occupational health psychology, and health physics. A new ERC (the Mountain and Plains ERC) was established in Colorado a year ago, which offers continuing education, outreach and hopes to intersect with ag center activities. Several of our HICAHS faculty are members of the ERC, Steve is the Deputy Director and Lee Newman at CU Denver is the Director. Focus on at risk populations, including Hispanic and Native American workers, is of particular importance. While there is a large amount of activity in Colorado, expanding outside the state is also a goal.

When HICAHS received new funding, Colorado Senator Ken Salazar expressed an interest in the Center and offered his assistance. Steve sees this as an opportunity to work more directly with political representatives and hopefully have more influence in steering the national agenda regarding rural and agricultural issues.

NATIONAL ACADEMY OF SCIENCES EVALUATION OF NIOSH

Paul Gunderson has led the recent National Academy of Sciences (NAS) review of NIOSH ag programs funded by the Center for Disease Control (CDC). The evaluation of mining occupations has been finalized, and the review of agricultural programs, including agriculture, fishing and forestry (AFF) has been essentially completed. Paul offered specific information concerning this evaluation process in a PowerPoint presentation (attached). There are reviews of six other divisions of occupation safety underway. These evaluations are funded directly by the federal government, with NAS as an independent agency. The scope of this review was to evaluate program relevance and impact. The full report is due out next month (March).

This was the first national review of NIOSH. The ag centers were initially funded in 1990, and centers were first contacted for input and historical data in November, 2006. The program review began in January, 2007. While the framework of the review was communicated before the evaluation, the panel looking at the ag programs took a more global approach, rather than concentrating on specific regions of the country. They looked at the types of people which their review affected, especially concentrating on the fact that these are generally outside workers. The evidence package submitted to the

NAS committee has been published on the internet at www/nap.edu. Of particular interest was testimony from producers, as well as energy and trade agreements.

Scoring was based on a five-point scale, with NIOSH scoring only a three. Congressional response noted a need to ascertain impact of the current programs. John Rosecrance asked if NIOSH funding was jeopardized by the low score, but Paul did not believe that was an issue, noting that some congressional personnel were involved with the review. Steve added that all national organizations supported directly by Congress are in need of funding. He recommended investigating resources outside of NIOSH, such as partners dealing with food safety issues for example.

Priorities

The main objective of the committee was to assess the NIOSH ag programs. Ag center priority was the third goal determined, and the fifth goal noted that center impact is muted without outreach funding. Much concern with the lack of surveillance was expressed. High priority was given to how resources were utilized. In the fishing industry, changes in programs were noted, including contact with Somalia speaking workers. Forestry issues included increased use of contract laborers, and the rapid change in the industry with foreign trade agreements. Differences noted in ag business included industrialization and the preparation of fresh produce moving directly from the fields to market, rather than through processing plants.

In 2006, with the US development of a global view related to the production of food and fiber fuels, all of the ag industry is seen as changing. The divergence of money will shape the future workforce, putting NIOSH on the cusp of an enormous opportunity to develop an agenda based on worker concerns.

Medium priorities determined by the NAS committee included the enormous implications of biofuels on the ag industry. For example, Paul noted that in 2000, most of the grain produced in North Dakota was exported. However, by 2007 virtually all grain was kept within the state. Specialized ag, currently 13%, is also rising quickly. 80% of the produce is harvested by 17% of farms growing bulk agricultural products. Livestock confinement issues are also an increasing concern. Equipment dangers have lessened in importance, with the use of automatic steering tractors by eight of ten producers. More tractors without ROPS are also being retired.

Low priorities identified are global warming affects on workers, such as violent weather, the effectiveness of personal protective equipment, and land grant institutions' identification of molds and fungi moving to the north. Transportation of workers to and from the worksite, rather than living in housing on the farm, is increasing. Genetic moderation of respirable dust is also being studied.

Recommendations

Some of the NAS committee recommendations include fusing of regional Centers, and recognizing surveillance as a crucial necessity. Without proper surveillance, Congress cannot be shown evidence of the impact of progress, and this type of testimony is the most compelling influence for funding of future programs. National security is threatened without a healthy workforce. The NAS reviewers also support translation of research to end users (r2p), and see the need for stakeholder involvement to assist in identifying regional needs.

Centers of Excellence, joining public and private partners are encouraged. A demonstration of knowledge of worksite or "real work" problems must also be exhibited.

Participant Input

Roy Buchan identified himself as a member of the NORA 2 counsel for NIOSH, and noted that while there has been little interaction with NAS, he observed a large amount of overlapping findings. The NORA 2 counsel is developing a strategic plan for NIOSH, identifying goals, objects and specific tasks required to achieve recommended aims. The NORA 2 counsel agrees that surveillance is necessary to target activities needing attention, in addition to documenting the impact of programs. Steve added that a NORA meeting is being held in Denver in the end of July, and that the ERC is assisting in the organization of the meeting. HICAHS plans to follow-up with the ag sector meeting, and is encouraging participation by producers and partners as well as researchers. Doug Steele pointed out the need for program as well as philosophical surveillance, and recommended the troubles with surveillance issues be researched. Paul added that R01 and R21 proposals should outline the necessity of surveillance, and emphasize this portion of the research. He further sees a need to revamp NIOSH, to limit surveillance of children and encourage a more substantial impact with adults and older workers. Risks for children are dropping with newer technologies and more worker families living in town and going to rural areas only for work. Partnering with the Department of Labor (DOL) to access their National Agricultural Survey System has been recommended. The forestry and fishing industries do not have this advantage, as there is no master roster of such workers, especially in the gulf coast regions, with the possible exception of IRS records. Steve pointed out that recent Tractor Safety Initiative (TSI) projects found it extremely difficult to gain access to the DOL information. Paul is aware of a NIOSH senior staff briefing, in which membership on the task force was identified as crucial, and USDA involvement essential.

Eric offered another example of surveillance problems with the Health Hazard Evaluation program, a part of the NAS review as well. This program also had no plan for review or documenting its outcomes. Showing impact was not designated as part of the assignment, as the program was approached from a risk-

based perspective. It has been difficult to determine lasting effects as there was no design to track such information, and it is the employers' choice whether recommendations are implemented. John Rosecrance was pleased that the NAS recognized the difficulty a lack of surveillance has caused. Eric added that surveillance divisions have not been working with the Department of Health and Human Services (HHS), but that NIOSH has expressed a desire to combine these operations. With the NAS outcomes, he anticipates a realignment of programs to demonstrate positive outcomes, moving toward performance-based funding.

Doug pointed out that the impact of educational and prevention projects cannot be measured, with the possible exception of behavior changes. Eric indicated an industry-wide study might reveal what had been accomplished, but agreed that measuring affects on chronic disease is more difficult, since innovations would not be withheld in order to measure effect. He compared this problem with the gas and oil industry, where hazards have been well-known, but improvements in health aspects have been difficult to determine. A long-term review is necessary. John believes that scientists tend to be isolationists, and appreciated the NAS stimulus to offer alternative approaches, including studies of global warming issues. He further suggested dealing with the effects of such things as rodents in farm worker housing. He believes by prioritizing the need for surveillance, bureau chiefs may be convinced of its importance. In addition, he hopes for a determination of how the 17% of ag-related funding going to the CDC is being applied towards pertinent studies. He expressed concern that political agendas may impede progress in these areas. Dave Gilkey agreed that evaluation without a control group is difficult, and noted that historical appraisals cannot identify what specific factors contributed to any changes. He believes more funding is necessary from NIOSH and must be requested within an R01 proposal.

ADVISORY COMMITTEE STRUCTURE

Steve asked for input as to how the Advisory Committee could be most effective. He pointed out that Center proposal reviewers commented negatively on the current Committee organization. One reviewer felt the current group was too large, causing difficulties in scheduling meetings, and saw a problem with the lack of organization and no designated chairperson. Steve pointed out that the Texas (Southwest Center) Advisory Committee was much smaller and asked for Jeff Levin's input on this issue. Jeff has found that regional representatives have been the goal at his Center, as well as determining the most effective and economical method of holding meetings. They have utilized some electronic meetings, conceding that it is not the equivalent to personal meetings, but adding that time issues become less of an obstacle. They have appointed a chairperson, generating a more cohesive and directed response mechanism. This allows Committee members to communicate through a spokesperson, who can also meet with administrators and PIs as needed.

Steve offered that working with sub-groups at meetings in the past has provided great feedback. Paul noted that the current Committee represents 12 producers or ag

client service organizations, which he believes is a strong feature he would encourage maintaining. He suggested exploration of alternative methods to convene, and inclusion of organization counterparts in regional states outside of Colorado (i.e. Livestock Association, Workers' Comp. carriers, etc.). Jeff sees the reviewers remarks as a "catch 22" situation, in keeping Committees small while achieving a good cross-section of representation. Doug recommended a brief description of expectations of Committee members would offer a better understanding of their role. He also suggested rotating terms and sub-committee gatherings outside of full group meetings. Steve agreed that expectations should be clarified, and suggested following-up with more specifics. Garrett O'Keefe recommended that members in similar fields assist in facilitating partnerships.

Committee Expectations

Steve would appreciate assistance with accomplishing a needs assessment and having the Committee members identify and prioritize important regional issues. He also asked for help in identifying potential partners, community connections and advice on building these relationships.

As future proposals are developed, the Committee's input regarding the relevance of the direction being pursued both from a scientific as well as the distribution of knowledge achieved would be helpful. Vicky Buchan feels that in order to prioritize strategies and project proposals a larger group is needed. Likewise, pilot project proposals can be encouraged through Committee contacts. Jeff agreed that engaging the Advisory Committee in solicitation of proposals, as well as their review and judgment regarding the best use of the funding available would be useful. He further suggested using interns or students placed with organizations outside of Colorado to increase outreach efforts.

John feels the Advisory Committee could be of assistance by identifying how outreach can be most effectively accomplished. Steve added that he recently presented at a Colorado Livestock Association meeting and learned that many members were unaware of the existence of HICAHS and what we might offer.

Terms of Committee service have generally coincided with the duration of grant funding, and Steve asked if this time commitment was excessive. However, continuity on the Committee is critical. Vicky noted that many Committee members have served over several funding cycles, but she understands that members' willingness to participate needs to be confirmed.

Issues

Issues to consider include an increase in outreach activity, especially outside Colorado. Partners in other states within the region are desirable. Committee identification of strategies to encourage pilot projects with PIs outside of Colorado would be appreciated. Bill Wailes believes that industrial cooperation informs HICAHS personnel regarding work being done, industry

requirements and engages ag businesses in the process of project planning which could lead to funding within the industry related to a specific workforce. John believes businesses could also realize financial incentives. Committee guidance in approaching businesses and identifying the most effective stimulus would be helpful.

Dave sees the Committee input as vital in establishing priorities from competing areas and integrating plans, which can be a difficult task.

Meetings

Steve asked for input regarding the frequency of Advisory Committee meeting, which have generally been conducted twice a year. He suggested using other forms of communication, adding that the Committee has assisted in planning research and providing guidance as to how it could be effectively applied in the workplace. Bob Ellis feels face-to-face discussions are generally the most productive, and Paul suggested sub-committees meet electronically.

The Southwest Center has recently purchased the Elluminate system, which cost approximately $45,000, with a $1,600 per year maintenance agreement. Paul feels this is a good communication instrument. Steve has proposed that the School of Public Health purchase the program to coordinate the CSU, CU (University of Colorado - Denver) and UNC (University of Northern Colorado – Greeley) participation, but has not yet received a response.

Structure

The designation of a chairperson was discussed, but Steve feels the current organization works well from the HICAHS perspective. A central contact from which specific information could be collected might be helpful. Paul believes a chairperson could attend related meetings throughout the region. Doug suggested a small executive committee which might be more available and most effective in carrying out Committee recommendations. Garrett agreed that an executive committee is more efficient, especially related to specific associations, such as producers. Paul recommended instituting cohorts, with one representative from factions like insurance, producers, extension, etc. Representatives from specific categories could be solicited for interest.

Dan Fahrenholtz recommended developing profiles of the Advisory members outlining their areas of expertise. Paul added that a short description of their roles in ag areas would be helpful, and Jeff commented that members' specific investment in ag health and safety would also be useful.

PROJECT UPDATES

Dairy Parlor Study

David Douphrate presented a PowerPoint (attached) on the Dairy Parlor study he is coordinating on with John Rosecrance. Notable abbreviations include: UE = upper extremity, MSS = muscular skeletal system. Focus groups were conducted with parlor workers. Jeff asked about the survey mentioned, with was a questionnaire. John added that a structured interview was utilized with Spanish speaking workers. Noa Roman-Muniz, a recent PhD graduate in the Veterinary college has assisted in translation for this study.

Dairy Endotoxin Exposure Study

Following lunch, Steve offered a PowerPoint presentation related to his dairy study (attached). It was clarified that pre-post shift testing was performed on the same day and in the same timeframe. Steve added that with the growth in the dairy industry, many owners have come to CSU for assistance in dealing with increased injuries in numerous new workers in the field. Nancy Schleining added that substantial employee turnover has caused concerns within the industry as well. Steve noted the attempt to reflect the 50% turnover rate in data analysis. Del Chase asked if collaboration with the National Jewish Hospital has been considered. Steve explained that he has indeed been working with National Jewish.. He added that he has been pooling resources with California (Western Center) researchers and producers to conduct a parallel study of the dairy industry in California.

Translation and Social Marketing Study

John showed a brief PowerPoint presentation regarding his translation project (attached). Work on this interdisciplinary study is being coordinated with Garrett of the Communication and Technical Journalism department and Peter Chen, specializing in Occupational Health Psychology. John is currently searching for partners, and hopes the Advisory Committee can be of assistance in identifying groups to include in this project. He is not seeking any particular types of partners, but hopes to have community needs identified by focus groups. Eric asked about the amount of success there has been with social marketing dissemination of information. John responded that Peter and Garrett have past success with this type of dissemination. Steve noted that while this is a new field, the recent TSI social marketing models were successful. Dave added that social marketing has been determined the best approached on issues such as supplying information, associated costs, barriers and behavior change. Garrett explained that the social marketing model has been used for 25 years, and sited the HIV/aids campaign as an example. This model offers a clear structure and includes researching the audience prior to dissemination of information. John added that

communication readiness, as well as change agents, are being examined, and this approach appears to be the most effective method of information distribution.

4-H CD Development and Evaluation

Vicky explained her 4-H CD project, briefly demonstrating the first CD which has been produced. This interactive CD was developed over the last three years, with the five modules being identified as important areas of emphasis. It is currently being tested nationally in Kentucky (Southeast Center), New York (Northeast Center) and Texas (Southwest Center). It concentrates on knowledge gain and translation of knowledge to behavior change, and will be tested on over 350 children. Regional panels are assisting in determining the applicability of topics, from which a second CD will be created. Eventual goals for this project may include making individual modules available on the web and national dissemination through 4-H or other national organizations dealing with rural children. The first CD was tested in Montana and South Dakota, indicating increased knowledge. Behavioral changes will be examined in the current project through parent interviews. Vicky stated that a rigorous evaluation of educational projects has been called for in the literature. Following completion of testing, control groups were given access to the CD.

Outreach Activities

Darla Borges discussed outreach activities, demonstrating the newly updated HICAHS website. She asked that Committee members offer suggestions for other items to include on the website. She plans to publish noteworthy activities and accomplishments as they occur. She also demonstrated the Google analytics she has installed to precisely monitor website hits. Del asked how the website is publicized, which Darla has communicated through e-mails, and Steve has announced at presentations he has made. Doug recommended utilization of Extension listings and development of an accurate distribution list. He further suggested that Agents provide a link to the HICAHS website in their weekly columns in rural publications. Steve asked about using key word references, a list of which Paul understands is available through Google.

Additional outreach activities have included work with children at various youth-based fairs and similar events. She has worked with regional Extension Agents, supplying funding for continuation of educational projects, but no evaluation of this venture has been accomplished. She has experienced inconsistency in dealing with Extension Agents, partially due to decreased Extension funding, and loss of designated Safety Agents.

Past outreach activities performed by the Center included OSHA on-site consultations, attendance at farm safety day camps for children, work with associations such as the Colorado Corn and Onion Growers, and personal protective equipment trainings. Future plans include continuing work with

producer organization, depending on financial support. She would like Committee input on where to pursue work with migrant and Native American populations in particular.

A quarterly newsletter was discussed, but Steve feels newsletters may receive little attention. He is uncertain if such a publication is worth the time and effort required, based on limited resources. Jeff noted that the Center-wide publication, Ag Connections is now dormant, agreeing that its usefulness is debatable. He agreed with the strategy of posting information on the website, and possibly including stakeholder findings as well. Paul proposed promotion of the Center and website availability in key journals, such as Ag Enterprises; to more effectively apply the limited funding available. Nancy believes that publishing articles though other ag organization's newsletters might be more efficient than a Center newsletter. By providing a link to the website in these publications, Darla believes a wider audience could be reached.

Other methods of creating awareness of HICAHS are needed and might be identified via a broader needs assessment. Use of the website to aide in a needs assessment was proposed.

Pilot Project Proposals

Bill Hanneman stated a call for proposal of pilot projects is complete, and asked the Committee's assistance in encouraging relationships with target sectors and studies pertaining to them as well as promoting pilot project proposal submissions. Steve envisions the translation projects as more population directed, with pilot projects aimed at scientists in hopes of their progressing to larger grant submissions. He acknowledged the difficulties in writing larger grant proposals, and having success measured by writing abilities rather than research value. An improved method of identifying people in the region (outside Colorado) is needed. Steve hopes to foster partnerships with academics, Extension personnel and producers. He noted that the ERC is experiencing similar problems. Bill H suggested matching funds from partnering industries might be available. Paul noted that acknowledgement of in-kind contributions is also helpful.

Bill H asked if target areas should be pursued, and John responded that injuries appear to be higher in the Hispanic worker population. Clyde Serna said specific group management is being pursued, as opposed to particular ag types Tom Levy added.

GENERAL DISCUSSION

Dairy Workers

Mitch Anderson inquired into the problem of new hires leaving the industry (i.e. dairy workers) after training, and Vicky wondered if this type of data was being tracked. Del (?) understands Pinnacol has ascertained that the average new hire leaves a position within 60-days to one year. Clyde noted that Pinnacol is working to determine the affects of education and training on this statistic. Vicky feels there may be an opportunity for pre/post tracking of these workers. Dan asked what benefits there are to employers encouraging safety issues, such as insurance incentives. Steve believes that by targeting new workers, employers will reap economic benefits, requiring less repeated training as well as fewer injuries. Dave Douphrate's dissertation data may offer insight into hot spots to target.

Pilot Projects

Jeff asked about the number and size of awards available. Steve responded that three or four projects could be funded in the amount of $10,000 to $20,000 each, with the possibility of these projects being extended for over more than one year. Jeff agreed that one-year awards are difficult, as it often requires a good deal of time to obtain IRB or human subjects approval, leaving little time to accomplish proposed studies. He does feel this is a good opportunity for young investigators, who might be considered as the target audience. Keeping indirect costs minimized is also important. Steve suggested the possibility of encouraging a cap on indirect constraints from institutions accepting these grants. He hopes to develop potential links through the Advisory Committee which can assist in connecting current needs and interests with available pilot funding, not necessarily related to current projects. Announcement of funding availability through rural healthcare providers and departments was recommended. Jeff also suggested connecting with graduate students or faculty outside of ag-related disciplines (e.g. college of business). Steve advised that some animal science professionals have been granted pilot funding in the past. Paul feels one issue of interest could be the loss of enterprise in both animal and grain production. John noted that healthcare issues are becoming more significant in the area of psychology, and associations with counterparts outside of CSU and the region could be encouraged. Eric asked if individuals could apply for pilot funding, and Steve responded that any proposals would be considered, as long as a health and safety aspect is included in the research. Dan suggested brainstorming on possible pilot topics, and bringing those areas with the most interest to the Advisory Committee for review. Steve would like the Advisory Committee input on proposals submitted for funding as well.

Insurance/Incentive Issues

Mitch asked about wellness programs related to ag insurance, and how underwriters might be engaged in considering such options. He understands that as processes (e.g. dairy parlors) become more mechanized, more sedentary work is performed. He mentioned his understanding that 60% of ag workers are taking medications, a large number of which are anti-depressants. With improved safety records, wellness should increase as well. Paul recommended working with HICAHS to generate a research design looking into these issues. Bob Ellis added that the relatively small workforce is an advantage in encouraging safety, as investments are impacted to a larger extent within smaller organizations. Darla pointed out that David's study incorporates similar economic factors as well. Clyde noted Pinnacol's association with ten or more ag-related organizations, which could supply separate, more detailed information. Paul feels these organizations could be a source of opportunistic areas in which insurance rates could be at least partially based on the establishment of safe practices. He wondered if data could be segmented out to illustrate the economics of introducing a safer work environment. Steve again recommended applying David's study by providing his findings to producers.

Outreach

It was recommended that dissemination of results of an insurance data review, as well as pilot project funding availability be circulated through e-mail communications. Paul encouraged the use of the website to increase outreach with minimal expense. Increased partnering opportunities, and expansion with more focused outreach efforts were recommended. John suggested sharing of study findings with dairy and livestock associations to encourage partnerships, both within Colorado and expanding to sister and similar interest organizations within the region. Steve noted a meeting planned in March to include John, David, himself and Pinnacol's dairy membership. Paul suggested attracting producer organizations by attending their meetings and informing them before or following of HICAHS and its programs. Nancy Schleining added that many such organizations operate both at regional and state levels. Tom also recommended attending livestock shows. Paul felt attendance at the Denver Livestock show would be excellent, but believes groundwork should be started a year ahead of time. The Denver Livestock show has become more focused on dairy and hog production, but Nancy pointed out that hog raising is on the decrease in Colorado. John mentioned other national meetings, such as Cow Comfort meetings. Paul recommends staying responsive to future trends in production concepts.

Eric mentioned the human/animal interaction and emerging genetic disease. Many of these have been present for 20 – 30 years, but many of these viruses have only been identified as ag-related within the last nine months. As ag commodities change, new diseases have emerged related to crops and livestock.

The ag community needs to be aware of this safety issue. Steve added this issue presents an opportunity to involve the veterinary college at CSU, regarding immunization of animals, and understands there has been some progress in this area. He mentioned the programs offering a Veterinary and Masters of Business combined degree. Bob Ellis offered that he is the Executive Director of the Conference on Animal Disease, which has been meeting yearly since the 1920s. This group looks at both food borne and zoonotic diseases. There were 540 attendees at the last meeting, and 310 abstracts submitted. He is also President-Elect of the Biological Safety Association. Paul believes this opportunity for collaboration should be acted upon, especially concerning emerging diseases.

Tom noted a related problem with ag workers being infected while vaccinating livestock. Steve commented on problems with Micotil, which is currently being utilized in dairy and cattle operations, resulting in several recent deaths. Bob understands this drug has cured a respiratory outbreak which common drugs did not affect. An increase has also been noted of infection by animals to such diseases as pertussis, tuberculosis, and tetnis. Bob added that the USDA has recently conducted surveys of beef, pork and horse producers, with results noting animal disease and its economic impact. Prevention, rather than treatment of the illnesses is recommended. Another medical problem involves the number of suicides being reported.

Jeff believes regional partners should include producers as well as academic organizations, and asked how familiar the Center is with both in the area. Steve asked that Darla compile a list including academic institutions, producers and producer organizations to be used in pursuing a needs assessment. Jeff added that academic bodies may have additional local partnerships. Darla noted that Doug has been a productive contact leading to additional producer organizations. She has experienced difficulty in maintaining a similar contact in Utah. Steve noted that the ERC is working closely with Utah State University, but they have shown little interest in research. John and David are meeting with dairy owners in Utah who could provide further contacts. Additional Wyoming contacts are also needed, in addition to the former Extension Agent, Ron Cunningham, who is currently working on the Wind River Reservation.

Steve offered that the ERC is working to build relationships with tribal nations, where ag is of great interest, but some diplomacy is required. ERC pilot grants are being offered soon. Jeff stated that ERC participation in ag Center efforts has been accomplished in the past in Iowa (Great Plains Center) and Washington (Northwest Center). He feels a voice for ag in the ERC is important. Eric noted that ERC and ag participation was not mentioned throughout his education in Utah.

Steve advised that NIOSH has funded a specific ag component in Iowa, Chicago and Minnesota, and he believes it is pushing for more integration of ERC and ag research centers.

Regional meetings with the Texas (Southwest) Center have been funded with conferences being planned for 2009 and 2011. The aim is to include more producers and growers, as well as livestock associations and dairies. Another proposed project which was not funded centered on working with Agribility, an organization focused on disabled ag workers. Inclusion of this organization as well as migrant stream associations in the regional meeting is intended. Karen Gilmore at the Southwest Center is pursuing collaboration between these groups. Vicky also provided information regarding the upcoming Western Centers conference, formerly including only the Northwest and Western Centers, which has expanded this year to include HICAHS as well as the Southwest Center. The meeting will take place in Washington state, but is more scientifically focused. The Washington meeting was scheduled for November 11-13, in order to avoid conflicting with the international conference in Saskatoon, Canada in October. The Saskatoon conference is held every five years, and has traditionally been very beneficial and productive.

Funding Sources

Expanding funding sources beyond NIOSH was discussed, as well as attraction of external PIs (outside of Colorado); with Steve noting possibilities within the forestry trade in Utah. He mentioned a study of fisheries maintained by prison personnel proposed in collaboration with Bob McKnight of the Southeast Center. This project was not funded. Paul recommended seeking additional support with ag cooperatives, such as those in Minneapolis/St. Paul. These organizations would be natural partners, and offer many resources including education and promotion of young people going into ag lines of work. Steve added that the TSI project identified specific funding groups given the direction a project may be headed.

Proposal Review Process

Jeff commented on the difficulty in providing an overall Center theme with linkage of projects, and maintaining that cohesive element following funding of diverse projects. Vicky suggested responding to this issue by make the theme broader, including regional, rather than Center focus. Paul agreed that the structure of the review process and the way panels share information with independent project reviewers is complex. He believes NIOSH could improve on this process, employing other assessment models. Vicky informed the Committee of a recent meeting with Teri Palermo (NIOSH) and Allen Robison regarding the Cross-Center (ACE) evaluation project. One topic discussed related to ending the discouraging of cross-Center projects, which are needed to perform national project evaluation. Paul believes this relates to the surveillance issue noted by the NAS review (see above), resulting in a loss in public health awareness. He sees a need to develop regional intelligence, especially in clinical settings. Eric added that the CSTE is increasing surveillance in the west, hiring workers with

evaluation backgrounds. Eric noted that the CDC and NIOSH or state funding is being used to support this increase in staffing. Steve suggested that collaboration between Centers and sharing of resources will assist in obtaining more regional data.

FUTURE PLANNING

Bob suggested that the next renewal present a portfolio of science, relating more to struggling populations. He asked what NIOSH has indicated as its top priorities. Steve believes NAS and NORA summaries should be used as guidelines, as well as a regional needs assessment including as many stakeholders as possible.

A fall meeting of the Advisory Committee was briefly discussed, with plans to meet prior to the Washington and Saskatoon meetings (beginning in October).

Steve noted that the Minutes, as well as a summary would be circulated for input from meeting attendees. He welcomed comments on specific issues. Angi would also like contact information updates (see attached Advisory Committee listing, as well as HICAHS Staff).

Steve asked for input regarding the next proposal, due in 2010.

HIGH PLAINS & MOUNTAIN REGION
DAIRY HEALTH & SAFETY WORKSHOP
EXECUTIVE SUMMARY

Introduction

US dairy production has steadily moved to industrialized operations because of associated economies of scale. These "mega-herd" dairy operations present new occupational health and safety challenges to both dairy owners and workers. There is limited research addressing worker health and safety on these large-herd operations.

Regional Dairy Industry Profile

Roughly 57% of US milk production comes from large-herd (500 head or more) dairy farm operations. Federal Region VIII (CO, UT, ND, SD, WY and MT) has over 135 large-herd operations and produces over 60% of the region's milk supply. Federal Region VI (TX, NM, OK, LA, and AR) has over 350 large-herd operations and produces over 88% of the region's milk supply. These large-herd dairy operations employ a predominantly Latino workforce.

Purpose

The High Plains Intermountain Center for Agricultural Health and Safety (HICAHS) partnered with the Southwest Center for Agricultural Health, Injury Prevention, and Education (SWAG) to host the High Plains and Mountain Region Dairy Health and Safety Workshop October 15 - 16, 2009 in Denver, Colorado.

The purpose of the workshop was to bring together dairy extension specialists, dairy owners and managers, dairy manufacturers and support specialists, and health and safety researchers to discuss current dairy health and safety research and outreach initiatives, and identify future research and outreach needs.

Objectives

The objectives of the workshop included the following:

1) to provide an interactive forum to exchange ideas and strategies to effectively address dairy worker health and safety;

2) to identify and prioritize dairy worker health and safety issues;

3) identify process management strategies that address worker health and safety; and

4) to identify future research and outreach priorities.

Attendees

In addition to Center personnel workshop attendees included faculty from a US university and one Swedish university, dairy extension specialists (representing CO, TX, NM, SD, ND, IA, and UT); six dairy owners and managers (representing CO, TX, NM, and SD); one dairy equipment manufacturer, one workers' compensation provider, and dairy producer organizations (CO, TX, and NM). Refer to Appendix A for complete list of attendees.

Workshop Agenda

Day 1 p.m.

A. Welcome/Introductions/Purpose and Objectives of Workshop
B. Overview of NIOSH Agriculture Centers
    1. High Plains Intermountain Center for Agricultural Health and Safety
    2. Southwest Center for Agricultural Health, Injury Prevention, and Education
C. Current dairy research
    1. Dairy Endotoxin Study
    2. Dairy Parlor Ergonomics/Productivity/Efficiency
    3. Pilot 1-Exposure to Extreme Postures Among Parlor Workers
    4. Pilot 2-Exposure to Muscle Force Among Parlor Workers
    5. Pilot 3-E-Coli Exposure Among Parlor Workers
    6. Translation-Dairy Safety Process Management Using Lean Six Sigma
D. Specific Topic Breakout Group Discussions
    1. Dairy Labor Issues (Appendix B)
    2. Worker Health Issues (Appendix C)
    3. Worker Training (Appendix D)
    4. Process Management (Appendix E)

Day 2 a.m.

A. Summary Reports based upon discussion
B. Presentation related to injury & death in dairy work
C. Discussion related to creating a "Safety Culture."
    1. Lock-out, tag-out
    2. Potential role of OSHA and small business consultation program

Future Steps

A. Second workshop for project HICAHS and SWAG renewal proposals
B. Solicitation of projects through HICAHS & SWAG Translation and Feasibility Programs
C. Incorporation of dairy health and safety into national Dairy Sustainability Initiative

Appendices

A. Workshop attendees and contact information
B. Dairy Labor Issues Discussion Summary
C. Worker Health Issues Discussion Summary
D. Worker Training Discussion Summary
E. Process Management Discussion Summary
F. Workers' Compensation Article
G. Australian Information related to lock-out, tag-out
H. Solicitation for Feasibility Project Proposals
I. Solicitation for Translation Project Proposals

APPENDIX A
DAIRY WORKSHOP ATTENDEES

Participant	Affiliation	Email
HICAHS		
Borges, Darla*	CSU-HICAHS Outreach	darla.borges@colostate.edu
Buchan, Vicky	CSU, Professor,HICAHS Deputy Director	buchan@cahs.colostate.edu
Douphrate, David	CSU, Assistant Professor, HICAHS Scientific Coordinator	david.douphrate@colostate.edu
Lamm, Dennis*	CSU, Professor, HICAHS Outreach/Education Core Coord	dennis.lamm@colostate.edu
Matsumoto, Anne	CSU-HICAHS Secretary	anne.matsumoto@colostate.edu
Reynolds, Steve	CSU, Professor,HICAHS Director	stephen.reynolds@colostate.edu
Rosecrance, John	CSU, Associate Professor,HICAHS Prevention Core Coord	john.rosecrance@colostate.edu
Kovis, Doree	CSU, HICAHS	doreeek@lamar@colostate.edu
Southwest Ag Center		
Gilmore, Karen*	UTHCT-Soutwest Ag Center	karen.gilmore@uthct.edu
Levin, Jeff	UTHCT-Soutwest Ag Center Director	jeffrey.levin@uthct.edu
Nonnenmann, Matt	UTHCT-Soutwest Ag Center Deputy Director	matt.nonnenmann@uthct.edu
Academia		
Kolstrup, Christina	Swedish University of Agricultural Sciences	christina.kolstrup@ltj.slu.se
Lundqvist, Peter*	Swedish University of Agricultural Sciences	Peter.Lundqvist@ltj.slu.se
Penske, Stefan	Swedish University of Agricultural Sciences	stefan.pinzke@ltj.slu.se
Rautiainen, Risto	University of Nebraska	rrautiainen@unmc.edu
Stal, Marianne	Swedish University of Agricultural Sciences	marianne.stal@ltj.slu.se
Extension		
Bruno, Ralph	Texas Agrilife Extension	rgbruno@ag.tamu.edu
Francesa, Umberto	South Dakota State University, Dairy Ext	Umberto.Francesa@sdstate.edu
Garcia, Alvaro	South Dakota State University, DVM, Dairy Ext	alvaro_garcia@sdstate.edu
Garry, Frank*	CSU, Professor, DVM, Integrated Livestock Mgmt Coord	franklyn.garry@colostate.edu
Hagevoort, Robert*	New Mexico State University, Professor, Dairy Ext	dairydoc@nmsu.edu
Lambert, Barry*	Tarleton St Univ/Texas A&M Univ,Prof, Dairy Ext	blambert@tarleton.edu
Mondak, Chris	Iowa State University, DVM, Dairy Ext Spec	cmondak@iastate.edu
Roman-Muniz, Noa	CSU, Assistant Professor, Dairy Ext Spec	noa.roman-muniz@colostate.edu
Rosas-Goulart, Cecy	CSU, DVM, Integrated Livestock Mgmt Dairy Specialist	cerosas@colostate.edu
Schroeder, JW	North Dakota State University, Professor, Dairy Ext	jw.schroeder@ndsu.edu
Smith, Molly	NM Cooperative Extension	smithmo@nmsu.edu
Wailes, Bill	CSU, Professor, Department Head Animal Sciences	W.Wailes@colostate.edu
Young, Allen*	Utah State University, Associate Professor, Dairy Ext	alleny@ext.usu.edu
Dairy Stakeholders		
Cowan, John*	Texas Association of Dairymen Executive Director	jcowan@milk4texas.org
Fikse, Beverly	Dairyman Producers New Mexico Executive Director	dpnm3@juno.com
Lombardi, Sharon*	Dairyman Producers New Mexico Executive Director	dpnm1@juno.com
Motteram, Rachel	Colorado Livestock Association	rmotteram@coloradolivestock.org
Pedraza, Juan Rodgrigo*	Pfizer Animal Health	juan.r.pedraza@pfizer.com
Serna, Clyde	Pinnacol Assurance (CO Workers' Compensation)	clyde.serna@pinnacol.com
Smith, Rob	DeLaval Inc. (dairy equipment manufacturer)	rob.smith@delaval.com
Smith, Wyatt*	DeLaval Inc. (dairy equipment manufacturer)	wyatt.smith@delaval.com

Producers

Manlove, Howard	Midwest Dairy Institute Manager, Milbank, SD	mcfdairymanager@tnics.com
Reed, Chris*	Del Rio Dairy Manager, Friona, TX	txcowman@wtrt.net
Ruyne, Leo	Dairy Fountain Owner, Edmonson, TX	dairyfountain@yahoo.com
Schaap, Andy	Little Creek Dairy Owner, Hereford, TX	awschaap00@hotmail.com
Slutsky, Jon	La Luna Dairy Owner, Wellington, CO	jslutsky@lalunadairy.com
Smith, Dave*	Shelton Dairy Manager, Greeley, CO	dslittlehorse7@aol.com
Velez, Juan	Aurora Dairy Vice President , Longmont, CO	JuanV@auroraorganic.com

*participating but unable to attend

APPENDIX B
LABOR ISSUES DISCUSSION SUMMARY

Two consistent and separate issues: 1) language/cultural issues and, 2) immigration and immigration reform.

1) Language/cultural issues:

Identified problem: Lack of effective communication between management and labor. Lack of cultural awareness and language barriers both play a role in dysfunctional communication.

2) Immigration & immigration reform: root cause of many labor issues discussed.

Context: relationships between workers and families & difficulty with labor coming from Central & South America

Identified problem: Typically individuals thrown into leadership position without developed skills – often, an individual does well & is promoted.

Identified need: Different types of training, esp. *leadership training*

Identified need: Recruitment & retention training

APPENDIX C
WORKER HEALTH DISCUSSION SUMMARY

***Worker Health Issues*:** training management, labor & its implications – causing health problems, related to systems for controlling these issues.

-Consistent themes:

1. ***Preventive health, wellness, more of a big picture for the health of the worker:*** measures to ensure a healthy workforce – employees are fit, not spreading infectious diseases amongst each other & with families.

Identified Need: Resources for developing health programs/wellness

Identified Issue: Access to vaccinations – tetanus

2. ***Reproductive health:*** protecting workforce from sexually transmitted diseases, relationships & how workers treat each other, effects on families and children

Identified question: How much interrelation exists?

Identified Lack of Information: How much responsibility do owners have relative to this issue?

3. ***Worker treatment, perception and respect relative to community***

Identified Issues: Major issues continue to exist regarding fitting in and community acceptance, thus creating problems that impact workers in workplace and the community they live in.

4. ***Chemical exposures*:** pesticides, drugs, formaldehyde, self-medication, use of pain relievers, etc.

Identified Issues: Self-medication: people understanding associated risks, communication management issues, training.

5. ***Mental and emotional health*:** looking at owners, operators, and workers as different – having different needs.

Identified Issue: In general, most of workforce is young and healthy and do not recognize that there are problems (lack of awareness). Generally, this is a healthier workforce.

6. ***Injuries*:** occurs primarily with livestock or tractors

Identified Issue: Owner and worker recognition of issues, problems, risks, and prevention strategies. This issue ties in with ties in with management and training.

7. ***Sanitation*:** controlling transmission of infectious diseases among workers and also from workers to livestock, to families, and from livestock to workers.

Identified Needs: good information, good management practices (hand washing), using clean towels, wearing gloves to handle clean towels. Need for attention in training related to prevention.

Identified Issue: Workers not paying attention to what doing when they're eating or smoking – not washing hands (creating most of the problem).

Identified Issue: Infectious agents and transmission between workforce & livestock

APPENDIX D
WORKER TRAINING DISCUSSION SUMMARY

The issues generated from the 4 groups varied a bit, but they could be consolidated into five key areas or themes. These themes are presented in order of priority as identified by the groups.

1. The need for training – a consensus among all groups was clear here.
2. Need for training materials: also a consensus, but a great variety of topics:
    a. Specific to tasks of production: calving, feeding, reproduction, cow care, milking, fresh cow care, teamwork, sick cow care.
    b. Clustered around "how to train" and the importance of quality.
3. Methods of training and training delivery – some questions raised about approach.
    a. In-house versus outside the dairy trainers: hands on/apprenticeship/coach approach versus:
    b. CDs, DVDs;
    c. Operation specific versus more generic.
    d. One suggestion brought back to the group was related to the use of computer programs such as Illuminate or Adobe with national experts providing the training.
4. "Who" needs the training?
    a. Supervisor/manager – these positions assume prior experience, but it was suggested that to move from line staff to these positions, training to become a supervisor was important.
    b. Workers –
        i. recognize organizational hierarchy workers are in:
        ii. responses that workers have to owners versus managers will often be different.
5. Cultural/ Language Barrier Issues
    a. Need to recognize cultural norms- e.g. who can talk with whom?
    b. Need for language specific training
    c. Need for interpersonal communication skills
6. Several cross-topic discussions emerged from the four groups:
    a. Agreement on need for reinforcement, refreshers or "boosters" in order to avoid returning to old ways.
    b. The issue of incentives was also discussed: various forms were brought up including extra pay, bonuses, and making sure there was time to attend trainings set up.
    c. The "how to" of training:
        i. Reinforce good behavior, not always identifying what the worker is doing wrong.
        ii. The importance of positive feedback to enhance training impact.

APPENDIX E
MANAGEMENT DISCUSSION SUMMARY

Identified Differentiation between Management and Leadership:

Difference between management (ex: putting milk in the tank) & leadership (ex: making sure still in operation & business for long-term)

Identified Necessities for a Successful Dairy

1. Effective communication among employees.

2. Owner engagement and visibility among employees.

3. Positive employee relations.

4. Employee ownership of what they do/specific responsibilities/accountability (holding worker accountable job performance according to established rules & regulations).

5. Motivation (consistent theme) – increased pay is not a motivator.

6. Direct owner/manager involvement motivates employees.

Delegation (consistent theme)

1. Identification of good leaders amongst employees and training.

2. Promotion and rewarding for stellar performance.

3. Lack of delegation leads to owner stress (responsibilities pile up, health is affected as result).

Safety Management: any specific management safety process improvement must be incorporated into overall dairy operation mission and strategy

1. A successful dairy is reflection of consistency – reducing any variability in milking, feed operation, waste management. Must improve consistency & efficiency, reduce variability.

Identified Need: Process management training would be beneficial (ie. Lean six sigma)

2. Good delegation of management, good training, employee empowerment (give employees ability to make decisions, ownership)

Identified Need: Leadership training for both managers and labor.

3. Any training needs to be process specific that tailors initiatives to specific processes.

4. All training must be dairy specific and customized.

Identified Need: OSHA training specific to a dairy operation and customized to specific operation.

Minutes

HICAHS Dairy Board Meeting
April 27, 2011 (12:30 pm - 5 pm)
April 28, 2011 (9 am – 1 pm)

The Armstrong Hotel
Fort Collins, CO

Executive Summary

The High Plains Intermountain Center for Agricultural Health and Safety had its first meeting with its Dairy Advisory Board from April 27-28, 2011. Attendees included dairy producers, extension agents, dairy equipment manufacturers, producer organizations, and academics. The meeting centered on familiarizing advisory board members with each other and with HICAHS researchers, further understanding the needs and concerns of the dairy industry, review of current and proposed HICAHS dairy projects, and planning of next steps.

Discussions reinforced many of the major issues identified in the Regional Dairy Health and Safety Workshop held in 2009 by HICAHS and the Southwest Center for Agricultural Health, Injury Prevention, and Education (SW Center), but identified specific gaps and action items.

Major themes of discussion included: immigration, communication, OSHA/regulatory compliance, management skills, building further partnerships, and funding models.

Producers shared that immigration laws stress both employees and employers. Employers would like to keep their employees but it is difficult to verify legal status, plus the immigration visas do not accommodate the dairy farmer's needs. Drug use, domestic violence, and suicide add to/or are a result of stress. Louise Quijano (HICAHS), Lorann Stallones (HICAHS), Bob Fetsch (CSU Extension Agent) and other HICAHS members have worked on these issues and prevention strategies.

Cheryl Beseler (HICAHS) shared her proposed study on evaluating availability and use of healthcare services. Producers confirmed that this is a problem on dairies: in some cases where workers are provided health care, they do not use it. Plus, employees do not understand their benefits, tax deductions, or bonuses.

Another facet of HICAHS' research focuses on changing the physical work environment to reduce physical stressors. John Rosecrance and Dave Douphrate have proposed evaluating the ergonomic and economic impact of a number of engineering interventions in dairy milking partners, including an evaluation of lightweight milking units. Producers shared their concern that these units are not durable enough.

Producers and extension agents shared their thoughts about best practices for communicating with non-English speakers. A key point was need for training of managers on Communication – more than just Spanish (how, when, how often). Increasing OSHA regulations are a growing concern for the industry, and led to some discussion of how HICAHS research data is shared and how it might be used. This also led to discussion about the quality and relevance of research and disseminated results. The board members stressed that is important to them that a solution is provided when a problem is identified.

Much of discussion kept coming around to skills or tools that managers need. In addition, the overall sentiment from producers is that HICAHS needs to continue communicating clearly that our approach is grounded in engaging and listening to the industry so that our work is relevant and of value – there is a perception that HICAHS is sheltered within the ivory tower of academia.

Given current economic challenges and likely federal budget reductions, advantages and disadvantages of a business model versus research model approaches were also discussed. A successful model will need to address both value to the industry and retention of scientific rigor. John Rosecrance's work with the construction industry may serve as a model.

The board members suggested a number of additional organizations that HICAHS could partner with to address these issues, leveraging resources, expertise, and networks for implementation and outreach.

Organization of this advisory board and tools to facilitate board activities were also discussed. A dedicated section of the HICAHS website can serve as an important cornerstone for resources and communication. Specific action items are detailed on the following page.

Action Items

- OLGA's Farm teaches her workers English through a program conducted by South Dakota State University utilizing students. Bill Wailes suggested engaging Community Colleges to do something similar. Matt Nonnenmann, Risto and Noa all expressed interest in following up.
- MATT offered to contact the Journal of Dairy Science and review articles submitted for publication.
- Select groups for HICAHS to contact. This list is not comprehensive. An extensive number of organizations were suggested during the meeting, beginning on page 13. HICAHS would like to follow-up with all of them, but these are the ones with which board members have contacts:

  1) ROBERT: The Western States Dairy Association meets four times/year. They are probably not aware of the Ag Centers and Robert can make an introduction. The members typically consist of progressive dairy producers.

  2) WYATT suggested that HICAHS talk to the DMI group. Funds for this group come from the check-off program.

  3) HICAHS is working with Wyatt and DeLaval to develop and present OSHA workshops for dairy owners. (This has been initiated since the board meeting). We will partner/coordinate with WI National Farm Medicine Center and then with other Ag Centers as this develops nationally.

- HICAHS needs to do an inventory of what programs are already underway, what organizations or partners have we not yet engaged. We need to identify gaps and our niche.
- ROBERT says J.W. Schroeder in North Dakota has information on measuring impact.
- HICAHS will develop a Dairy Board webpage and discussion board on the HICAHS website that can be used to help facilitate connections and information sharing. Access to the website will include the Dairy advisory board and a wider network of dairy producers and related businesses (equipment, feed, pharmaceuticals). The Website will include: Contacts/Members, links to resources, translated research – our work and others in a format that can be used by producers, list serve/chatroom, upcoming events, tools and other products (such as audits, basic information on OSHA).
- HICAHS will distribute a list of Dairy Advisory Board members and HICAHS contacts.

Table of Contents

Executive Summary 1

Action Items 3

Day 1 Minutes 6

Overview of NIOSH Ag Program and HICAHS (Reynolds) 6

2009 Dairy Workshop: Identified Concerns of Dairy Industry (Reynolds) 6

Outreach to Dairy Producers (Douphrate and Rosecrance) 6

Seasonal and Migrant Farmworker Stress: Mental and Physical Health Implications (Quijano) 6

Group Discussion: Immigrant Workers, H2A Visas, & Stress 7

Verifying Legality of Farm Worker Employment 7

Farmworkers and Income 7

Producer Stress 7

Proposed HICAHS Projects: 2011-2016 (Reynolds) 8

Changing Healthcare Utilization Patterns among Dairy Workers (Beseler) 8

Group Discussion on Healthcare Services 8

Exposure Assessment and Intervention Analysis (Douphrate) 8

Group Discussion-Exposure Assessment and Intervention Analysis 9

Enhancing Safety Training Effectiveness in Industrialized Dairy Production (Rosecrance) 9

International Dairy Research Consortium (Reynolds) 9

Group Discussion-Language Barriers 9

Note that all the proposed projects are dependent upon the HICAHS Center receiving funding for FY 2012 or alternative funding. 10

Table of Contents, continued…

Day 2 Minutes 11
Federal Budget Update (Reynolds) 11
Group Discussion on Funding & HICAHS' Role 11
Funding & Collaboration Opportunities 11
Management and Safety Programs by Other Organizations 11
Politics, Accountability, and Mistrust/Misunderstanding of HICAHS 11
Data Ownership & Confidentiality 12
Maximizing Value to the Dairy Industry (Douphrate) 12
Practical Solutions Based on Sound Science 12
A Market-Driven Business Model in conjunction with a Scientific/Academic Model 13
Build Trust and Work with Other Organizations 14
Measuring HICAHS Impact to Dairy Industry (Reynolds) 15
Benchmark Dairyworker Health 15
Meet Face-to-Face, Host Seminars, and Talk to Dairy Councils 15
Effectively Translating Research to Practice (Rosecrance) 15
OSHA Consultation 16
Indicators for Measuring Impact 16
HICAHS Dairy Advisory Board Operations 17

Attendance 19

Day 1 Minutes: Wednesday, April 27, 2011

Overview of NIOSH Ag Program and HICAHS (Reynolds)

- HICAHS one of 8 Ag Centers across country
- Seven HICAHS Cores/Programs:

1) Administrative Core
2) Pilot/Feasibility Program: For young scientists
3) Outreach Program
4) Evaluation Program:
   Example – Vicky Buchan, Deputy Director, surveyed the attendees of this meetings as part of program evaluation of this meeting
5) Research Core
6) Prevention/Intervention Core
7) Education/Translation Core

2009 Dairy Workshop: Identified Concerns of Dairy Industry (Reynolds)

- Language/Cultural Issues
- Immigration & Immigration Reform
- Need for Leadership Training
- Need for recruitment and retention training
- Worker Health Issues: Preventive Health, Worker Health Programs, Reproductive health, Worker Treatment (immigrants fitting in to the community), chemical exposures, mental health, injuries, sanitation

Outreach to Dairy Producers (Douphrate and Rosecrance)

- OSHA Training Workshops, Lean Six Sigma Training, and Training for Managers and Workers. The OSHA Training workshop was conducted in South Dakota.

Seasonal and Migrant Farmworker Stress: Mental and Physical Health Implications (Quijano)

- Louise Quijano conducted a pilot survey of 15 Farm Workers: 14 Hispanic, one non-Hispanic

- Study asked respondents how they defined stress, what stressed them, and how they deal with stress. Immigration laws were a source of stress. None of the respondents reported drug use, but they did say that their buddies did drugs.

Group Discussion: Immigrant Workers, H2A Visas, & Stress

Verifying Legality of Farm Worker Employment

- DAIRY PRODUCER: raised issue of employee satisfaction and discussion included need to deal with domestic violence, drug use, suicide prevention. The immigration laws are very stressful to farm operators and farm employees. This stress can lead to unreported domestic violence -> the abused spouse is afraid of being deported so she does not report the abuse. Eighteen of my farmworkers have received deportation letters.
- Producers also indicated some using regular drug testing and that this drastically reduced rates. Rachel indicated CLA willing to assist with these issues. There are lessons to be learned from work with migrant worker populations.
- DAIRY PRODUCER: says that her farm uses eVerify to ensure that her employees can be legally employed in the U.S. Five of their 32 employees have and H2A Visas. Since South Dakota has a low unemployment rate, legal employees have more freedom to find employment elsewhere.
- Utah has a bill in process that will improve immigration laws.
- BOARD MEMBER on H2A Visas. It takes 3 years to train worker and then the H2A visa expires. Dairies are different than other industries and need a continuous labor force. It would be better if a different type of visa was created.
- BOARD MEMBER: No match on H2A is NOT an indicator of illegal employment status.
- DAIRY PRODUCER:: eVerify is not perfect but it is close
- Verifying that the SS# and DOB match can eliminate a lot of illegal documents.

Farmworkers and Income

- DAIRY PRODUCER: For many immigrants, their job on the dairy is the first time that they have had a steady income. Many of them do not understand their healthcare benefits, tax deductions, and employee bonuses.

Producer Stress

- It was reported that Bob Fetsch (CSU faculty) conducted a talk on suicide on farmers and it was very well received. The plummeting economy led to an increase in suicides in the farming industry.

- BESELER: Depression is a bigger predictor of safety behavior than knowledge (this journal article is under review and will be published soon by the American Journal of Epidemiology).

Proposed HICAHS Projects: 2011-2016 (Reynolds)

Changing Healthcare Utilization Patterns among Dairy Workers (Beseler)

- Project goals:
  1) Increase access and availability to healthcare services in dairy workers
  2) Identify barriers to access and reduce the barriers
  3) Increase self-efficacy in accessing healthcare
  4) Increase health literacy
- This project aims to do the following: (1) Collect information on the factors that influence workers' use of healthcare services, (2) Use a local community health clinic (Salud Family Health Center) to provide medical services, and (3) Evaluate how these actions affect healthcare use and healthiness of the workers
- Length of study will be ~6 months

Group Discussion on Healthcare Services

- DAIRY PRODUCER: HIPAA laws prevent Cheryl and HICAHS from reporting specific diseases in dairy workers
- BOARD MEMBER: My facility has been using Salud's services. Family members of his employees also come to use Salud. He used to provide health insurance to his workers but they did not use it, or wanted money instead of the insurance, or just did not see the value in it – so he stopped providing it altogether.
- DAIRY PRODUCER: I provide health insurance for my workers but they do not use it!
- BOARD MEMBER: Employees are young and think they are bullet-proof.
- DAIRY PRODUCER: Employees utilizing homeopathic medicine for treatment.
- DAIRY PRODUCER: I would like to provide dental insurance to my employees.

Exposure Assessment and Intervention Analysis (Douphrate)

- Study will evaluate (A) ergonomic stress and compare stress in each dairy parlor designs: herringbone, parallel, rotary, (B) The design of the lightweight milking units by DeLaval, including their durability and product failure. Tests will be conducted at the new milking facility at Tarleton State University. (C) A teat scrubber produced by Alpha Technology that is used in rotary milking parlors will be tested for ergonomic stress.

Group Discussion-Exposure Assessment and Intervention Analysis

- DAIRY PRODUCER: Does the lightweight equipment last as long?
- Wyatt from DeLaval: Durability of the lightweight units is an important issue
- If DeLaval can provide it cheap enough, then we can use it and replace it as necessary! (Laughing – joking with Wyatt from DeLaval)

Enhancing Safety Training Effectiveness in Industrialized Dairy Production (Rosecrance)

International Dairy Research Consortium (Reynolds)

- Consortium was developed this year with researchers from Sweden, Finland, Germany, Italy, Canada, Australia, Brazil and New Zealand.
- First meeting will be in July
- Focus on bringing together international researchers to identifying the greatest OH&S needs and make research more efficient by pooling resources.

Group Discussion-Language Barriers

- One producer teaches her workers English through a program conducted through the university.
- BOARD MEMBER: Agricultural managers are typically not extroverts. They would prefer to do things themselves rather than explaining it. They would just like to get on with it!
- BOARD MEMBER: The main means of communication in a dairy is still the blackboard that is at the head of the milking parlor.
- MATT heard from one farm worker that he learned English because he wanted to understand the things written on the blackboard and the English-written lists given to him at work.
- BOARD MEMBER: Writing things down works best. Telling things to your workers sometimes works, but if you want to ensure that it gets down, you need to write it down.
- OLGA heard of a dairy with 300+ workers in Minnesota where they chose to teach their English-speaking workers Spanish, rather than vice versa. This is not the choice Olga and her husband made for their farm, but it is another option.
- BOARD MEMBER: The language barrier is an important factor in farm management. Teaching programs go a long way to help, including teaching dairy owners Spanish.
- REYNOLDS: Scholarships could assist in this area.

- Key point was need for training of managers on Communication – more than just Spanish (how, when, how often). Much of discussion kept coming around to skills or tools that managers need.

Note that all the proposed projects are dependent upon the HICAHS Center receiving funding for FY 2012 or alternative funding.

Day 2 Minutes:
Thursday, April 28, 2011

Federal Budget Update (Reynolds)

- Funding is secured through fiscal year 2011 (September 2011), but unknown for fiscal year 2012.

Group Discussion on Funding & HICAHS' Role

Funding & Collaboration Opportunities

- BOARD MEMBER: The Western States Dairy Association meets four times/year. They are probably not aware of the Ag Centers. The members typically consist of progressive dairy producers.
- BOARD MEMBER: Has HICAHS talked to the DMI group? Funds for this group come from the check-off program.
- BOARD MEMBER: One dairy management group received $1 million through USDA to promote dairy products etc.
- BOARD MEMBER: Wal-Mart spends a lot of money on sustainability. Also, if you use the right "buzz words" there is funding through the Gates Foundation

Management and Safety Programs by Other Organizations

- DAIRY PRODUCER:: Pfizer has started a management training program called "People First." If the employer/employee relationship is bad, injuries will go up. Team building is very important. In the People First Program, the 1st consultation is free. They provide advice from field experts and analysis of leadership and supervision. Could be interested in joint venture.
- DAIRY PRODUCER:: There is a need to train supervisors to be better leaders. Safety suffers where there is poor communication. Example given of fake injuries. Use of bilingual safety messages.
- Action item – HICAHS needs to do an inventory of what programs are already underway, what organizations or partners have we not yet engaged. HICAHS needs to identify gaps and our niche.

Politics, Accountability, and Mistrust/Misunderstanding of HICAHS

- BOARD MEMBER: There is a perception that HICAHS is part of OSHA, and that HICAHS is setting up the industry for additional regulations by "gathering ammunition" for OSHA
- RESEARCHER: The funding and the goals of the Agricultural Research Centers are subject to political whims. It would be good to develop some independence.

- RESEARCHER: What is of value to industry may not be necessarily of value to NIOSH.
- BOARD MEMBER: If support can be brought in through the producer section and these groups have a bigger impact on the Hill.
- BOARD MEMBER: It would be helpful for industry groups to have 1 page documents on HICHAS research. This could increase access to Hill 10 fold.
- BOARD MEMBER: Organizations will ultimately not trust HICAHS if it is supported by government funds rather than a dairy management group. Ultimately, your research is accountable to the government rather than the producers.

Data Ownership & Confidentiality

- BOARD MEMBER: Who owns the data?
- STEVE: By federal law, HICAHS must share its data with other researchers. This is part of a push for accountability and transparency. What we do if data is requested is we ask the researcher to work with us because there is much contextual information that a researcher needs to know in order to properly analyze the data.
- ALLISON: All data must be de-identified though.
- JOHN R: Yes, but I think the industry's concern is that someone will use the data to make a case against the industry.
- STEVE: University must provide confidentiality for subjects and adhere with strict ethical guidelines for research. Our approach has been that de-identified data can be provided but persons must specify how and where the data will be used, especially to avoid misuse or misinterpretation of the data.
- BOARD MEMBER: This issue relates to the role of government. Producers need to be aware that if we pay for the research, then we can have control over how it is used.

Maximizing Value to the Dairy Industry (Douphrate)

Practical Solutions Based on Sound Science

- BOARD MEMBER: There is a need to translate data to action, use the research findings to create engineering solutions.
- BOARD MEMBER: Find solutions to problems. Producers will say, "Don't tell me I have a problem; tell me how I can solve it!" Be wary of regulation based on poor or old science:
    - Example: Much of California's legislation is based on an air pollution study that was conducted in the 1930s.
    - Example: One paper in the Journal of Dairy Science recommended that all dairy workers needed to wear respirators. This recommendation was based on findings from studying old dairy parlors that had gas heaters.

- MATT offered to contact the Journal of Dairy Science and review articles submitted for publication.

A Market-Driven Business Model in conjunction with a Scientific/Academic Model

- BOARD MEMBER: Try not to duplicate other work, this will reduce the burden on research participants. With every study, have an end goal to improve a problem and not just conduct research for research's sake.
- STEVE: Some projects (large scale) can take up to 5 years (bioaerosols etc.) and we do not want to overburden supporters.
- MAGGIE: (Speaking about research approaches): On the other hand, exploratory research is conducted to identify issues before they become a problem. For example, research on preventing asbestos from coming out.
- A Market-Driven Research Center?
    1) RESEARCHER/BOARD MEMBER: If there were a market-driven program, would producers be willing to pay for it?
    2) BOARD MEMBER: The last 3 years have been devastating for the industry. When the industry booms, producers may be willing to pay. Otherwise, they would not.
    3) RACHEL conducts safety meeting for the Colorado Livestock Association. In her experience, the best time to have meetings in on pay day (so that workers show up), and the meetings must be short (~half hour). [Indication that not many resources are being devoted to safety and health on farms right now).
    4) BOARD MEMBER: I think it is important to bring academia back to the entrepreneurial environment, and take out research from the ivory walls to the business world.
    5) BOARD MEMBER: Feed companies can bring in experts for workshops with dairy supervisors. Colorado is one of the biggest and fastest growing dairy regions.
    6) Would 3M be a potential source of funding or trial products?
- The Science Approach
    1) JOHN R: As we saw in Cheryl Beseler's presentation yesterday, our grant funding requires the development of complex scientific models. Each grant must pass scientific scrutiny. What you (the producers) are saying is that this research should be pertinent to the industry at the same time.
    2) STEVE: We should use scientific rigor to learn about the issues and propose answers.

3) BOARD MEMBER: Science highlights issues and leaves it to other agencies (e.g. regulatory) to solve problems.

4) JOHN R: We could use our projects with the construction industry as the basis for development. Currently doing 5 year leadership and management training (health and safety) safety climate program and John Deere is involved.

5) DAVE: Historically, research has been funded by industry groups has been criticized for being biased.

6) Maggie: Yes, for example, some important findings in the research conducted by chemical and tobacco companies was withheld from dissemination.

7) DAVE G: Science occurs in 2 steps: (1) Understanding Mechanism and (2) Developing a solution.

8) DAIRY PRODUCER: Industry and Ag Extension ask the "what" (how do we solve this problem) while academia ask the "why" (what is the problem, why is there a problem).

9) BOARD MEMBER (in response to DAIRY PRODUCER): Extension used to work like this.

- STEVE's Summary: There is a need to avoid duplication of other research and push academia into the entrepreneurial sector. Sell the concept of research.

Build Trust and Work with Other Organizations

- BOARD MEMBER: Building trust will lead to more access to farms.
- The **Farm Bureau**: The Farm Bureau is one organization that works to solve agricultural problems. The Farm Bureau is not active in all states.
- BOARD MEMBER: **New Mexico Extension** is working to rebuild the dairy program to build an unbiased platform between industry and academia. **E-Extension** could move research from academia to the field.
- **CLA** is collaborating with **CSU Department of Animal Sciences** to write articles for CLA's newsletters.
- DAIRY PRODUCER: There is a need to change **immigration** policy. Producers want well-trained workers, but you can't train them if the visas are short. We want to keep our employees and employees are going to become more and more valuable.
- BOARD MEMBER: The **National Milk Producers Federation** could access insurance companies and their with programs i.e. Nationwide and Reece Meyers.
- BOARD MEMBER: **Workers compensation** is not efficient. Why aren't the agencies all working together?

- BOARD MEMBER: Iowa offers an independent evaluation (safe farms accreditation) which could be modified to fit dairy industries so that farmers can get discounts
- BOARD MEMBER: It could be better to have the farm safety programs initiated and created by the farmers, rather than insurance companies. The farmers could use the program as bargaining tool to lower insurance rates.
- NOA works with the **Western Dairymen's Association**

Measuring HICAHS Impact to Dairy Industry (Reynolds)

- BOARD MEMBER: J.W. Schroeder in North Dakota has information on measuring impact

Benchmark Dairyworker Health

- BOARD MEMBER: Not all businesses provide health insurance and workers don't always get medical attention. Need to find a way to benchmark population health status.

Meet Face-to-Face, Host Seminars, and Talk to Dairy Councils

- BOARD MEMBER: The focus groups need feedback, but surveys are useless. Feedback is best when it is done face-to-face for longer than 30 minutes.
- BOARD MEMBER: Need to ask producers what is of value, what are the day-to-day issues and what needs to be done.
- BOARD MEMBER: Short educational seminars are good; what we propose, solutions and challenges etc.
- BOARD MEMBER: Try to access dairy council meetings to learn more about the dairy producers' areas of interest.
- BOARD MEMBER: Board meetings are an essential source of information.

Effectively Translating Research to Practice (Rosecrance)

- STEVE: There is not good baseline data on the impact of agriculture research. Need to find ways to measure i.e. training course, stakeholders, website hits.
- MATT: The well-collected data is on tractor incidents, data collected from newspaper clippings! Other areas where data could be collected is on worker stability and turnover.
- BOARD MEMBER: Could use animal happiness as part of worker assessment. There is a link between animal happiness and worker satisfaction. The understanding of the human/animal interface is changing.
- DAVE: It would be nice to be able to collect fatality data on all farms, not just those with 10 or more employees. OSHA investigates all fatalities.

- STEVE: could learn from the mining industry regarding how to gather information for near misses as a guide for collecting similar information in farming industry. The industry is driving data collection, sharing its data and using that information to prevent incidents in the mining industry.

OSHA Consultation

- BOARD MEMBER: The industry would like more information on OSHA consultation (how, where and why). Are producers required to implement their recommendations? It would be great to have an OSHA course developed on how to prepare for an audit.
- DAVE: There is a Wisconsin presentation that could be repackaged.
- DAVE D.: OSHA consultation is backlogged with visit requests in Colorado. Also, OSHA Consultation is not available in all states.
- RACHEL received a brochure the OSHA Englewood Office and it said that the program required that the problems that they find be fixed within six months. They cannot fine if the problem is not fixed.
- Dave D.: Wisconsin has some information developed which could be repackaged for the newsletter.
- BOARD MEMBER: A Training course on OSHA inspection process would be great – 1 page handouts on what to expect. Facts and figures etc.
- STEVE: Would like to develop information for OSHA dairy visits.

Indicators for Measuring Impact

- DAIRY PRODUCER:: Outcomes could be measured i.e. cash flow, workers comp/accident and incident data using a selective group of dairies to share information. You would need to first research the baseline rate.
- Baseline data must include days of work missed and near misses. This information could help with formal record keeping. Perhaps OSHA consultation help with formal record keeping, training logs etc?
- HICAHS could compare 2 groups. First group has training and 2nd without training program.
- Exposures to an irritant is (relatively) easy to measure but an exposure is not always matched with an "outcome" (e.g. a health effect that you see or experience
- BOARD MEMBER: Need to be cautious because workers compensation collection varies between States. The Bureau of Labor Statistics could be of assistance. The dairy industry has 5.3 injuries per 100 workers per year (using data only from farms with 10 or more employees).

- Dave D: The workers compensation rate higher than the national average
- NOA: Has found that 40% of dairy workers have an injury.
- DAVE G.: We need to think of leading indicators instead of lagging indicators
- BOARD MEMBER: There are 2 worlds: the compliance world and the industry world. The compliance world is driven by OSHA regulations, and not industry needs. The industry world is producer driven, based on individual farms' needs and may team up with insurance companies and other stakeholders.
- BOARD MEMBER: A Worker Safety program could benefit the producer by containing the cost of insurance. For example, a 5% discount when taking up the 6 step safety/training program.
- BOARD MEMBER: Farmers are not traditional book-keepers. Family farms are rapidly expanding and data documentation may not be keeping up with growth. Not traditional book keepers.
- DAIRY PRODUCER:: Collecting data on worker safety, health, ergonomics is difficult but doable.
- DAVE D: HICAHS could offer students information/classes on safety and health regarding dairy and large animal handling. Great way to disseminate information.
- MATT: Poultry extension could be another avenue for OHS. Could include awareness.

HICAHS Dairy Advisory Board Operations

- STEVE: The purpose of the dairy board is to share information. The proposed time commitment is 1 face-to-face meeting per year. Conference calls (e.g. Skype) can also be made available.
- STEVE Showed a slide of suggested tools:
- BOARD MEMBER: A website chat room would be useful – could have a dairy chat room and also put on links to other information sources . For example, the National Agricultural Health and Safety Database.
- BOARD MEMBER: A website resources section that could link to research papers would be nice.
- MAGGIE: A HICAHS database of research papers is being developed.
- BOARD MEMBER: There could be a membership-only section for papers and discussion boards because we need to think of issues such as Agro terrorists (PETA). There are also copyright issues for sharing publications. Need to be careful of mentioning immigrant status.

- JOHN R's Suggestion: We could have a project report every 4 months, including funding updates and who is working on what.
- STEVE: Would two people in this group be interested in representing the HICAHS Dairy board. These two representatives would drive the broader agenda for advisory group and serve as a leader.
- ROBERT agreed to be a liaison

Attendance

Name		Association	Wednesday April 27, 2011	Dinner April 27, 2011	Thursday April 28, 2011
Cheryl	Beseler	HICAHS	X		X
Mary	Bradford	HICAHS	X		
Vicky	Buchan	HICAHS	X		
Kristin	Danhoff	HICAHS			X
Maggie	Davidson	HICAHS	X	X	X
Garrett	De Vries	Monte Vista Dairy - Colorado	X	X	X
Allison	De Vries	HICAHS	X	X	X
Dave	Douphrate	HICAHS	X	X	X
Alvaro	Garcia	SD State Univ - Dairy Extension	X	X	X
Dave	Gilkey	HICAHS			X
Larry	Goodridge	HICAHS		X	
Robert	Hagevoort	NM State Univ - Dairy Extension	X	X	X
Dennis	Lamm	HICAHS	X		
John	Mehaffy	HICAHS	X		X
Rachel	Motteram	Colorado Livestock Association	X		X
Matt	Nonnenmann	HICAHS	X	X	X
Diana	Perez	HICAHS	X		X
Louise	Quijano	HICAHS	X		X
Risto	Rautiainen	HICAHS	X	X	X
Olga	Reuvekamp	Hilltop Dairy - South Dakota	X	X	X
Steve	Reynolds	HICAHS	X	X	X
Noa	Roman-Muniz	HICAHS	X		X
Cecilia	Rosas-Goulart	Pfizer			
John	Rosecrance	HICAHS	X		X
Jon	Slutsky	La Luna Dairy - Colorado	X	X	X
Wyatt	Smith	DeLaval	X	X	X
Lorann	Stallones	HICAHS		X	
Juan	Velez	Aurora Organic Dairy - Colorado	X		X
John	Volckens	HICAHS			
Bill	Wailes	CSU Animal Sciences Dept. Head	X	X	
Allen	Young	UT State Univ - Dairy Extension	X	X	X

Jeff Levin and Ralph Bruno participated remotely through the video-conference system. However, the audio quality was poor and they could not hear most of the conference.

HICAHS International
Dairy Research Consortium
Fort Collins, Colorado, USA
July 11-13, 2011

Minutes

Day 1 • July 11, 2011

On the first day of the conference, researchers shared information on the state of the dairy industry in their respective countries and the research and service programs on occupational safety and health that they are conducting.
A CD of all the presentations and other files from the conference was provided to the attendees following the meeting. A CD can be provided to you by emailing hicahs@colostate.edu. Details of each presentation can be found by reviewing the slides and the notes written beneath each PowerPoint slide.
The following is a categorization by theme of identified concerns.

Concerns mentioned by themes from Day 1 Presentations

- Education of primary care physicians related to occupational disease & injury
  - Assess for occupational diagnosis
  - Return to work issues
  - Modified work needs

- Workforce Issues
  - Language issues due to workforce needs
  - Health care access, particularly undocumented
  - Training needs at all levels (management & labor)
  - Mental health effects of market volatility/suicide – price of milk

- Methodology
  - Difficulty of data comparison between current data collection methods and older data
  - Developing and adoption of new methodology – ex: DNA pyro sequencing
  - Standardization of data collection methods and/or analysis – e.g. dust collection methods
  - Need for applied research – e.g. go to the work site to do research, don't expect workers to come to you

- Mechanization of dairy operations
  - Impact on dairy operation size
  - Ergonomic impact
  - Repetitions
  - Training needs related to new milking procedures

- Overcoming barriers to health and safety messages
  - Whom do you target?
  - Delivery method
  - How increase receptivity – overcome "won't happen to me"
  - Time and finance pressures
  - Modifying traditional approaches to production

- Working conditions
  - Long hours
  - Every day of the week
  - Multiple types of tasks
  - Repetitious
  - Task analysis needed

- Policy Issues
  - Who is covered by Workers' Comp Insurance?
  - Access to workers' comp/insurance data
  - How is a worker defined?
  - Agriculture versus urban environment – environmental issues
  - Regulating pesticide use
  - Reporting issues/requirements – laws/regulations

- Funding issues
  - Long term research funding scarce
  - Potentially relate to climate change

- Occupational Health
  - Need for consistent surveillance data
  - Respiratory Disease
  - Ergonomics – musculoskeletal
  - Zoonotic Diseases
  - Pesticide exposure
  - Heat stress

- Occupational injury
  - Need for consistent surveillance data
  - ATVs, tractor rollovers – high fatality rate
  - Animal handling
  - Work environment - hot, slippery

- Impact of globalization
  - Harmonization of labeling
  - Differences in country regulations/standards related to:
    - Products
    - Workers
    - Health and safety requirements

Day 2 • July 12, 2011

During Tuesday's group session, researchers brainstormed to create a list of potential research topics for agricultural safety and health. A master list of concerns was created in advance by Vicky Buchan and Kristin Danhoff from Day 1 Presentations. Consortium attendees added to this list and discussed the needs related to these topics during the group session. Vicky Buchan and David Douphrate each facilitated a discussion with half of the Consortium Attendees and then the Consortium Attendees voted which topic areas had the highest priority and relevance.

SESSION 1

In which areas of occupational health and safety is collaboration needed?

A broader scope of health

Addressing stress and mental health while working on other issues as well such as sanitation and diabetes is needed.

Leadership Training

- Managers want assistance on how to be better leaders and managers to their employees.
- Develop a more cohesive network to plan interventions, work together, and build off each other's ideas. Employee and management training are two key areas.
- There are some safety areas that should be spearheaded by leadership: sharing near misses and safety training.
- Apply to NIOSH to include a larger view with management/leadership training?
- So much of this change of health and safety is imbedded in the culture. The change agent is the middle management.
- The dairy owners really appreciate what we are doing from a business stand point. Management drives safety.
- The question is how to get producers involved in a safety program. Producers do seem to be taking on more of a systems perspective. HICAHS has used tools such as Six Sigma to show them how to do this from a systems perspective. Six Sigma is a process of improving production by eliminating inefficiencies.
- It is also a question of "marketing" safety to a farmer or producer. How to craft the message about the necessity of safety that will speak to them; what is their motivation for incorporating best "health and safety" practices.

Considering Health and Safety from Multiple Perspectives

- Need to consider the different levels and makeups of farms so as to target multiple groups.
- Owners and producers wear many hats when looking at their farms, so how can this group assist them on the different levels. Differences in language, education, size of farm, finances, etc. will make their needs different across countries and regions.
- Keep in mind the end-user; tangible products and applied knowledge.

SESSION 2

The agenda for the second small group session included discussion of how we researchers can collaborate on potential resources, research, and other projects. The discussion naturally followed earlier discussion regarding the highest priority research areas identified by group votes.

The following is a list of resources that may address the research topics above.

- Guidelines/starting points
  - ISO 9002/14000
  - COSHH Essentials (Control of substances hazardous to health)

- Standardization resources (Aerosols)
  - Australia standardization of dust exposure report *(Sue)*
  - Literature review and database *(Maggie)*
- Resources within our group of attendees:
  - Integrated management programs *(Dave, John R., Paul, Steve, Bill, Peter)*
  - Occupational medicine *(Matt K, Dave) (DeLaval)*
  - OSHA/Extension
  - Cultural Competence *(Matt K, Lorann, Louise)*
  - Audit *(Risto)*
  - Engineering/integration (Lelia)

SESSION 3

Areas for Potential Collaboration

1. Safety Process model/approach
   a. Needs Assessment of Stakeholders (worker/owner/operator)
      i. Related to Motivation (Why adopt Safety?)
      ii. Other topics: training needs, safety practices, etc
   b. Identification and sharing of best Practice Models/Examples
2. Standardization/Data Collection
   a. Exposure assessment / agreed upon methods
   b. Developing useful Profiles
      i. Related to data sharing Re: Occupational Disease
3. Impact of Climate Change on Health of Dairy Workers
   a. Popular due to Funding Potential
   b. Relationship to Zoonotic Diseases

Day 3 • July 13, 2011

Christina Kolstrup gave her presentation on her research projects that are being conducted in Sweden.
Notable Features of Dairies in Sweden:

- 40% work on farms with <75 cows
- Cows are housed most frequently in tie-stall barns, rather than free stalls
- recent survey showed that farmers perceive a positive economic outlook for farming

Possible Collaborative Projects – From Day 1 Discussions

1. Discussing Dairy industry from international perspective
    a. Summarization of different needs and concerns in dairy
    b. Group statement
    c. Draft of topics and ideas have been generated
    d. Easy win as product from this group
2. Database of different tools developed between everyone
    a. Comments by different users on use of tools
    b. Potential blog discussing problems based on culture, etc.
    c. Collaborate with Anthropologists looking at culture issues
3. Electronic Site
    a. HICAHS can setup a resource list
4. Basic understanding of Resources
5. State of science in dairy research: literature reviews in different topics
    a. What don't we know and do we need to know here in the states
    b. What contributes to motivation of workers: Comparative analysis
6. Aerosol Evaluation
    a. Similar Data collection
    b. Exposure similarities between different parts of the world
    c. Evaluate sampling methods and simulate differences in aerosol characteristics
7. Human Factors in Agriculture and Safety

Potential Projects & Activities

Steve recommended we identify potential objectives, short term and long term, based upon previous discussions.

Collaboration Opportunities and Obectives Broken down by Time frame along with established Responsibilities

1. Short Term
    a. Compile Resources available: HICAHS website restricted
        i. ILO: Government, union, and employers
        ii. Sweden
        iii. WHO
            - Regional disparities
    b. Evaluate and Provide Feedback: HICAHS: Allison, Steve, Matt K, Italy
        i. Use of LinkedIn and E learning System
            - Calendar of Events for meetings
        ii. Blog: Structure, Vicky and John G,
            - First Blush: Does this work, will it work
            - Pilot: Add demographics
            - Apply and Evaluate
        iii. Industry contribution: producers and workers
    c. Producers and workers Feedback Dave Douphrate, Louise Quijano, Vicky Buchan
        i. Design Tool specifically for Producers
    d. Contribute Documents: Everyone
    e. Organize thoughts about adaptability of different tools
    f. Aerosol Project: short to long, Marcos, Sue, John G., Matt K, Maggie, John V, Steve, Shelley
    g. Ergonomics Project: Dave, John R, Theresa, Martina, Kristina, Lelia
2. Medium Term
    a. WHO collaboration Dairy project (Sue and Claudio)
    b. Journal Article publication (Steve, Kristina, Matt K, David, Matt N)
    c. Marketing (Publications or conferences: ISASH, IOHA)
3. Long Term
    a. Explore opportunities nationally of partnership with WHO center: Sue, Claudio
        i. WHO orgs: ICOH, WONCA, OHTA, IDF
    b. Develop partnerships with Vets
        i. One health: John G, Matt K, Claudio C, Steve R, Theresa, Rob, Susan B

International Dairy Researcher Meeting – Dublin

Monday, August 22, 2011

Irish Meeting on Agricultural Occupational Health and Safety

Attendees

1. **Maggie Davidson**, HICAHS, USA
   Post-doctoral fellow who specialized in bioarosols.
2. **Allison De Vries**, HICAHS, USA
   Research Coordinator for HICAHS, an agricultural research center that conducts various dairy safety and health projects. Her Dad is a dairy farmer
3. **David Douphrate**, HICAHS, USA
   Ergonomist who is studying dairy parlors.
4. **Martina Jakob**, Leibniz Institute for Agricultural Engineering, Germany
   Ergonomist who has spent the last five years focusing on dairy parlor problems.
5. **Janne Karttunen**, TTS - Work Efficiency Institute, Finland
   Has been a researcher in TTS for 10 years. Currently on study leave writing his thesis regarding occupational safety and health of farmers.
6. **Christina Kolstrup**, SLU, Sweden – Agronomist (livestock) and researcher. Her PhD thesis was about physical and psychosocial work environment and health among livestock workers. Intersection of human and animal health, work motivation and work satisfaction, and agricultural safety and health in developing countries (Africa).
7. **Jarkko Leppälä**, Finland
   PhD student and researcher who is focusing on sustainable risk management on dairy farms. Has a dairy farming background.
8. **Lotta Löfqvist**, Sweden
   Ergonomist and PhD-student, who is studying MSD and ergonomics in horse stables.
9. **Peter Lundqvist**, Sweden
   Study areas include business economics and environmental psychology. Has worked with the dairy industry since the 1980s.
10. **John McNamara**, Health and Safety Officer Teagasc, Ireland
11. **Risto Rautiainen**, USA
    Director of NIOSH Ag Center in Nebraska called the Central States Center for Agricultural Health and Safety (CS-CASH). Researcher expertise includes ag engineering, epidemiology, and economic (cost/effectiveness) evaluations. His family farms in Finland.
12. **Steve Reynolds**, Director HICAHS, USA
    HICAHS has worked with the dairy industry for the past 10 years. HICAHS emphasizes a comprehensive approach to health and safety in the dairy industry, including research and prevention efforts encompassing respiratory health, ergonomics, cost-effective interventions, training and, management practices.
13. **Tom Ryan**, Teagasc, Ireland
    Conducts specialist training on farm buildings and machinery

Meeting Minutes

Summary of Project Ideas from the International Meeting

Steve Reynolds summarized results from previous meeting in Colorado, described three ideas, which were: (1) Compile Agricultural SH resources and distribute through the HICAHS website, (2) Evaluate and provide feedback on the resources, (3) Collaborate with other organizations and target other research areas. (WHO Research Center, Canadian ISASH conference, veterinarian safety and health.)

Discussion: Which research areas are important?

- Animal Handling
- Injuries
- Partnering with veterinarians and dairy service companies
- Fatalities from falling into manure pits
- Communicating occupational safety and health regulations to stakeholders
- Evaluating the effectiveness of occupational safety and health interventions

Worldwide Trends in Dairy Farming

- Finland dairy farmers are experiencing a need to train workers on how to use advanced technology for dairying.
- U.S. dairy farms are experiencing an increase in OSHA inspections.
- U.S. dairy industry has labor issues. Dairies are dependent on foreign-born workers, mostly from Latin America.
- Many European dairies are also dependent on migrant laborers.
- Ireland dairy farms are also experiencing problems finding skilled laborers.
- Ireland dairies account for a disproportionate number of farming accidents (compared to cattle or crop farms).
- Ireland dairy farms are getting larger or going out of business.

Conversation Details

Peter Lundqvist: (1) ***Animal Handling****, especially preventing bull injuries and (2)* ***Injuries*** *are important research areas.*

David Douphrate thinks that partnering with ***veterinarians*** *and* ***dairy service companies*** *is important. De Laval has been a great partner to HICAHS. Thanks go to Peter Lundvist for establishing that connection.*

David Douphrate: The US Occupational Safety and Health Administration (OSHA) has traditionally not focused on dairies, but there has been a recent increase uptick in the number of investigations. David Douphrate authored wrote an article regarding OSHA trends.

John McNamara: In Ireland only 17% of farms are dairies, but they account for 58% of farm deaths and 28% of non-fatal accidents.

Jarkko Leppälä: In Finland the production technology is becoming more sophisticated, which brings new challenges to occupational safety and health. Workers need to be highly skilled to operate the equipment that has new technology.

Maggie Davidson: The United States dairy industry is experiencing worker issues. [The challenge is to keep a steady supply of qualified, legally-immigrated workers. Dairies rely on foreign-born workers.]

Peter Lundqvist: Migrant workers are also a trend in Europe.

Tom Ryan: Finding skilled laborers is also a problem [for Ireland.]

John McNamara: Dairy farms are either getting larger or going out of business.

ADDITIONAL NOTES FROM STEVE'S MEETING IN UPPSALA SWEDEN 8/19/11

Attendees:

1. Anna Rask-Andersen
2. Lena Elfman
3. Steve Reynolds, USA

One of their colleagues (a nurse)– Christina (didn't get last name) worked on New Zealand dairies.

Lena (PhD) is particularly interested in collaborating on the aerosols group and can contribute allergen analyses.

Anna (MD) interested in overall health and health care access issues with immigrant/migrant workers. She has worked on models for changing health behavior.

Appendix 4: Advisory Board Responsibilities

The HICAHS Advisory Board is committed to assisting HICAHS staff in advancing the mission of "reducing or eliminating accidents and injuries, disease and death resulting from agricultural operations." This mission is addressed by: undertaking applied research; providing prevention services such as hazard evaluation and control; and developing educational programs for those who work in agricultural production. The Advisory Board is representative of the geographic region including Colorado, Montana, North Dakota, South Dakota, Utah and Wyoming and constituents actively involved in agricultural health and safety.

I. GENERAL DUTIES

1. Attend scheduled meetings to provide advise and support to HICAHS staff, research projects and educational/outreach efforts.
   - A. Generally there is one face-to-face meeting utilizing a one day format.
   - B. Conference calls or web conferencing may be requested to assist with specific research or educational efforts.
   - C. An advisory board term runs congruent with the term of the current granting cycle.

2. Support, encourage, and advise the HICAHS staff and research, education and outreach efforts in the region.

3. Serve in an advisory role for HICAHS staff in determining research, education and outreach needs for the region.

II. SPECIFIC DUTIES

1. Program Planning and Evaluation
   - A. Advise the HICAHS staff as to priorities and goals for achieving the mission of the Center.
   - B. Review and assist in evaluating current research, education and outreach projects.
   - C. Monitor progress on annual program goals and research objectives as identified by HICAHS staff and collaborators.

2. Resource Development

   - A. Review annual budget and provide feedback to HICAHS staff and collaborators.
   - B. Use your influence and provide assistance in identifying opportunities for partnerships and serving as advocates for continued federal funding.

C. Assist and advise in the process of proposal development and grant renewals.

3. Advocacy and Outreach

A. Promote HICAHS and its impact with the broader public.
B. Assist in promoting and building positive relations with HICAHS and stakeholders, constituents and collaborators.
C. Identify prospective advisory board members and promote HICAHS to these individuals.
D. Assist in the public dissemination of research findings and education/outreach efforts.

III. Board Composition

A. Advisory board membership will be limited to a minimum of (?) members and maximum of (?) members.
B. Advisory members will be selected based on interest/knowledge areas, a willingness to be actively engaged with Center activities and ability to help expand influence and research in agricultural health and safety.
C. There will be an Executive Committee not to exceed five persons selected to represent the major sectors that comprise the Advisory board membership. Executive Committee members will be selected by HICAHS staff and serve for the duration of the granting period. The Executive Committee will serve as a rapid response team to requests from the HICAHS staff and provide timely advise as requested from the Center.

Regional Needs Assessment Results

Survey administered to Cooperative Extension and HICAHS Advisory Board Members

2008-2009

David Douphrate, PhD and Victoria Buchan, PhD

Methodology

- Design:
  - Survey
    - Handout at Extension meetings
    - Telephone interview
- Sample:
  - Extension N = 81
  - Board N = 28

Research Questions

1. What are the health and safety topics of most concern to constituents? (research)
2. What topics would constituents be interested in receiving information about? (reseach)
3. What is the best way to reach target populations with that information? (outreach)
4. What issues may impact outreach delivery?

Location By State

	Extension N = 81	Board N = 28
Colorado	15%	71%
Montana	-	9%
North Dakota	60.5	4%
South Dakota	17.2	4%
Utah	-	4%
Wyoming	6.2	4%
Texas	-	4%

Gender

	Extension	Board
Male	**69%**	**67%**
Female	**31%**	**34%**

Owner / Operator

	Extension	Board
Yes	27	43
No	73	43

Advisory Board years of experience averaged by category

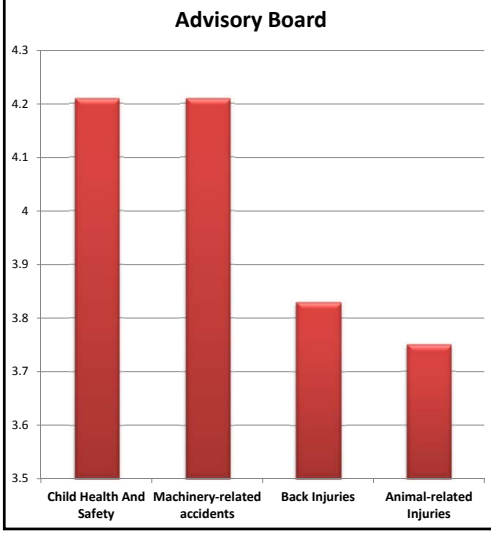
Years in Farming and Ranching?	**31.95**
Years in Agricultural Services?	**24.25**
Years in Production Processing?	**15**

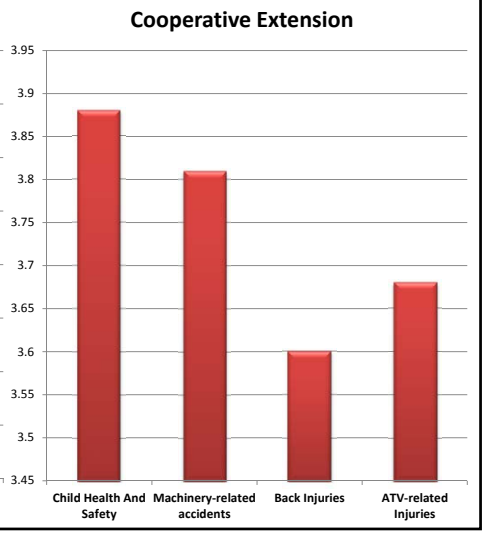
Cooperative Extension
years of experience and position by category

- Years in Current location? = 12.85
- Extension Position

Agriculture	**35.5%**
Crops	**18%**
Live Stock	**16%**
Youth	**13%**
Agricultural Economics	**5%**
Horticulture	**4%**
Other	**8%**

How concerned do you believe your constituents are about the following Health and Safety Problems ?

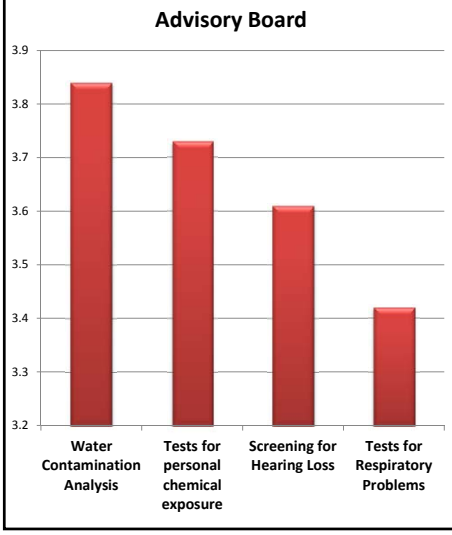


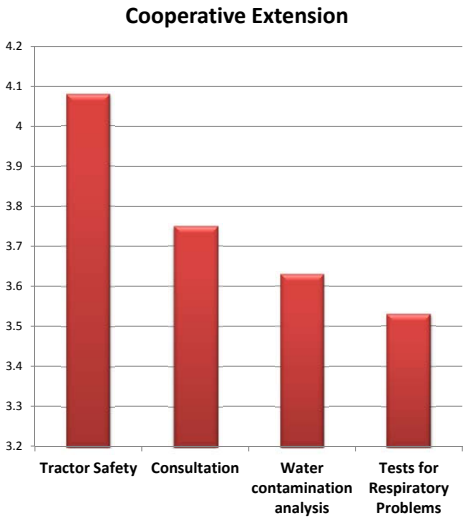


If your constituents where interested in more information about the causes and prevention of agricultural related injuries and diseases, what topics would be of most interest?

	Advisory Board			Cooperative Extension
Animal-related Injuries	1		Child Health And Safety	1
Machinery-related accidents	2		ATV-related Injuries	2
Pesticide and Fertilizer-related illnesses	3		Machinery-related accidents	3
Tractor Related Injuries / Respiratory Problems (tie)	4		Pesticide and Fertilizer-related illnesses	4

If any of the following services where made available to your constituents which would be most useful?





What factors might influence those seeking information on agricultural health or safety?

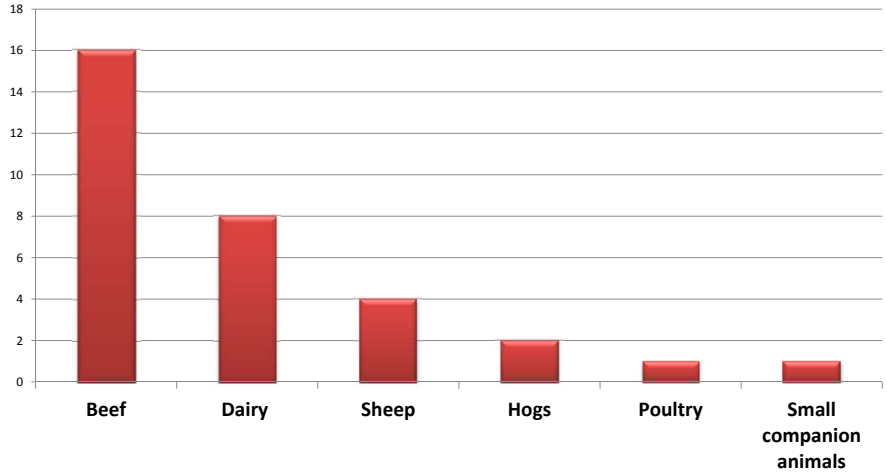
	Advisory Board		Cooperative Extension
Location	50%	Lower Insurance Rates	72.5%
Time of Year	36%	Location	67.5%
Cost	32%	Time of Year	67.5%
Time of Day	29%	Cost	55%

The best methods for distributing or presenting the information?

	Advisory Board		Cooperative Extension
Farm / Ranch Publications	1	Cooperative Extension	1
Veterinarians	2	Websites	2
Farm / Ranch Org	3	Farm / Ranch Publications	3
Feed Chemical Equipment Dealers	4	Farm / Ranch Org	4
Cooperative Extension	5	Feed Chemical Equipment Dealers	5
Radio	6	Youth Org's	6

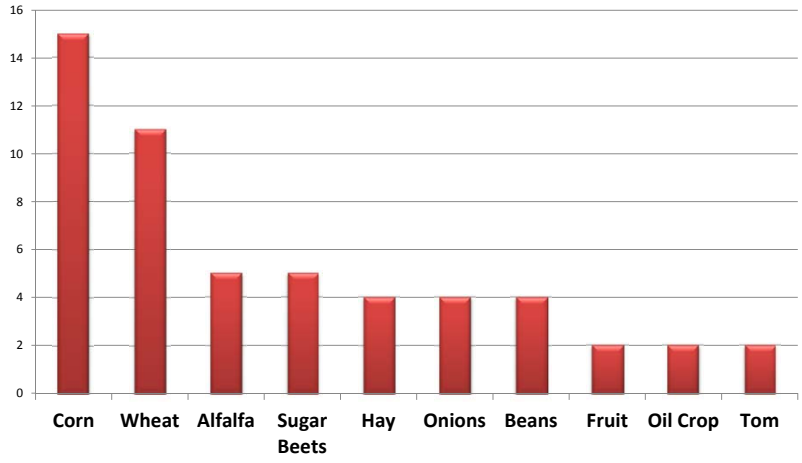
1. What are the major agricultural products in your state/region?

Live Stock

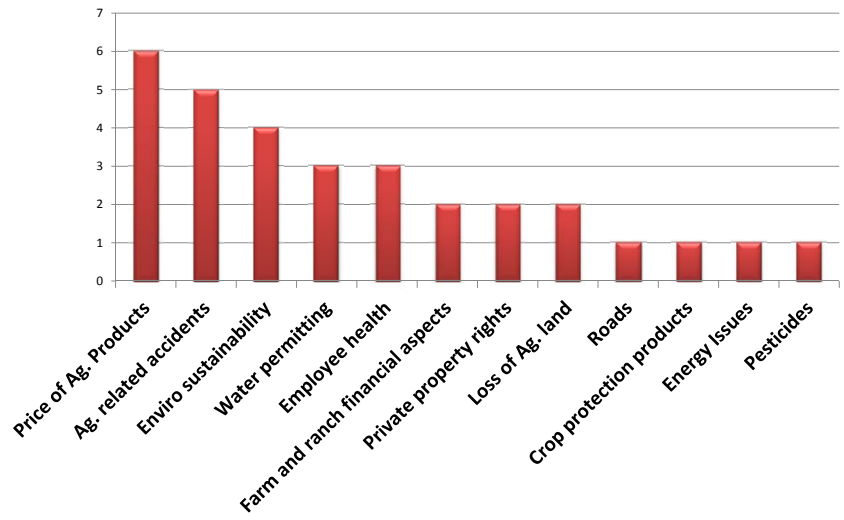


What are the major agricultural products in your state/region?

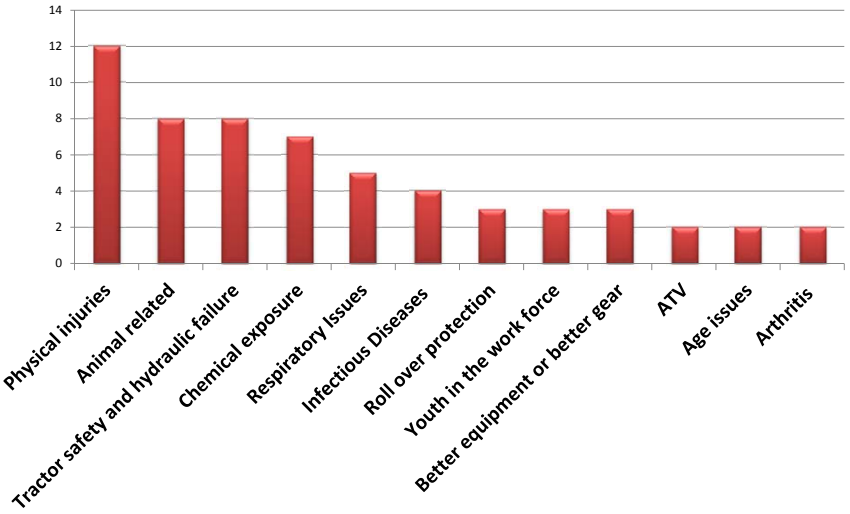
Crop Products



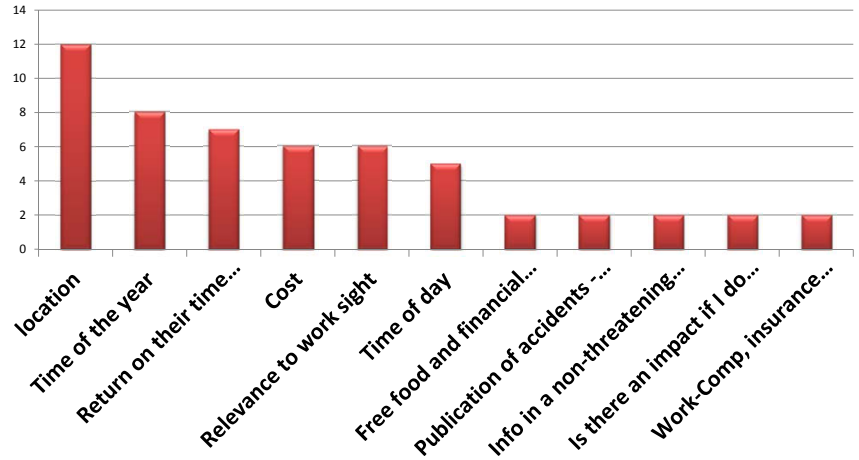
Relative importance of issues that are often concerns for farmers and ranchers?



Can you think of any other health or safety issues perhaps related to your constituency or region that concern you?



Other Factors you believe might influence your constituents attending programs on agricultural health or safety



Future Directions For HICAHS?

Collaborations
More interaction with states outside of Colorado
Partner with Iowa State on the Capacity Building Project - Health Care
Work more closely with agricultural associations to spread a safety message
Linking with research and ext personnel at land grant universities
Link more closely with medical school, nursing school and school of public health for education and research.

Future Directions for HICAHS?

Information Sharing
Put material in layman terms
New techniques for getting information out
New Materials on: tractor safety, animal handling, equipment
Training materials for new employees in: equipment, milking parlors, livestock handling (English & Spanish)
Information materials for older folks that are culturally sensitive

Future Directions for HICAHS?

Services
Onsite safety assessments
Mock OSHA audits

Research
Exposure to toxins (2)
Safer squeeze chutes

Appendix 6: 2007-2011 Distribution of Projects and PAR Priorities

Project	PAR Priorities (See below)																
	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	#17
R-A. Endotoxin/Dairy (R01)						♦♦♦			♦♦♦		♦			♦♦♦	♦	♦♦♦	
R-B. Pesticides (R01)	♦	♦	♦♦♦	♦♦♦	♦♦♦	♦								♦♦♦		♦♦♦	
R-C. GC/MS Endotoxin (R21)						♦♦♦											
R-D. Prison Farms (R21)	♦♦♦	♦♦♦	♦♦♦	♦♦♦		♦♦♦	♦♦♦	♦♦♦	♦♦♦		♦	♦♦♦	♦♦♦	♦♦♦		♦♦♦	
P-A. ATV (R01)	♦♦♦	♦♦♦								♦♦♦	♦		♦♦♦			♦♦♦	
P-B. E Coli (R01)						♦				♦♦♦	♦			♦♦♦		♦♦♦	
P-C. Dairy Interventions (R01)		♦♦♦							♦♦♦		♦			♦♦♦		♦♦♦	
E-A. Enhancing Translation (R0	...	...	...	...	...	...	...	...	...	...	♦♦♦	...	...	...	...	...	
E-B - CD/4H (R01)	♦♦♦	♦♦♦					♦♦♦		♦♦♦	♦♦♦	♦♦♦		♦♦♦				

PAR Priorities

1 - Unintentional Fatalities, 2 - Unintentional Injuries, 3 - Unintentional Acute Pesticide Poisonings, 4 - Pesticide Illness,
5 - New Pesiticide Biomarkers, 6 - Respiratory Disease, 7 - Increase farm machinery with PTO, 8 - Fall Protection, 9 - Livestock Handling Facilities,
10 - Intervention/Prevention Injuries to Youth, 11 - Ed/Outreach - Increase Knowledge,
12 - Interventions Increase Use Hearing Protect/Reduce Noise, 13 - Intervention/Prevention to Reduce Machine Fatalities,
14 - Better Surveillance Methods, 15 - Improved Engineering Controls to Reduce Bioaerosol Exposures,
16 - Interventions for Migrant/Seasonal Farmers, 17 - Helicopter Logging Injuries.

♦♦♦ = strong emphasis
♦ = some emphasis
... = will interface with other projects