DISSERTATION

OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEMS IN ANIMAL PRODUCTION AGRICULTURE

Submitted by

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ABSTRACT

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The relationship between the level of occupational health and safety management system (OHSMS) programming and the rates of occupational injuries and illnesses in dairy and poultry production industries was investigated in this study. It was hypothesized that higher rates of OHSMS programming would be associated with lower injury rates. The individual OHSMS components and attributes with the strongest associations were identified, and the relationships between workforce size, injury rates, and OHSMS programming were also investigated. Data on OHSMS and injury rates for the U.S. dairy industry were obtained from Occupational Safety and Health Administration (OSHA) On-Site Consultation Service records. The OHSMS and injury data were paired using a non-descript identification number and analysed using Spearman Rank-Order Correlation. Generally, weak-to-moderate negative associations were observed between OHSMS programming and injury and illness rates, overall and by OHSMS component. The observed associations were much stronger and tended to be statistically significant when only those records with the most complete assessments of an organization's OHSMS were considered in the analysis. A major limitation of correlational studies is the possibility that an unknown variable(s) may explain some or all of the observed association. To account for this limitation, the research method was applied to a second dataset: OSHA consultation records from the U.S. poultry production industry. Similar associations were found, suggesting that the observed relationships are indeed representative of the true relationship between OHSMS programming

and injury rates. The lack of temporality was another important limitation, because there were no data available on the potential changes in injury and illness rates that may have occurred due to the OHSMS assistance provided by OSHA consultants. To address this limitation, data from a survey of OSHA consultation clients across a wide range of industries was reviewed to determine the usefulness of the OHSMS assistance provided by OSHA consultation to Colorado small business clients, and identify changes that were enacted as a result of that assistance and what the effects of those changes might be. The survey results indicated that the OHSMS assistance was helpful for clients to enact changes such as improved safety programs and training, and that these changes resulted in positive outcomes, including fewer injuries and improved morale. Ultimately, the results of this study provide important preliminary data supporting further research and development of OHSMS interventions for animal production agriculture industries as part of a comprehensive risk management approach to reduce work-related injuries and illnesses. Management leadership was the OHSMS component with the strongest association with lower injury and illness rates, in both dairy and poultry production industries. In addition, the importance of thorough assessments of client OHSMS programming by OSHA consultants was evident, as were the benefits of OHSMS consultation services to small business clients. Further research is warrented to develop and evaluate OHSMS interventions for animal production industries. Economic outcomes should be considered in this research, as well as OHS outcomes and OHSMS programming.

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DEDICATION

For my wife, Amber, and our sons, Anthony and Jacob…and Princess too.

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CHAPTER 1: INTRODUCTION

Working in agriculture is dangerous. Even modern, commercial farms have a number of occupational hazards, including ergonomic hazards, operating heavy machinery, contact with electrical hazards and mechanical equipment, and exposures to dusts, biological agents, hazardous chemicals, and physical agents including noise and extreme temperatures (NIOSH, 1997). It is no surprise then, that agriculture workers suffer a disproportionate number of work-related injuries and illnesses (BLS, 2015b). Animal production agriculture work is particularly dangerous, because of additional hazards associated with contact with animals and animal waste (Douphrate, Rosecrance, & Wahl, 2006).

Improving worker safety in U.S. agriculture is challenging because of social, economic, and political factors. U.S. farm workers are increasingly foreign-born, non-English speaking, and have not completed a very high level of formal education (Schenker & Gunderson, 2013). Fams are also generally located in rural locations, far from city centers that provide services to underserved populations, and workers often live on the farms for which they work (U.S. Bureau of Labor Statistics, 2014). Farmers face many economic challenges outside of their control, including severe weather, the sale price of animal products, and the cost of feed, equipment, and materials (Douphrate, Hagevoort, et al., 2013). This creates financial pressure that may limit farmers' ability to afford safety equipment and professional health and safety services. In addition, U.S. agriculture businesses are often neglected by (or spared from, depending on one's perspective) regulations and enforcement designed to protect workers and ensure a safe work

environment (AFL-CIO, 2014; Reed et al., 2013). As a result, many farms lack even basic safety programs common in other hazardous industries.

Much of the research investigating worker health and safety in animal production agriculture has focused on the identification of health effects in farm workers, and risk factors for injuries and illnesses, including ergonomic and respiratory hazards (Douphrate, Lunner Kolstrup, Nonnenmann, Jakob, & Pinzke, 2013; Pratt et al., 1992; S. J. Reynolds et al., 2013). Little research has focused on comprehensive risk management in these dangerous industries. Safety training has been the focus of several studies, showing mixed results regarding the ability to actually reduce injuries and illnesses on farms (Chapman, Brunette, Karsh, Taveira, & Josefsson, 2011; Hagel et al., 2008; Román-Muñiz et al., 2006). Given the high number of injuries, illnesses, and fatalities suffered by animal production agriculture workers, further research on comprehensive risk management strategies is sorely needed. This project will focus on one such strategy: occupational health and safety management systems (OHSMS).

Although highly touted by many industries, governments, and safety and health professionals, there is little convincing evidence demonstrating the effectiveness of OHSMS approaches to control hazards or reduce injuries. Generally, studies that have attempted to explore the connections between OHSMS programming and occupational health and safety outcomes have suffered from several important limitations (Robson et al., 2007). In particular, small sample sizes and failure to isolate the OHSMS from other health and safety activities have proven particularly challenging for researchers of OHSMS in U.S. businesses (Robson et al., 2007). That is because businesses and management systems are complex. OHSMS approaches

generally involve many people, they take time to develop and implement, they are difficult to measure, and they are often applied in conjunction with other health and safety activities, such as return-to-work programs or employee wellness. Research into related organizational hazard control approaches is more established, including ergonomics programs, safety climate, and safety leadership, but these cannot be substituted for OHSMS research because the focus, purpose, application, and evaluation of each approach is distinct. For example, a recent review found that, despite several overlapping themes, participatory ergonomics program research differed from OHSMS approaches in more areas than they had in agreement (Yazdani et al., 2014).

The U.S. Occupational Safety and Health Administration (OSHA) has long been a proponent of using OHSMS to protect workers. OSHA officials encourage the use of OHSMS through non-regulatory guidelines, "good faith" reductions in penalties for businesses who have an OHSMS, and through employer recognition programs (OSHA, 2009). In fact, a primary function of the OSHA On-Site Consultation Service is to help clients establish an OHSMS (OSHA, 2008a). This is accomplished through the use of the Safety and Health Program Assessment Worksheet (Revised OSHA Form 33), which is used to measure the level of OHSMS programming of a participating business (OSHA, 2008a). OSHA regulators store the results of these assessments in a national database and use them to establish industry norms (OSHA, 2008a).

The goal of this project was to address two of the major limitations of OHSMS research, small sample sizes and co-incident health and safety activities, and to provide evidentiary

support for a new approach to risk management in an industry in desperate need of health and safety solutions; specifically the U.S. dairy production industry. The relationship between OHSMS programming and injury and illness rates on dairy and poultry growing operations are described in two manuscripts presented in Chapters 3 and 4, respectively. Existing data collected by OHSA consultants on OHSMS programming level and injury rates was used in these studies, and correlation was measured between the variables. The potential effects of the OHSMS assistance provided by OSHA consultants was explored in another manuscript presented in Chapter 5. In this study, Colorado OSHA consultation clients were surveyed on their perceptions of the OHSMS assistance that they received. Respondents provided information on changes that they made and effects they observed as a result of the OHSMS assistance they recieved. All of these studies used existing data to establish the preliminary research foundation for the development of OHSMS interventions in animal production agriculture.

CHAPTER 2: LITERATURE REVIEW

Agriculture in the U.S.:

The U.S. was built on agriculture. Today, nearly a billion acres of U.S. land is devoted to food production, totalling over 20 percent of the land area in the U.S (NASS, 2014a). Americans produce enough food to feed themselves and much of the world each year. In 2014, the U.S. exported over 150 billion dollars in agricultural products (Economic Research Service, 2015b). Agriculture contributed nearly a trillion dollars in Gross Domestic Product in 2013 (Economic Research Service, 2015a). As human populations continue to grow, so do demands for food. As U.S. food production has grown in scale to accommodate the higher demand for food, so has the number of workers employed in agriculture. In April 2015, there were nearly 650,000 hired employees working on U.S. farms (NASS, 2015). Most work in agriculture production pays low wages relative to the national average and does not require much education (NASS, 2015). Thus, agriculture producers have increasingly relied on immigrant labor to sustain their growth (Schenker & Gunderson, 2013).

Modern U.S. agriculture is much more efficient today than in the past, producing more food per unit of land, energy, supplies, and resources than ever before. However, despite these technological advances resulting in increased production efficiencies, human resource management has remained largely stagnate (Hagevoort, Douphrate, & Reynolds, 2013).

Health and Safety in Agriculture:

Health and safety in agriculture is an important public health and economic issue in the U.S. Preventable occupational injuries in agriculture are costly. It was estimated that occupational injuries and illnesses resulting from work in agriculture cost the U.S. nearly five billion dollars in 1992, and that number will have increased dramatically with increases in farm labor, direct and indirect costs (Leigh, McCurdy, & Schenker, 2001). These economic estimates of the burden of occupational injuries in agriculture included direct medical expenses, lost time, lost earnings and other measures of economic impact (Leigh et al., 2001). The human toll of these injuries and illnesses is much greater. Every preventable injury and illness suffered by U.S. agriculture workers has the potential to harm many lives beyond the immediate victim (Leigh et al., 2001). For example, the aithors acknowledged that family caregivers time could not be accounted in their analysis, not to mention the psychological toll on the family who cares for an injured person (Leigh et al., 2001).

Injuries, Illnesses, and Fatalities:

Workers in agriculture, fishing, forestry, and hunting (AFFH) suffer occupational injuries and illnesses at rates higher than workers in most other U.S. industrial sectors. In 2013, the AFFH sector accounted for over 10 percent of all reported occupational fatalities in the U.S., despite employing less than two percent of the workers (BLS, 2013a; 2013b). The number of fatalities in the AFFH sector has averaged more than 500 deaths per year in the past four years (BLS, 2015a). In comparison, only construction and transportation sectors had higher numbers

of fatalities over the same time, but lower rates (BLS, 2015a). The rate of injuries resulting in lost-time reported by BLS in the AFFH sector was 5.7 per 100 full time workers in 2012, which was higher than all other private industry sectors (BLS, 2013a). The number of nonfatal injuries and illnesses in agriculture have remained high despite overall decreases in U.S. industries. Between 1970 and 2002, the rate of occupational fatalities per 100,000 workers in the U.S. fell, on average, by nearly 80 percent from 18.0 to 4.0 (AFL-CIO, 2014). In contrast, the fatal injury rate in agriculture has only decreased by 64 percent in the same 32-year period, the slowest decline of all U.S. industrial sectors (AFL-CIO, 2014).

Recently, injury rates in animal production agriculture have been consistently higher than other industry sectors in the agriculture, fishing, forestry, and hunting injury rates. Between 2008 and 2012, the rate of occupational injuries and illnesses averaged 6.4, 5.3, and 4.5 for animal production, crop production, and forestry logging sectors, respectively (BLS, 2015b). The rates of serious injuries and illnesses resulting in lost-time in animal production are higher than the other subsectors, averaging 3.4, 3.2, and 2.8 between 2008 and 2012 (BLS, 2015b). The fatality rate in animal production is also the highest of the three major sectors within agriculture, fishing, forestry, and hunting, averaging 22 per 100,000 workers in the same time period (BLS, 2015b).

The rate of injuries and fatalities in the dairy industry has been comparable to other animal production industries over the past five years. On average, the total rate of injuries and illnesses was 5.4 for dairy production, as compared to 5.7, 5.5, and 5.1 for beef, poultry, and pork production, respectively (BLS, 2015b). The rate of more serious lost-time injuries was 3.0,

3.2, 3.3, and 2.8 respectively for dairy, beef, poultry, and pork production (BLS, 2015b). Further, there were 349 occupational fatalities in the dairy industry alone between 2003 and 2011 (BLS, 2015b). BLS injury and illness reports are also likely much lower than the actual number of injuries and illnesses occurring in the dairy industry. In 2006, Douphrate et al. examined worker's compensation insurance claims in Colorado and found that the injury rate was higher than those reported by BLS for the same years (Douphrate et al., 2006). Additionally, the tendency of BLS statistics to undercount injuries and illnesses has been previously described (Leigh et al., 2001)

Risk Factors for Injuries and Illnesses:

The causes of the high injury and illness rates in the dairy industry are numerous and varied. Most serious acute injuries occur from operating heavy machinery (tractors, bucket loaders) and from contact with animals (McCurdy & Carroll, 2000; Pratt et al., 1992; Román-Muñiz et al., 2006). Dairy production requires routine contact with live cattle, including calving, feeding, milking, and corralling. The average full-grown milking cow can weigh as much as 1500 to 2000 lbs, and hundreds to thousands of cows are moved through the milking process daily by only a handful of workers using pen, gate, and chute confinement (Lindahl et al., 2013). Workers can easily be crushed or stepped on by cows. The risk of injury caused by animal contact may be largely dependent on experience and training. In 2006, Douphrate et al. reported that farm workers with less than one year on the job had a 100% increased risk of being injured (Douphrate et al., 2006). In 2014, Sorge and colleagues found that dairy farmers viewed experience and training in stockmanship (handling cattle) on dairy farms as the most important

factors to reduce the risk of injury (Sorge, Cherry, & Bender, 2014). Other common causes of acute injuries in dairy farming include slips, trips, and falls, contact with machinery, and transportation accidents (Douphrate et al., 2006).

The causes and risk factors of occupational illnesses in dairy workers have been less well established. The results of epidemiological studies have suggested that dairy workers suffer from high prevalence of chronic respiratory symptoms and impaired lung function (Chaudemanche et al., 2003; Gainet et al., 2007; Marx et al., 1990). Allergic rhinitis, pneumonitises and pnemocosises, asthma, and chronic obstructive pulmonary disease have all been implicated as work-related diseases in dairy workforce populations (S. J. Reynolds et al., 2013). Exposures to chemicals, biological dusts, and endotoxins have all been proposed as exposures that contribute to respiratory illness in dairy workers (S. J. Reynolds et al., 2013). In 2013 summary of existing literature, Reynolds et al. reported that sufficient evidence had been established to conclude a cause and effect relationship between endotoxin exposure in dairy parlors, and occupational respiratory diseases in dairy workers (S. J. Reynolds et al., 2013). The authors found that endotoxin exposure was a contributing factor, noting also the effects of other occupational exposures, genetics, and behaviors as important risk factors for respiratory illness in dairy workers (S. J. Reynolds et al., 2013). Musculoskeletal disorders (MSDs) are also common in U.S. dairy workers due to strenuous and repetitive tasks in milking operations (Douphrate, Lunner Kolstrup, et al., 2013). In particular, a high prevalence of musculoskeletal disorders (MDSs) of the upper extremities has been reported (Nonnenmann, Anton, Gerr, Merlino, & Donham, 2008; Patil, Rosecrance, Douphrate, & Gilkey, 2012). Risk factors for upper extremity MSDs in milkers include equipment design and configuration (i.e., milking cluster, parlor

design), work rate, long work shifts, and inadequate rest time (Douphrate, Lunner Kolstrup, et al., 2013). Other common occupational illnesses suffered by dairy workers include allergic and irritant contact dermatitis and noise-induced hearing loss (May, Marvel, Regan, Marvel, & Pratt, 1990; Sell, Flyvholm, Lindhard, & Mygind, 2005).

Injury and Illness Prevention:

Considerable work has gone into researching workplace injury and illness prevention on dairy farms, particularly with respect to respiratory and ergonomic hazard controls. However, research on comprehensive, organizational controls have been largely limited to safety training. There have been mixed results concerning the effectiveness of occupational health and safety (OHS) training for dairy workers. Scientists have found that some training approaches can be effective in increasing safety knowledge of workers, but have found no protective effect of safety training alone and few have examined the impact of training on intermediate OHS outcomes (e.g., number of hazards, safety behaviours, and worker perceptions) or final OHS outcomes (e.g., injury/illness rates, worker's compensation costs).

In 2006, Román-Muñiz et al. reported the results of a survey of 72 dairy workers about dairy training methods and worker injuries on Colorado dairy farms (Román-Muñiz et al., 2006). The authors found that workers who received safety training alone were not significantly less likely to have suffered an injury in the previous year (Román-Muñiz et al., 2006). However, they observed that workers who received task-related training and training by a co-worker were significantly less likely to have suffered an occupational injury (Román-Muñiz et al., 2006).

The authors concluded that the involvement of trained co-workers could improve dairy safety training and they recommended further research using objective data that include occupational injury and illness severity and rates (Román-Muñiz et al., 2006). In a 2008 study, the results of an analysis of the effectiveness of an ambitious 19 year Canadian farm safety education program were described (Hagel et al., 2008). The education program was mostly print-based, in the form of newsletters and flyers, but also included conferences and on-site demonstrations (Hagel et al., 2008). The study included data on 2,392 Canadian farms located in Saskatchewan (Hagel et al., 2008). The authors found that participation in the education program was not significantly associated with any differences in farm safety practices, occupational injuries, or a reduction in hazards (Hagel et al., 2008). They suggested that education-based interventions alone are unlikely to result in improved OHS outcomes, but rather should be considered as part of a larger strategy that includes other approaches including engineering controls and government regulation (Hagel et al., 2008). In contrast, another information-based educational intervention was found to be effective in changing dairy farm practices when the messages included economic aspects and the route of dissemination followed existing pathways, such as trade journals and equipment suppliers (Chapman et al., 2011). The authors created an information campaign on three production practices that they believed were more profitable for dairies and safer for dairy workers (Chapman et al., 2011). The safer and more profitable farm practices were improved barn lighting, which can stimulate milk production and help improve visibility for workers; silage storage in bags as opposed to towers or bunkers that helps preserve silage quality and reduces gas exposures and falling/drowning hazards; and calf feed mixing stations located adjacent to the raising hutches, which decreases the labor (and injury potential) involved in calf feeding (Chapman et al., 2011). The authors used multiple social and information

networks to disseminate their educational materials (generally printed and internet based articles), and chose these routes based on the preferences of dairy owners (Chapman et al., 2011). In a follow-up survey, they found a significant increase in the adoption of two of the three practices after four years (barn lights and silage bags) (Chapman et al., 2011). The authors concluded that promoting safety practices that are also more profitable may be an important step in the effort to improve worker safety on dairy farms (Chapman et al., 2011). However, they acknowledge a need for comprehensive risk reduction in the industry (Chapman et al., 2011).

The results of training interventions in agriculture and the dairy industry suggest that basic safety training and education alone is not effective to reduce injuries and illnesses, but rather training and education that is part of a more holistic approach that incorporates other aspects of dairy work, environment and management, and delivers information from trusted sources, may be effective at reducing injuries. However, the authors of all of these studies have pointed to the need for comprehensive strategies to reduce injuries and illnesses in the dairy industry (Chapman et al., 2011; Hagel et al., 2008; Román-Muñiz et al., 2006). Such strategies should include industry and organizational approaches as well as regulation.

Occupational Health and Safety Regulation in the U.S.:

In 1970, the Occupational Safety and Health Act was signed into law (Mintz, 1984). The act established the Occupational Safety and Health Administration (OSHA) as the regulatory agency responsible for ensuring safe working conditions in U.S. workplaces (Mintz, 1984). The means by which the agency would protect workers was regulation and enforcement (Mintz,

1984). These early regulations could be generally described as criteria standards that defined workplace hazards, and required that employers adequately control those hazards, either through total elimination or mitigation of the hazard to an appropriate level. OSHA hired and trained inspectors to visit U.S. workplaces and issue citations for failing to comply with OSHA regulations (Mintz, 1984). Penalties for failing to comply with safety and health standards ranged from warnings, to fines, to criminal charges in the case of wilful and negligent disregard for worker safety and OSHA standards (Mintz, 1984).

In the 1980's, there was a shift in the social and political environment that demanded OSHA regulators to reassess how they approach their mission. There was a popular view during this time that government had grown too big and inefficient, and that over-regulation was killing small businesses, contributing to high unemployment, and hurting the U.S. economy. OSHA officials had to re-evaluate their practices to ensure they could accomplish their mission in the new political landscape (U.S. Department of Labor, 2009). Regulations were reviewed, and obsolete or redundant standards were revised or removed (U.S. Department of Labor, 2009). OSHA also faced a workforce shortage during the 1980's. In 1980, there were 1,540 covered workplaces for each OSHA full-time employee, and even fewer OSHA inspectors (AFL-CIO, 2014). Of course, substantial budget increases were impossible in the current political climate, and OSHA actually faced budget cuts and freezes in several of the following years (U.S. Department of Labor, 2009).

During the 1980's, OSHA officials developed a strategy to maximize the effectiveness of their limited staff and resources, and that strategy is still in use today. OSHA began by focusing

their enforcement activities on the most hazardous industries and employers (U.S. Department of Labor, 2009). These were determined by employee complaints, investigation of serious and fatal accidents, and by collecting and evaluating injury and illnesses data using recordkeeping requirements and the Survey of Occupational Injuries and Illnesses administrated by the Bureau of Labor Statistics (U.S. Department of Labor, 2009). Compliance assistance education, and outreach programs were established or strengthened during this time to aid employers in fulfilling regulatory requirements and reducing injuries (U.S. Department of Labor, 2009). Despite these efforts to focus limited resources on the worst offenders in terms of occupational injuries and illnesses, the vast majority of workplaces are unlikely to ever receive a visit from an OSHA inspector. Thus, in addition, OSHA began to encourage employers to go beyond the standards and self-regulate using an OHSMS.

There are four primary ways that OSHA regulators encourage the establishment and use of an OHSMS, or as they have historically referred to it, a comprehensive safety and health program. This distinction is semantical only, and not indicative of a less comprehensive approach, as has been previously implied (Bennett, 2002). First, OSHA increased funding to the On-Site Small Business Consultation Program, and made it a primary objective to assist clients in establishing their own OHSMS (U.S. Department of Labor, 2009). Second, OSHA developed a recognition program for businesses that maintained low injury and illness rates and adopted an exemplary OHSMS. The Safety and Health Achievement and Recognition Program (SHARP) and the Voluntary Protection Program (VPP) were created in the early 1980's for small-to-medium and large-sized organizations, respectively (U.S. Department of Labor, 2009). Both programs rewarded participating businesses with recognition and some level of protection from

regulatory inspections (OSHA, 2008a, 2008b). Another way OSHA regulators encourage the adoption of an OHSMS is through penalty reductions. Employers that have established an OHSMS qualify for a "good faith" reduction in the amount of fines owed as a result of regulatory violations (OSHA, 2008a; 2008b). Finally, all U.S. organizations are encouraged to adopt an OHSMS through the publication of voluntary guidelines, in 1989, that described the importance and defined the essential components of an OHSMS (OSHA, 1989).

U.S. Occupaitonal Safety and Health Regulation of the Dairy Industry:

U.S. regulators have also recently increased their efforts to control the high rate of injuries, illnesses, and fatalities on dairy farms. In 2012, a local emphasis program (LEP) for dairy farms was established in the State of Wisconsin (2012a), which ranks second in U.S. total milk production (NASS, 2014b). The LEP establishes a program of comprehensive health and safety inspections for dairies throughout the state (OSHA, 2012a). The goal of the LEP is to reduce the exposure of workers to occupational health and safety hazards (OSHA, 2012a). The list of dairy farm hazards included in the LEP is lengthy, and includes animal handling, operation of heavy equipment, hazards associated with machinery or electrical equipment, and confined spaces (OSHA, 2012a). All Wisconsin dairies that employ 10 or more employees or have a temporary labor camp are eligible to receive an inspection under the LEP (OSHA, 2012a). The LEP was developed, in part, in response to six occupational fatalities that occurred on Wisconsin dairy farms in the preceding five years (OSHA, 2012a). Of the six fatalities, five were dairy farm employees and one was a contractor (OSHA, 2012a). Three of the fatalities occurred as a result of contact with cows, and the other two resulted from operating heavy machinery (OSHA,

2012a). A second LEP was issued by OSHA in 2013 that covered dairy farms in New York State (the fourth leading producer of milk in the U.S.) (NASS, 2014b; OSHA, 2013b). The LEP is similar in approach and scope. Four workplace fatality investigations in New York State that occurred in the previous five years were provided as partial justification for the LEP (OSHA, 2013c). Of the four, two were caused by heavy equipment, one was caused by contact with animals, and one was caused by a confined space entry and methane exposure (OSHA, 2013c). The increase in regulatory attention represents a change in health and safety regulation practice, and follows the increase in dairy workforce size and operation complexity that has occurred in the U.S.

Occupational Health and Safety Management Systems:

OHSMS means, quite literally, the systematic approach to occupational health and safety management in an organization. The term OHSMS is often used interchangeably with other systematic OHS approaches, including injury and illness prevention programs, comprehensive safety and health programs, safety management systems, and others. While there are many similarities between these approaches, the distinction between these terms should not be made arbitrarily. Safety management systems, for instance, contain many common OHSMS elements, but they are associated mostly with process safety management regulations and are designed to prevent catastrophic accidents in relatively large and complex organizations and processes (Robson et al., 2007). On the other hand, injury and illness prevention programs represent another systematic approach to OHS that is associated primarily with mandatory regulations in California and proposed national regulations in the U.S. (OSHA, California Department of

Industrial Relations, 1991; 2014). Comprehensive safety and health programs, on the other hand, are associated with voluntary guidelines for U.S. businesses (OSHA, 1989). The generally accepted terminology in national and international consensus standards is OHSMS (ANSI/ASSE, 2012; British Standards Institute, 2007; International Labour Organization, 2010).

Descriptions of OHSMS in the literature are varied, but most definitions share several common elements. OHSMS can be distinguished from traditional OHS program compliance by their broader applicability and focus on management support, employee participation, and continual improvement. In contrast, OHS program compliance usually involves fulfilling the requirements of a specific rule (i.e., the hazard communication standard, 29 CFR 1910.1000). An OHSMS approach, however, does not necessarily address the specific requirements of any rules, nor does one address specific hazards, but rather formalizes the process an organization uses to conduct health and safety functions. Many OHS standards, guidelines, and evaluation tools have been created in the past 30 years. Several other OHSMS standards are currently being proposed or are in development, including a renewed international standard from the International Organization for Standardisation (ISO) and proposed OHSMS regulations in the U.S. and Canada.

The elements that comprise OHSMS approaches can vary. In 1998, Redinger and Levine proposed a universal OHSMS assessment model containing 27 OHSMS sections derived from the "most comprehensive" management system documents available at the time, which included three OHSMS standards and one environmental management system standard. The 27 OHSMS elements were divided into 16 primary sections, and 11 secondary sections (Redinger & Levine,

1998). The elements included both management concepts and OHS activities. For example, goal setting (management concept) and hazard assessment (OHS activity) are both included within the 27 OHSMS elements (Redinger & Levine, 1998). Their proposed elements have been referenced in U.S. and international standard development documents and OHSMS reviews (Redinger & Levine, 1999; Robson et al., 2007), and represent reasonable attempt to define important OHSMS constituent parts. The 27 OHSMS elements proposed in the Redinger and Levine model were organized sequentially from the perspective of implementing and operating an OHSMS (Redinger & Levine, 1998). The 27 proposed OHSMS elements are provided in Table 2.1.

Table 2.1 Commonly Accepted OHSMS Elements, Proposed by Redinger and Levine (1998)

Section		OHSMS Element
Primary	**Secondary**	
		Initiation
1.0		Management Commitment and Resources
	1.1	Regulatory Compliance and System Performance
	1.2	Accountability, Responsibility, and Authority
2.0		Employee Participation
		Formulation
3.0		Occupational Health and Safety Policy
4.0		Goals and Objectives
5.0		Performance Measures
6.0		System Planning and Development
	6.1	Baseline Evaluation and Hazard/Risk Assessment
7.0		OHSMS Manual and Procedures
		Implementation/Operations
8.0		Training
	8.1	Technical Expertise and Personnel Qualifications
9.0		Hazard Control
	9.1	Process Design
	9.2	Emergency Preparedness and Response
	9.3	Hazardous Agent Management
10.0		Preventive and Corrective Actions
11.0		Procurement and Contracting
		Evaluation
12.0		Communication
	12.1	Document and Record Management
13.0		Evaluation
	13.1	Auditing and Self-Inspection
	13.2	Incident Investigation and Root Cause Analysis
	13.3	Medical Program Surveillance
		Improvement/Integration
14.0		Continual Improvement
15.0		Integration
16.0		Management Review

OHSMS – Occupational health and safety management system

Not all OHSMS standards, guidance documents, and evaluation tools contain all of the 27 listed OHSMS elements. For example, the Safety and Health Program Management Guidelines published by OSHA in 1989 do not explicitly include several of the 27 OHSMS elements, although many are addressed (OSHA, 1989). However, many of the 27 elements are present in

most OHSMS standards, and modern consensus standards (ANSI/ASSE Z10:2012 and OHSAS 18001:2007) include all of them in one form or another. The predominant OHSMS consensus standards also are organized sequentially; typically borrowing the Plan-Do-Check-Act model popularized by W. Edwards Deming in 1982, and adopted in ISO quality and environmental management systems (Deming, 1986; ISO, 2004, 2008). The sequential organization in these standards simply presents the OHSMS elements in the order that an organization might typically try to address them, with planning elements first, followed by implementation, then auditing, and then review. The philosophy of continual improvement is addressed by the results of the review feeding back into the planning and implementation phases of the system.

Occupational Health and Safety Management Systems - Implementation and Effectiveness:

International Research on Mandatory OHSMS Regulations:

The history of OHSMS research began in the 1990's. Many other developed countries faced similar challenges as the U.S. in regulating workplace health and safety with limited resources, and they adopted regulations that required OHSMS approaches of their countries' businesses. Norway was one of the first to adopt such legislations, enacting the so-called Internal Control (IC) regulations in 1992 (Saksvik & Nytrø, 1996). This law required that all businesses establish and document a systematic process to manage (i.e., control, internally) and continually improve health and safety in the workplace. In other words, the law mandated the use of an OHSMS. Early research efforts focused on determining if and how Norwegian businesses were adopting the regulations, and what some of the effects of the regulations were.

In 1996, Saksvik and Nytrø reported the results of a survey of a large number of Norwegian businesses (n=2092), which showed that the majority of those surveyed were unaware of and had not implemented the IC requirements. In 1997, researchers from the Norwegian University of Science and Technology found a decrease in operating expenses, health and safety expenditures, and injuries for a single company over a ten year span that included the adoption of IC regulations (Kjellén, Boe, & Hagen, 1997). However, there were many company changes and initiatives that occurred during the study period that could have resulted in the observed OHS improvements (Kjellén et al., 1997). In a 1998 follow-up to their earlier study, Norwegian researchers surveyed 1184 businesses, including small enterprises, and found that the size of a business had no significant effect on whether or not IC was implemented (Nytrø, Saksvik, & Torvatn, 1998). In another study conducted in Norway, workers (n=2174) and managers (n=237) in the automotive repair industry were surveyed about IC regulations, OHS activities, work environment, and health (Torp, Riise, & Moen, 2000). The authors found that workers from garages where IC regulations (and thus, OHSMS) were enacted had significantly fewer musculoskeletal symptoms as compared to workers from garages without an OHSMS (Torp et al., 2000). Sick leave, the other OHS outcome measured, was not significantly associated with OHSMS status (Torp et al., 2000). In 2003, Saksvik, Torvatn, and Nytrø reported that after 10 years following the creation of IC regulations, only 51 percent of survey respondents (n=1789) indicated that they had fully implemented the IC requirements. Sick leave as it relates to mandatory OHSMS implementation, was further examined in a 2004 study by Mikkelsen and Saksvik that found that sick leave was negatively associated with the stage of implementation of IC requirements among 13 energy companies in Norway.

OHSMS regulations began in Australia and New Zealand in the early 90's. The Australian/New Zealand approach was another example of OHSMS performance standards, this time focused on auditing requirements for organizational OHSMS components (Gallagher, Underhill, & Rimmer, 2003). Initially, each Australian state had their own OHSMS requirements (Gallagher et al., 2003). Though similar, there were inconsistencies between the standards of each state, and a uniform Australia/New Zealand guidance document was developed in 1997 and a national standard was adopted in 2000. In 1999, Australian researchers Alsop and LeCouteur reported on the changes that resulted from the adoption of an OHSMS in a city-level government agency (n=1). Improvements in the level of OHSMS programming were observed during the four year study period, and worker's compensation premiums and the number of claims also decreased (Alsop & LeCouteur, 1999). However, downward trends were also present in years prior to the implementation of the OHSMS (Alsop & LeCouteur, 1999). A 2002 study of 16 small- and medium-sized (less than or equal to 350 employees in this study) metal manufacturers compared OHSMS programming (measured using an external audit) pre- and post- implementation of an OHSMS (Pearse, 2001). The results showed that the audit scores improved following OHSMS implementation for all but one of the companies, suggesting that the implementation process used was effective (Pearse, 2001). In 2003, Gallager reported the results of a literature review and interviews with Australian OHSMS stakeholders (government officials, academics, union leaders, employers, etc.). The author concluded that the management leadership, employee participation, and integration of the OHSMS with other aspects of the business are critical for an effective OHSMS (Gallagher et al., 2003).

In Japan, the Japanese Industrial Safety and Health Association (JISHA, 2015) has published OHSMS certification guidelines since 1993. In 1999, the Japanese government adopted their own guidelines for OHSMS (JISHA, 2015). One standardized OHSMS approach in Japan, a participatory occupational health and safety program, focused on management support, employee participation, and regular cooperative OSH activities (safety walkthroughs, accident investigations, training) for a large government agency (n=1) (Koda, Nakagiri, Yasuda, Toyota, & Ohara, 1997). Reductions in the incidence rates of low back pain and other injuries were observed during the study period, although the OHSMS was expanded to include employee participation half-way through the 10 year study period (Koda et al., 1997). In a second study of the same organization, the number of total low back pain worker's compensation claims, and the number of compensated claims decreased over the study period (Koda & Ohara, 1999). These studies lacked a comparison group and suffer from changes in the intervention during the follow-up period (Koda & Ohara, 1999). However, the authors concluded that the OHSMS approach is capable of reducing a broad range of OHS injuries and illnesses (Koda & Ohara, 1999).

Research on Voluntary OHSMS use in the U.S. and Canada:

Neither the U.S. nor Canada has national OHSMS regulations. Instead, businesses are encouraged to establish an OHSMS by the government or industry and labor groups. Perhaps due to the lack of regulatory incentives, there is a paucity of early peer-reviewed studies regarding OHSMS use in the U.S. and Canada. In 1998, Yassi, a Canadian OHS researcher, reported the results of an OHSMS-like intervention at a Canadian health science center (n=1). The "occupational health program" included several important components of an OHSMS, and

employed the use of a health and safety committee, but didn't specify employee participation or management support (Yassi, 1998). There was an observed decrease in worker's compensation claims and costs following the intervention, but the effect could not be isolated from other OHS activities including return-to-work program (Yassi, 1998). In 2001, a study of an OHSMS intervention at a large U.S. automotive manufacturer (n=1) was published (Bunn III, Pikelny, Slavin, & Paralkar, 2001). The authors reported a decrease in the rates of incidents and lost-time cases pre- and post-intervention, as well as decreased worker's compensation costs, and improved audit scores (Bunn III et al., 2001). Again, however, the OHSMS implementation was concurrent with other OHS and cost accounting activities (Bunn III et al., 2001). In one of the highest quality published studies to date, LaMontagne et al. (2004) reported the results of a randomized, controlled study of an OHSMS intervention of 15 U.S. manufacturing companies (LaMontagne et al., 2004). Seven manufacturers received the intervention and eight were controls (LaMontagne et al., 2004). An OHSMS audit instrument was used to assess the level of OHSMS programming at baseline and follow-up, which was approximately two years after the initial assessment for both groups (LaMontagne et al., 2004). There were observed increases in OHSMS programming level in both groups, but the intervention group had larger increases, overall and for each OHSMS component (LaMontagne et al., 2004). No other OHS or economic outcomes were evaluated (LaMontagne et al., 2004). In a follow-up study, 25 small-sized manufacturers (50 to 150 employees in this study) were surveyed about OHSMS programming (Barbeau et al., 2004). The authors concluded that small size was not a barrier to implementing an OHSMS and that external motivation from sources such as insurers, corporations, or regulators was important for establishing a system (Barbeau et al., 2004).

Mandatory Injury and Illness Prevention Program Regulations in California:

In most of the U.S., OHSMS guidelines are voluntary and are not enforceable by law. In 1989, however, California passed Senate Bill 198, which established OHSMS requirements for all businesses that operate in the state (RAND, 2012). Since then, the so-called injury and illness prevention program (I2P2) regulations are the most frequently cited in California, with over 16,000 citations from 1992 to 2007 (RAND, 2012). The authors of this report found that citations for non-compliance with specific subsections of the I2P2 regulations resulted in reduced injury rates (RAND, 2012). In 1997, Wells, et al., reported the results of a two-year study on an OHSMS train-the-trainer program. Eight companies were divided into treatment and control groups, the treatment group receiving the train-the-trainer intervention (Wells, Stokols, McMahan, & Clitheroe, 1997). The authors reported a significantly decreased number of self-reported illnesses, and increased access to personal protective equipment in the treatment group as compared to the control group (Wells et al., 1997). A major limitation of the study was the high rate of participating companies lost to follow-up (12 of 20 companies initially selected were not included in the analysis) (Wells et al., 1997).

Recent OHSMS Research:

In the most comprehensive review to-date, Robson et al. (2007), systematically examined the results of 13 studies of OHSMS interventions (seven were voluntary interventions, six were mandatory adoption of OHSMS per legislation). The authors found that all showed mostly positive results and that none found any negative effects (Robson et al., 2007). The authors

concluded that, despite the promising results, there was insufficient evidence to recommend OHSMS interventions due to a small number of studies and generally weak methodological quality of the reviewed studies (Robson et al., 2007). The authors evaluated article relevance by determining if the intervention addressed at least two OHSMS elements (of the 16 primary OHSMS elements listed in Table 2.1) (Robson et al., 2007). It should be noted that, despite the lack of negative results found in this review, there are published reports that question the effectiveness of OHSMS approaches. In a review article published in 2000, an Australian researcher reported that there was a high failure rate (85 to 95 percent) reported in studies on quality management systems (Gardner, 2000). They go on to suggest that caution should be exercised before anointing OHSMS or environmental management systems approaches as a magic bullet to improve safety (Gardner, 2000). The disparity between quality management system results and those of OHSMS could be because the aspects of quality management focus on core aspects of business (customer satisfaction, product quality) that are traditionally targets for optimization. Conversely, environmental and OHS issues have traditionally been viewed as auxiliary functions separate from core business goals. Thus, OHS and environmental issues may be elevated by a management system to a degree not possible for quality management. In another contrary opinion, Bennet (2002) argued that OHSMS approaches undermine traditional regulatory processes (i.e., hazard regulation and enforcement) by excusing businesses from regulatory responsibility in exchange for voluntary self-regulation that is, in fact, not regulated. The author was particularly critical of vague standards and rules, and legislative approaches in Europe and other developed areas of the world that fail to emphasize employee participation and involvement in all aspects of the OHSMS (Bennett, 2002). The author points to the International Labor Organization's OHSMS guidelines as a better alternative because it includes specific

requirements and emphasizes employee involvement at all aspects of the OHSMS (Bennett, 2002). It is important to note that modern consensus standards, including the American national standard and the de facto international standard (OHSAS 18001:2007) include specific requirements and emphasize employee participation as critical system components.

In a 2009 study that surveyed 455 Spanish companies, researchers found associations between the level of OHSMS programming for a business, and improved safety and economic performance (Fernández-Muñiz, Montes-Peón, & Vázquez-Ordás, 2009). The surveys in this study were completed by the participating companies' safety officer only, and may therefore not be representative of management or worker perspectives (Fernández-Muñiz et al., 2009). In another Spanish study, Arocena and Nunez (2010) surveyed 193 small and medium manufacturers (250 or fewer employees in this study) to determine their degree of adoption of OHSMS, and their accident experiences. The results indicated that the level of implementation (advanced, technical, basic, or none) was negatively associated with accident rates, with lower levels of OHSMS implementation associated with the highest rates (Arocena & Núñez, 2010).

In 2014, Italian researchers studied four companies of various sizes to estimate the economic impacts of OHSMS adoption, specifically payback period of the net present value of OHSMS investments (Bianchini, Pellegrini, Peta, & Saccani, 2014). They found that the return on investment period is shorter in large companies (greater than 1,000 employees) and prohibitively long in the smallest company evaluated (14 employees) (Bianchini et al., 2014). Despite the very small number of companies included in their study, the authors recommend additional government incentives to make OHSMS investments competitive with production

investments (Bianchini et al., 2014). Also in 2014, Yazdani et al. reviewed published research on participatory ergonomics programs to determine the level of compatibility with OHSMS approaches. The authors found that of the 21 OHSMS elements considered in the study (taken, this time, from OSHAS 18001:2007), only five of the 21 were adequately represented in participatory ergonomics programs and that the language used to describe aspects of both approaches are not necessarily compatible (Yazdani et al., 2014). The authors concluded that the adoption of participatory ergonomics programs may be improved by incorporating more management system elements (Yazdani et al., 2014). Further, it can be concluded based on the authors' findings that research into the effectiveness of participatory ergonomics approaches cannot be used in support of OHSMS approaches, or vice versa.

Mandatory Adoption of Voluntary OHSMS Standards in Developing Economies:

Global trade, large, convoluted supply chains, and widely publicized industrial accidents have introduced a unique circumstance faced by some companies in developing economies: the compulsory adoption of voluntary OHSMS standards. International corporations produce many major brands of products that enjoy world-wide recognition, and the preservation of a brand's image is a top priority for these corporations. Reports in popular media on industrial accidents and terrible working conditions in facilities that supply these corporations can tarnish a brand's image and result in reduced sales (Choi et al., 2012). As a means to demonstrate corporate responsibility, many large corporations have begun to require auditable compliance with voluntary consensus standards by all of their contract and sub-contract suppliers (Choi et al., 2012). Although the standards are voluntary, failing to comply would result in contract penalty

or termination. Thus, participation is mandatory if a company wishes to retain contracts and remain competative. The use of OHSMS certification as a form of "corportate social responsibility monitoring" has been criticized as ineffective at finding unsafe working conditions and preventing accidents (Brown, 2013). The reasons cited for the failures of these approaches are unqualified auditors, auditing for profit, and conflicts of interest between the auditing and auditee firms (Brown, 2013). The findings related to voluntary-in-name-only OHSMS certification in the scientific literature are presented here.

In 2009, Taiwanese researchers reported the results of a survey of eleven circuit board manufacturers and about factors that motivated OHSMS adoption and that influenced successful implementation (Chen, Wu, Chuang, & Ma, 2009). The authors found that customer requirements and conforming to international trends were, by far, the biggest motivators for adoption (Chen et al., 2009). They also found few significant differences between the reported relative importance of OHSMS performance indicators, as reported by the manufacturing company representatives and OHSMS specialists from academia (Chen et al., 2009). In a 2012 Chinese study, the authors examined financial data from 44 clothing manufacturers who were OHSAS 18001 certified (Choi et al., 2012). The authors found a significant increase in sales following the attainment of OHSMS certification, but a statistically significant decrease in profitability (Choi et al., 2012). The authors suggest that because improving health and safety was not the primary motivation for establishing an OHSMS, there may be few benefits realized and the adoption of an OHSMS may actually be bad for business (Choi et al., 2012). Unfortunately, the Chinese study was the only one to estimate economic impacts of mandatory use of OHSMS certification. However, several other studies found positive non-economic

effects. In 2015, the results of a survey of 400 Malaysian workers in the automotive parts manufacturing industry were reported (Mavis, Rahman, & Tamrin, 2015). The results indicated that workers from OHSAS 18001-certified companied scored higher on occupational hazard management questions as compared to workers from companies without certifies OHSMS, although it was not clear what these questions were or what scale was used for the comparison (Mavis et al., 2015).

Evaluation of Occupational Health and Safety Management Systems:

In 2010, Robson and Bigelow reported the results of the first and only systematic literature review on OHSMS auditing instruments that has been published to date. There are many types of OHSMS audits that have been described in the research literature, and the authors' aim was to identify those that had psychometric or methodological evidence to support the validity and inter-rater reliability of the instruments (Robson & Bigelow, 2010). They found that only eight of the 13 identified instruments had evidence supporting or rejecting the psychometric properties of the instruments (Robson & Bigelow, 2010). Most of the instruments with supporting evidence were designed for use only in specific industries (Robson & Bigelow, 2010). The authors concluded that there was insufficient research to support the use of these instruments for benchmarking and comparisons between companies or industries, because of the lack of psychometric data (Robson & Bigelow, 2010). However, the authors' literature search and inclusion criteria did not include several OHSMS audit instruments. In particular, audit instruments developed by OSHA for use in the On-Site Small Business Consultation Program, the Voluntary Protection Program (VPP), and the defunct 1996 proposed I2P2 standard were not

included in the review. This is likely because the psychometric studies that supported the development of the current Safety and Health Program Assessment Worksheet (Revised OSHA Form 33) are published in government reports (i.e., grey literature) and much of the information on the development of the Site-Based Participation Evaluation Report (for VPP) and the Personal Evaluation Profile (PEP, proposed in 1996 for I2P2 compliance) are proprietary and not readily available to the public.

In a 1998 report to the National Advisory Committee on Occupational Safety and Health (NACOSH), Weems and Smitherman described the results of a validity and reliability study of the OSHA Form 33. They described using interviews with business managers and consultants to establish construct validity (Weems, 1998). Using scenarios that described organizations with "high", "moderate", and "low" levels of OHSMS programming, and randomly assigning one of the scenarios to each of the 416 responding OSHA consultants of business managers, criterion validity was established (Weems, 1998). Evidence supporting internal and inter-rater reliability of the OSHA Form 33 was also found, using a Split-Half, Chronbach's Alpha test (Weems, 1998). The authors concluded that the OSHA Form 33 was a valid measurement tool for OHSMS programming level, and that the form was reliable (Weems, 1998). They recommended revision of the form and further study to investigate the ability for the instrument to predict OHS outcomes, and they cautioned that their findings may only apply to individuals trained in OHSMS assessment (Weems, 1998). In a follow-up report for the NACOSH, Weems and Smitherman reported the results of a predictability study of 497 OSHA consultants (Weems, 2000). In this second study, information sheets were sent to consultants who were asked to complete the sheet using data from existing businesses, including OSHA Form 33 scores and

injury rates (Weems, 2000). The authors found significant associations between the level of OHSMS programming and injury rates (Weems, 2000). Therefore, the authors concluded that the OSHA Form 33 is also predictive for lower injury rates (Weems, 2000). They recommended a national study to further establish the relationship and establish industry norms for OHSMS programming level (Weems, 2000). The current version of the Revised OSHA Form 33 was adapted based upon recommendations in the predictability study and was adopted for use in by OSHA consultants in 2001 (OSHA, 2001b).

There are few other research studies that used OSHA-developed OHSMS evaluation instruments. In the two studies described previously that evaluated OHSMS programming in multiple U.S. manufacturing companies, a modified version of the PEP was used (Barbeau et al., 2004; LaMontagne et al., 2004). In another U.S. study, an older version of the OSHA Form 33 was used to determine the relationship between OHSMS programming and workplace hazards in Ohio small business consultation clients (Akbar-Khanzadeh & Wagner, 2001). The authors found generally weak-to-moderate but significant associations between OHSMS programming level and the number of OSHA violations (indicating the presence of workplace hazards), both in the overall OHSMS, and by OHSMS component and attribute (Akbar-Khanzadeh & Wagner, 2001). The authors recommended further study to determine if OHSMS programming is associated with injury and illness rates, rather than just OSHA violations (Akbar-Khanzadeh & Wagner, 2001). The last known study that used an OSHA-developed assessment instrument was reported in a 2011 paper by Wurlzelbacher and Jin that used a modified OSHA Form 33 self-assessment as a leading metric for evaluating OSH program effectiveness. They found that self-reported OHSMS programming, as part of an overall self-assessment completed by 33

participating companies, was associated with fewer worker's compensation claims (Wurzelbacher & Jin, 2011). However, the modified OSHA Form 33 questions were completed by individuals not trained to use the form, and the self-assessment included elements beyond normal OHSMS programming (Wurzelbacher & Jin, 2011). Despite the small number of studies using the OSHA Form 33, there is substantially more data supporting its use as an OHSMS auditing instrument than most other published OHSMS evaluation tools, particularly when developmental reports from the grey literature are considered.

National OHSMS Data:

When completing their OHSMS assessments, OSHA consultants input scores from the Revised OSHA Form 33 and client injury data into a national database called the Web Integrated Management Information System (WebIMIS) (OSHA, 1995). These data were used to generate norms (per the recommendation of Weems and Smitherman) and to inform policy decisions (OSHA, 2008a). The generated norms that are most relevant to the OSHA consultation process are the average industry OHSMS performance data and the average industry injury and illness data (OSHA, 2008a). Average industry data are queried in WebIMIS using North American Industry Classification System (NAICS) codes to produce Industry Comparative Reports (ICRs) and Employer Comparative Reports (ECRs) (OSHA, 1995). The ICR and ECR reports are tools that OSHA consultants use to research industry OHSMS and injury and illness performance of similar businesses, and to benchmark their clients' performance in these areas (OSHA, 2008a). The ICR and ECR reports include average, overall Revised OSHA Form 33 scores by industry and average scores for each OHSMS component and individual attribute (OSHA, 1995). The

reports also include average Days Away, Restricted and Transferred (DART) and Total Recordable Case (TRC) rates as input by OSHA consultants from clients' Log of Work-Related Injuries and Illnesses (OSHA Form 300) forms (OSHA, 1995). When determining if potential SHARP participants have lower injury and illnesses rates than the national average, Bureau of Labor Statistics (BLS) rates are used by OSHA consultants because the rates can be directly compared for the year (or years) relevant to the SHARP applicant's candidacy (OSHA, 2008a). There is currently data stored on OHSMS programming and injury rates for consultation clients in all 50 states and all industrial sectors in the WebIMIS database. As of 2014, OSHA consultants now input client data into the new OSHA Information System (OIS) database, but they still use ICR and ECR reports generated in WebIMIS (OSHA, 2013a).

Research Opportunity:

The existence of a large database of records from OSHA consultation site visits presents a unique opportunity to address the important limitation of small sample sizes present in many OHSMS studies. Because OHSMS programming level and injury and illness data are both stored in the WebIMIS database, it is possible to access a large number of records with both variables and assess any relationships that exist between them. Given that U.S. dairy farming is an industry with a demonstrable need for comprehensive occupational risk management, dairy industry represents a prime candidate to explore the potential for OHSMS approaches. The dairy industry has also been historically underserved in terms of OHS regulation, and thus the industry is less likely to have many co-incident OHS activities, which is another important limitation of previous OHSMS research. This project will address the common limitations of previous

OHSMS studies by using WebIMIS database records from OSHA consultation site visits to determine the relationship between OHSMS programming and injury and illnesses in the dairy production industry. The results of this study will provide the preliminary data necessary to support the development of an OHSMS intervention for U.S. dairy producers.

Current Research Objectives:

This project will explore the potential for OHSMS approaches to reduce occupational injuries and illnesses in animal production industries through three separate studies, presented in Chapters 3, 4, and 5. The experimental methodologies and results for each study are described in their respective chapters. The overall objectives of this research project are to:

1. Evaluate the relationship between OHSMS programming and occupational injury and illness rates in dairy and poultry production industries.

2. Determine which OHSMS components have the strongest association with lower rates of injuries and illnesses.

3. Assess the relationship between worforce size, injury rates, and OHSMS programming level in dairy and poultry production.

4. Examine the OHS changes and effects perceived by small business clients that result from OHSMS assistance provided by the OSHA On-Site Consultation Service.

CHAPTER 3: EVALUATING OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEM PROGRAMMING IN ANIMAL PRODUCTION AGRICULTURE BUSINESSES AS MEASURED BY OSHA ON-SITE CONSULTATION: PART 1 – THE U.S. DAIRY INDUSTRY[1]

Summary:

U.S. dairy workers suffer occupational injuries and illnesses at rates higher than the national average. Occupational health and safety management systems (OHSMS) have been proposed as a way to reduce injuries and illnesses for businesses of all types and sizes. The Occupational Health and Safety Administration (OSHA) On-Site Consultation Service provides assistance establishing OHSMS to U.S. businesses, including commercial dairies. A correlational analysis was conducted using OSHA consultation data collected from commercial dairies. Spearman Rank-Order correlation was used to determine the strength and significance of the associations between injury rates and OHSMS programming level for dairy operations, as measured by the Safety and Health Assessment Worksheet. Additional analyses were conducted to examine potential relationships between workforce size, injury rates, and OHSMS programming levels. A total of 167 dairy records were obtained from OSHA. Forty-five of those records had both injury rate and OHSMS data. There was a negative correlation between OHSMS programming level and injury illness rates, both for the overall OHSMS and by

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OHSMS component. Management Leadership was the OHSMS component most strongly associated with lower injury and illness rates, and workers participating in the safety training of co-workers was the attribute with the strongest correlation. There was no significant relationship between the number of dairy workers and injury rates, but there was a positive association between workforce size and OHSMS programming level. OHSMS interventions for the U.S. dairy industry may be warranted to help reduce the unacceptable number of injury and illnesses suffered by dairy workers as part of a comprehensive risk management approach. Further research is needed to determine if similar relationships between OHSMS programming and injury rates occur in other industries.

Introduction:

The Federal OSHA On-Site Consultation Service was established in the U.S. in 1975 to provide small businesses (generally those with fewer than 250 employees) with professional occupational health and safety (OHS) services that such businesses may not be able to otherwise afford (Occupational Safety and Health Administration [OSHA], 2001a). Services provided by OSHA consultants include compliance assistance with OHS regulations and assistance in establishing an occupational health and safety management system (OHSMS) (OSHA, 2008a). An OHSMS is a series of interrelated policies, plans, procedures, and practices that specify how an organization manages OHS issues. The American National Standard for Occupational Health and Safety Management Systems (ANSI/ASSE Z10:2102) specifies the elements of an effective OHSMS, and includes requirements for management leadership, employee participation, hazard identification, hazard control, worker training, and periodic review (ANSI/ASSE, 2012). In the

U.S., there is currently no national requirement for most small businesses to adopt an OHSMS, although some states have mandatory OHSMS requirements or voluntary incentive programs for adopting such a program (OSHA, 2014). OSHA consultants use the Safety and Health Assessment Worksheet (Revised OSHA Form 33) to evaluate their clients' level of OHSMS programming, and as a tool to help businesses establish an OHSMS (OSHA, 2008a). Scores from the Revised OSHA Form 33 indicate the degree of implementation of multiple OHSMS attributes. Even if a business does not have a formal system in place at the time of assessment, the form measures the de facto level of OHSMS programming and is intended to be used as a way to establish or improve a formal OHSMS. The Revised OSHA Form 33 measures 58 OHSMS attributes divided into three content areas (operational, managerial, and cultural) and seven OHSMS components (hazard anticipation and detection, hazard prevention and control, planning and evaluation, administration and supervision, safety and health training, management leadership, and employee participation) (OSHA, 2001b). Revised OSHA Form 33 attributes are scored on a four item, forced choice scale ranging from zero (attribute not present) to three (attribute fully implemented) (OSHA, 2001b). Consultants are discouraged from guessing when completing the Revised OSHA Form 33, and consultants may choose not to score attributes if they do not have enough information; in this case, the attribute is "Not Evaluated" (NE) and the attribute is not included in the overall OHSMS score (OSHA, 2008a). Further, if an Revised OSHA Form 33 attribute is not applicable to a particular client, the attribute is scored "Not Applicable" (NA) and the attribute is included in the overall average score with a value of three (OSHA, 2008a). OSHA On-Site Consultation clients with exemplary OHSMS (as evidenced by high scores on the Revised OSHA Form 33) and relatively low injury and illness rates compared to other businesses in their industry may qualify for the OSHA Safety and Health Achievement

Recognition Program (SHARP) (OSHA, 2008a). Businesses that achieve SHARP status receive formal recognition from OSHA as OHS leaders in their industries and they receive exemptions from programmed OSHA regulatory inspections (OSHA, 2008a). Eight of the 58 Revised OSHA Form 33 attributes are considered optional 'stretch' attributes that are not normally evaluated except in the case of SHARP applicants. OSHA consultants are expected to conduct at least a partial OHSMS assessment using the Revised OSHA Form 33 for most visits, but they are only required to score all of the applicable attributes for SHARP participants (OSHA, 2008a).

Until recently, OSHA consultants input client injury and illness rates and Revised OSHA Form 33 scores into the WebIMIS database (OSHA, 1995). These data were used to generate norms and to inform policy decisions (OSHA, 2008a). The generated norms that are most relevant to the OSHA consultation process are the average industry OHSMS performance data and the average industry injury and illness data (OSHA, 2008a). Average industry data are queried in WebIMIS using North American Industry Classification System (NAICS) codes to produce Industry Comparative Reports (ICRs) and Employer Comparative Reports (ECRs) (OSHA, 1995). The ICR and ECR reports are tools that OSHA consultants use to research industry OHSMS and injury and illness performance of similar businesses, and to benchmark their clients' performance in these areas (OSHA, 2008a). The ICR and ECR reports include average, overall Revised OSHA Form 33 scores by industry and average scores for each OHSMS component and individual attribute (OSHA, 1995). The reports also include average Days Away, Restricted and Transferred (DART) and Total Recordable Case (TRC) rates as input by OSHA consultants from clients' Log of Work-Related Injuries and Illnesses (OSHA Form 300) forms (OSHA, 1995). When determining if potential SHARP participants have lower injury

and illnesses rates than the national average, Bureau of Labor Statistics (BLS) rates are used by OSHA consultants because the rates can be directly compared for the year (or years) relevant to the SHARP applicant's candidacy (OSHA, 2008a). As of 2014, OSHA consultants now input client data into the new OSHA Information System (OIS) database, but they still use ICR and ECR reports generated in WebIMIS (OSHA, 2013a).

Workers in the U.S. dairy industry suffer occupational injuries and illnesses at rates higher than the national average (U.S. Bureau of Labor Statistics, 2012). Despite historically meager regulatory enforcement of OHS on dairies, OSHA officials have recently enacted two Local Emphasis Programs (LEPs) in Wisconsin and New York State (OSHA, 2012a, 2013b). Through these LEPs, OSHA regulators have established a process of programmed regulatory inspections of dairies in the affected states (OSHA, 2012a, 2013b). Given this recent increase in regulatory attention, it may be helpful to consider ways that dairy producers can reduce their regulatory liability as well as their injury and illness rates. OSHA regulators believe that OHSMS are an effective means for businesses to prevent injuries, illnesses, and fatalities, and OSHA compliance officers use OHSMS as evidence of employers' good faith in providing a safe work environment (OSHA, 2009). There is also evidence that voluntary OHSMS interventions can improve an organization's OHS performance (Alsop & LeCouteur, 1999; Bunn III et al., 2001; LaMontagne et al., 2004). In the most comprehensive review of OHSMS interventions to-date, the authors found that most of the studies included in the review showed positive changes resulting from OHSMS interventions, but that there were insufficient data in the published literature to recommend any such interventions (Robson et al., 2007). No previous studies were found that have specifically evaluated OHSMS interventions in agriculture. However, dairies

were found to be one of the top adopters of mandatory OHSMS components as compared to other industries in the Australian agricultural sector (Lower, Fragar, & Temperley, 2011). The International Labour Organization has also included OHSMS guidelines in their most recent *Code of Practice on Safety and Health in Agriculture* (International Labour Organization, 2010). In the U.S. dairy industry, farm management practices have been shown to influence milk quality and production, but human resource management on dairy farms has not been well studied (Hagevoort et al., 2013). In a 2013 paper presented at the Western Dairy Management Conference, researchers called for a systematic approach to OHS management and the integration of OHSMS with other dairy systems, citing benefits including reduced injuries and improved productivity and quality (Reynolds et al., 2013). OHSMS and integrated systems are highly flexible and can be tailored to all sizes and types of businesses. The current increased attention from OSHA regulators, the potential OHS and regulatory benefits of OHSMS, and the flexibility and feasibility of OHSMS indicate that OHSMS interventions may be beneficial for the dairy industry.

No studies evaluating the relationship between Revised OSHA Form 33 scores and injury and illness rates were found during a literature search. However, Akbar-Khanzadeh and Wagner (2001) compared the Revised OSHA Form 33 scores of 107 Ohio OSHA consultation clients from a variety of industries to the number of OSHA violations observed in the client businesses and found a negative correlation between the number of OSHA violations and the level of OHSMS programming. It is estimated that a similar relationship between Revised OSHA Form 33 scores and injury and illness rate may also exist. Akbar-Khanzadeh and Wagner (2001) also reported a positive correlation between the number of employees and Revised OSHA Form 33

scores, and no apparent relationship between the number of employees and the number of OSHA violations. The authors speculated that as the number of employees increased so did an organization's OHS capabilities, which would lead to improved Revised OSHA Form 33 scores while keeping the ratio of OSHA violations to the number of workers stable (Akbar-Khanzadeh & Wagner, 2001). In contrast, Douphrate, Rosecrance, Stallones, Reynolds, and Gilkey (2009) analyzed worker's compensation claims from Colorado agriculture producers and found that smaller dairy farms (those with fewer than 10 employees) were more strongly associated with livestock handling injuries than farms with more than 10 workers. Therefore, a negative association between the number of dairy workers on a farm and farm injury and illness rates is hypothesized.

Akbar-Khanzadeh and Wagner (2001) suggested that fewer OSHA violations could indicate a decreased risk of injuries and illnesses, but they cited the lack of injury and illness data as a major limitation in their study. The authors used binary logistic regression to determine the strength and significance of the correlations in their study because the OHSMS scores and number of violations were not normally distributed (Akbar-Khanzadeh & Wagner, 2001). They divided the number of violations into two groups: a low and high group, split roughly in the middle to produce approximately equal group sizes for the types of violations they were analyzing (Akbar-Khanzadeh & Wagner, 2001). Thus, their reported correlation coefficients are really a measure of the strength of the relationship between Revised OSHA Form 33 scores from businesses with relatively low number of violations, compared to ones with relatively high number of violations. It is unclear why the authors elected not to choose a non-parametric alternative that did not require dividing the number of violations into seemingly arbitrary high

and low violation groups such as Spearman's Rank-Order Correlation. However, the authors did report that a large proportion of observations with no violations in the "regulatory violations" category, resulting in two groups for that violation type of no violations (low) and some violations (high) (Akbar-Khanzadeh & Wagner, 2001).

There was little other research found that evaluated the OSHA Form 33 or used OSHA Form 33 data. Weems and Smitherman (1998) reported the results of reliability and validity testing of a previous version of the OSHA Form 33 and concluded that OHSMS components and attributes on the form were valid measures of OHSMS programming level. The authors then reported the results of a follow-up predictability study in which they concluded that performance of a newer version of the OSHA Form 33 was predictive of reduced injuries and illnesses (Weems & Smitherman, 2000). This follow-up study included a representative sample of small, high-hazard industries from each state (Weems & Smitherman, 2000). Based on these findings, the OSHA Form 33 was revised again in 2001 to the 58 item version that is in use today (OSHA, 2001b).

The primary hypothesis for this project was that OHSMS programming level would be negatively correlated with injury and illness rates for commercial dairies. That is, as the OHSMS programming level increased there would be a reduction in the injury and illness rates. It was also hypothesized that workforce size on dairy farms would be correlated with increased OHSMS programming and decreased injury and illness rates. The objective of this research was to determine if OHSMS programming is associated with lower injury rates for dairy workers,

and if so, what components and attributes of an OHSMS are more likely to help prevent injuries and illness in the U.S. dairy industry.

Methods:

Data:

An authorized OSHA representative from the Office of Information Technology Solutions provided OSHA consultation data for the dairy cattle and milk production industry (NAICS 112120), including Revised OSHA Form 33 scores and injury/illness rates from WebIMIS. Injury and illness data were limited to TRC and DART rates; additional information about the number, type, and severity of the injuries and illnesses was not available. The consultation records also included the state in which the dairies were located and the number of workers employed by each dairy. A nondescript OSHA reference number was used to pair the demographic, OHSMS, and rate data for a particular dairy. The OSHA representative provided no information that would enable the identification of a specific dairy whose information was included in the data. A consultant code was also included with the data, which could be used to determine if the same consultant entered OHSMS and injury/illness data into WebIMIS for all of the dairy consultations in a particular state. All data received from OSHA was managed according to the requirements of the Research Integrity and Compliance Review Office (RICRO) at Colorado State University and the WebIMIS Rules of Behavior (Colorado State University, 2014; OSHA, 2005b).

An ICR for NAICS 112120 was produced that indicated there were 220 potential Revised OSHA Form 33 records in WebIMIS for dairies. Lenth's Power Applet was used to make a conservative estimate of the power of a test of correlation between OHSMS programming level and injury/illness rates assuming a R^2 of 0.1 for the 220 Revised OSHA Form 33 sample size indicated in the ICR (Lenth, 2009). The estimated power was greater than 99 percent. Another power estimate was made using only a third of the ICR-indicated sample size (n=75, 34%) and the power was estimated to be 80 percent assuming the same correlation. This second power estimate was conducted to account for the possibility that a large portion of the indicated ICR sample size may not be useable (e.g., if many records had OHSMS data but not injury and illness rates). The conservative correlation estimate that was used to estimate statistical power was similar to many of the associations reported by Akbar-Khanzadeh and Wagner (2001) between Revised OSHA Form 33 scores and serious OSHA violations.

Analysis:

Spearman's Rank-Order Correlation test was used to assess the strength of association between average, overall Revised OSHA Form 33 scores for each dairy and their paired average TRC and DART rates. Correlation was also tested between TRC/DART rates and the average OHSMS Form 33 scores for each of the seven OHSMS components. The non-parametric Spearman alternative to linear correlation was used because the assumptions for linear correlation were not supported. Specifically, the injury/illness rates and Revised OSHA Form 33 scores were not normally distributed, the potential relationships were not all convincingly linear, and there were some significant outliers that could not be omitted from the analysis. The

assumption of linearity was assessed using a Lack of Fit test and the assumption of normality was tested using a Shapiro-Wilk test. Diagnostic plots were also visually inspected in conjunction with the statistical tests to support or reject the assumptions for linear correlation. This approach allowed the relationship between OHSMS programming level and injury and illness rates to be assessed without dividing the observations into high and low rate categories when considering the overall Revised OSHA Form 33 scores and the scores by OHSMS component. The strength of association between injury rates and OHSMS programming level was also assessed using Spearman correlation for each individual attribute on the Revised OSHA Form 33.

To evaluate the strength of association between Revised OSHA Form 33 scores with higher completion percentages and dairy worker injury/illness rates, Spearman's Rank-Order Correlation testing was repeated using a sub-set of the OHSMS observations consisting of only those observations where 50 percent or more attributes had been scored on the Revised OSHA Form 33. The higher completion rate Revised OSHA Form 33 analysis was conducted for the overall OHSMS programming level and by each OHSMS component.

Spearman correlation testing was also conducted to assess the relationship between the number of workers at a dairy and the level of OHSMS programming. The correlation tests were completed for two samples, the first consisting of the observations that were included in the previous analyses by virtue of having paired OHSMS and rate data. In addition, the larger sample of observations that had OHSMS scores, but did not necessarily have paired injury and illness rate data, were also evaluated because average TRC and DART rates were not necessary

to evaluate the relationship between workforce size and OHSMS level. Spearman's Rank-Order Correlation test was again used to evaluate the strength of association between the number of dairy employees and worker injury and illness rates.

The dairy consultation records were also divided into two groups based on the number of dairy workers employed by each organization. The group consisting of records with fewer dairy workers was considered the small organization group, and the one with more dairy workers was considered the large organization group. The cutoff between large and small organizations was chosen to produce approximately equal group sizes. The mean, overall Revised OSHA Form 33 score, and the mean TRC and DART rates were compared for the two groups using a Wilcoxon signed-rank test to determine if the mean outcomes were significantly greater in the larger organizations as compared to the smaller organizations.

Descriptive analysis included examining the number and geographic distribution of dairies and dairy workers who received OHSMS assistance, as compared to the number and distribution of commercial dairies nationally using the most recent U.S. census of agriculture data (National Agricultural Statistics Service [NASS], 2012a).. In addition, the number of different consultants who provided services for the dairy industry and the numeric completion percentage of Revised OSHA Form 33 attributes was determined. The proportion of scored Revised OSHA Form 33 attributes was computed for each OHSMS component to determine which OHSMS components were being assessed less frequently by OSHA consultants. Finally, the completion percentage of each attribute was determined to ascertain which of the Revised OSHA Form 33 attributes were often not being evaluated for dairies.

Data analysis for this project was conducted using SAS software, Version 9.2 of the SAS System for Windows. Copyright, SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

Results:

Sample Characteristics:

One-hundred sixty-seven (167) OSHA consultation records were found for the dairy cattle and milk production industry (NAICS 112120). Forty-five of 167 (27 percent) had both Revised OSHA Form 33 scores and TRC/DART rates that could be paired. The OSHA records for each observation also included the state where the dairy was located, the number of workers employed by the dairy, and a consultant code. Only one of the 167 records had two sets of Revised OSHA Form 33 scores, indicating a potential follow-up visit to reevaluate the client's OHSMS. However, their scores were identical so only one set was included in the analysis. This indicates that the dairy records included in this study represented the initial OHSMS evaluation for each dairy, and that none had a follow-up assessment that resulted in changes in the Revised OSHA Form 33 scores. The OSHA records were created between 2003 and 2013. A summary of the major study variables is provided in Table 3.1.

Table 3.1 Summary of Dairy Industry Data from 45 OSHA On-Site Consultation Service Records with Revised OSHA Form 33 Scores and TRC & DART rates

Variable	Median	Mean (SD)	Min-Max
Number of Employees	23	22.7 (11.0)	3-55
TRC Rate	7.3	7.7 (5.3)	0-19.2
DART Rate	4.7	5.0 (4.1)	0-18.6
Revised OSHA Form 33 Scores[a]	**Median**	**Mean (SD)**	**Min-Max**
Overall	1.8	1.7 (0.4)	0.4-2.1
Hazard Anticipation and Protection	1.8	1.6 (0.4)	0.3-2.0
Hazard Prevention and Control	1.8	1.7 (0.4)	0.6-2.3
Planning and Evaluation	2.0	1.6 (0.6)	0-2.0
Administration and Supervision	2.0	1.8 (0.4)	0-2.5
Safety and Health Training	2.0	1.7 (0.5)	0-2.7
Management Leadership	2.0	1.6 (0.7)	0-2.3
Employee Participation	2.0	1.7 (0.4)	0-2.0

[a]Possible Scores for Revised OSHA Form 33 Attributes Range from 0 (attribute not present) to 3 (attribute fully implemented)
OSHA – Occupational Safety and Health Administration

All of the 167 dairy consultation records were from five U.S. states. A vast majority of the dairy consultation records were for California dairy farms (n=150, 90 percent). The other states with dairy consultation records were Wisconsin (n=13, eight percent), Oregon (n=2, one percent), Michigan (n=1, 0.5 percent), and New York (n=1, 0.5 percent). These states represent four OSHA regions, specifically OSHA Regions 2, 5, 9, and 10. Among the 45 dairy records that had both Revised OSHA Form 33 scores and injury and illness rates, only California (n=40, 89 percent), Wisconsin (n=4, nine percent), and Oregon (n=1, two percent) were represented.

Four of the five states with dairy consultation records are among the top 10 in U.S. milk production, and the top two milk producing states are represented (California and Wisconsin) (NASS, 2014b). The distribution of dairy consultation records by state to U.S. milk production is illustrated in Figure 3.1.

The number of dairy workers employed by the 167 dairies with OSHA consultation records was 2,862. The mean number of workers per dairy was 17. Only 26 of 167 dairies (16 percent) had fewer than 10 workers. Of the 45 dairy consultation records with paired injury/illness rates and Revised OSHA Form 33 scores, the mean number of workers per dairy was 23 and the total number of workers represented was 1,023. The number of dairy workers covered by OSHA consultation visits by state is also provided in Figure 3.1.

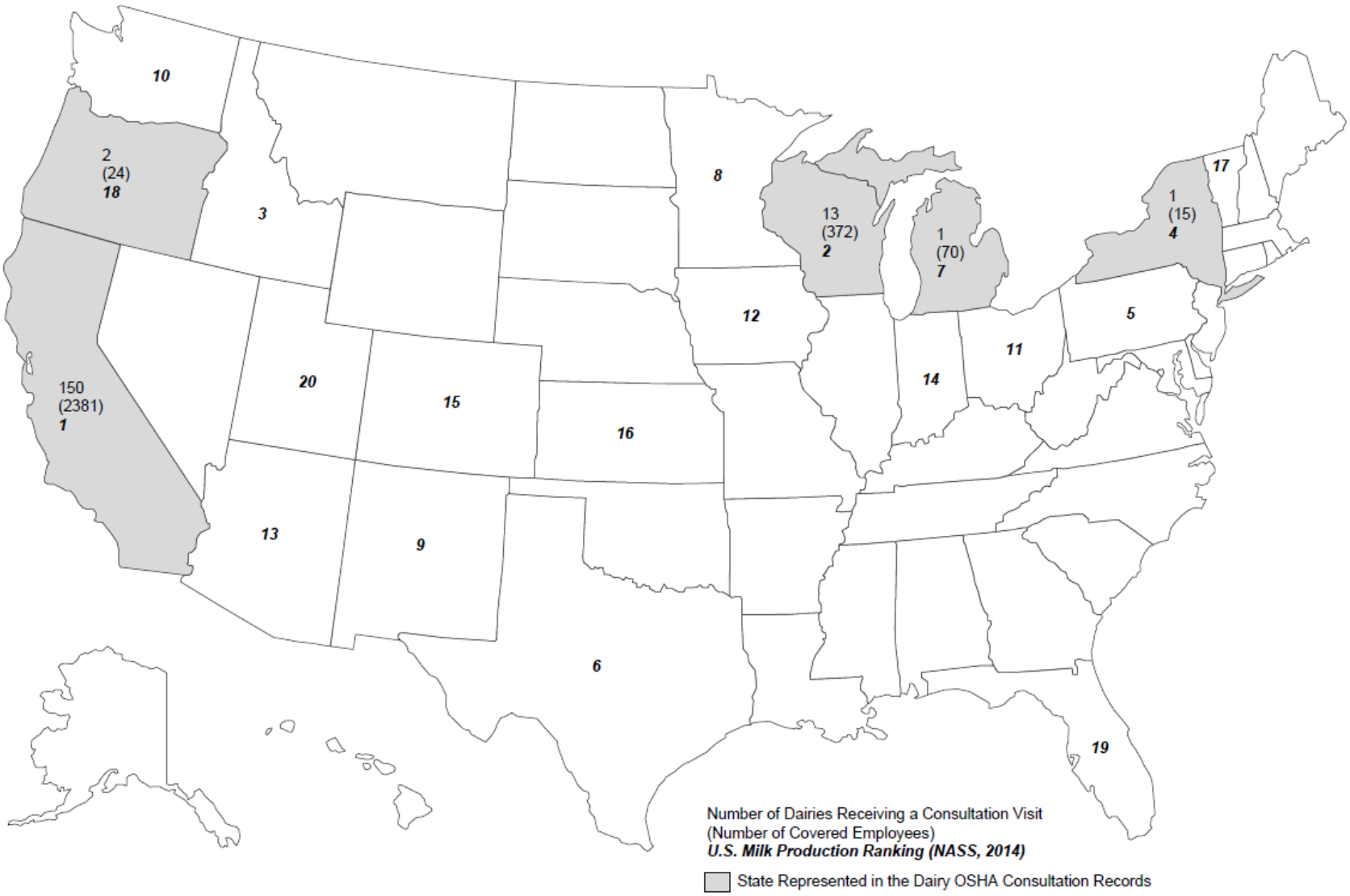

Figure 3.1 Ranking of the Top 20 Milk Producing States and the Number of OSHA Dairy Consultations and Covered Dairy Workers by State

The 167 OSHA consultation records for dairy farms were input into WebIMIS by only 25 consultants. Sixteen of those 25 (64 percent) conducted the 150 dairy consultation visits in California. Five of the 25 (20 percent) conducted the 13 consultation visits in Wisconsin. The remaining four consultants conducted the four consultations in Oregon, Michigan, and New York.

The mean numeric completion rate (the number of attributes not scored NE divided by the total number of attributes) for all of the Revised OSHA Form 33 records was 46 percent, ranging from a low of 26 percent to a high of 83 percent. The mean response rate per Revised OSHA Form 33 attribute was 46 percent, ranging from two to 100 percent. When the eight optional stretch attributes were not considered, the mean numeric response rate per attribute was 49 percent with the same range. The mean response rate per stretch attribute was 27 percent, ranging from four to 84 percent. The numeric response rates to Revised OSHA Form 33 attributes by overall Revised OSHA Form 33 and OHSMS component are presented in Table 3.2.

Table 3.2 Consultation Numeric Response Rate for Revised OSHA Form 33 and Each OHSMS Component

OHSMS Component	Total No. Attributes	Mean No. Scored Attributes	Overall Numeric Response Rate (%)
Overall Revised OSHA Form 33	58	26.7	46
Hazard Anticipation and Detection	10	4.7	47
Hazard Prevention and Control	9	4.4	48
Planning and Evaluation	6	3.2	54
Administration and Supervision	8	4.4	56
Safety and Health Training	6	3.6	59
Management Leadership	10	1.3	13
Employee Participation	9	4.2	47

OHSMS – Occupational Health and Safety Management System
OSHA – Occupational Safety and Health Administration

Measures of Association:

No statistically significant association was found between overall OHSMS programming level and TRC or DART rates. However, a significant association was found between both TRC and DART rates and the Hazard Prevention and Control and Management Leadership OHSMS components. The results of the Spearman's Rank-Order Correlation analysis for OHSMS programming level and injury/illness rates for the 45 paired dairy records are provided in Table 3.3.

Table 3.3 Spearman Correlation Coefficients for the Strength of Association Between Injury & Illness rates and OHSMS Programming Level (n=45)

OHSMS Element	TRC	DART
Overall	-0.17	-0.12
Hazard Anticipation and Detection	-0.15	-0.13
Hazard Prevention and Control	-0.30*	-0.33*
Planning and Evaluation	0.13	0.22
Administration and Supervision	-0.06	-0.08
Safety and Health Training	-0.19	-0.14
Management Leadership	-0.36*	-0.35*
Employee Participation	-0.10	-0.15

*Correlation was significant ($P < 0.05$)

OHSMS – Occupational Health and Safety Management System

Thirty-eight of 45 paired dairy industry records (84 percent) had Revised OSHA Form 33 entries where fewer than half of the 58 attributes were assigned a numeric score. Seven of 45 (16 percent) paired observations were included in a secondary correlation analysis because they included Revised OSHA Form 33 records where at least half or more of the attributes (≥ 29) were assigned a numeric score. When the smaller subset of more complete Revised OSHA Form 33 records were analyzed, a moderate association was found between overall OHSMS

programming and injury and illness rates. Moderate to strong associations were also found between each of the seven OHSMS components and TRC/DART rates. All but the Planning and Evaluation and Employee Participation OHSMS components had statistically significant associations. The results of this secondary analysis are included in Table 3.4.

Table 3.4 Spearman Correlation Coefficients for the Strength of Association Between Injury & Illness rates and OHSMS Programming Level Revised OSHA Form 33 Completion Rates ≥ 50% (n=7)

OHSMS Element	TRC	DART
Overall	-0.79*	-0.79*
Hazard Anticipation and Detection	-0.79*	-0.79*
Hazard Prevention and Control	-0.84*	-0.84*
Planning and Evaluation	-0.65	-0.65
Administration and Supervision	-0.76*	-0.76*
Safety and Health Training	-0.90*	-0.90*
Management Leadership	-0.91*	-0.91*
Employee Participation	-0.55	-0.55

*Correlation was significant ($P < 0.05$)

OHSMS – Occupational Health and Safety Management System
OSHA – Occupational Safety and Health Administration

Nonparametric correlation analysis between the number of workers and injury/illness rates was conducted for the paired (n=45) and unpaired (n=46) OSHA consultation records with injury data. The number of dairy workers was not significantly associated with the injury and illness rates when examining either sample. Moderate positive associations were found between the number of dairy workers and overall Revised OSHA Form 33 scores when both the paired (n=45) and unpaired (n=166) records with Revised OSHA Form 33 scores were included. Only the larger unpaired sample was statistically significant at the $\alpha=0.05$ level. The results of the correlation analysis for the number of dairy workers are provided in Table 3.5.

Table 3.5 Spearman Correlation Coefficients for the Strength of Association Between the Number of Employees on a Dairy, OHSMS Programming Level, and Injury & Illness Rates

	Correlations for Workforce Size	
Sample	**ρ[a]**	**P-value**
TRC Rate, *Paired* (n=45)	-0.18	0.25
DART Rate, *Paired* (n=45)	-0.17	0.26
TRC Rate, *Unpaired* (n=46)	0.12	0.43
DART Rate, *Unpaired* (n=46)	0.06	0.66
Revised OSHA Form 33 Scores, *Paired* (n=45)	0.28	0.07
Revised OSHA Form 33 Scores, *Unpaired* (n=166)	0.29	<0.001

[a]Spearman's rank-order correlation coefficient
OHSMS – Occupational Health and Safety Management System
OSHA – Occupational Safety and Health Administration

When considering associations between individual OHSM Form 33 attributes and injury/illness rates, only four of 58 (seven percent) attributes had statistically significant associations with both TRC and DART rates. Another five of 58 attributes (nine percent) had significant associations with only one of the TRC or DART rates. Twelve of 58 attributes (21 percent) had no variation in the numeric scores assigned to the attribute among the 45 observations, thereby precluding the attributes from inclusion in the analysis. Most of the associations were weak to moderate and in the expected (negative) direction. A summary of the associations for injury/illness rates and individual Revised OSHA Form 33 attributes is provided in Tables 3.6a, 3.6b, and 3.6c.

Table 3.6a Spearman Correlation Coefficients for the Strength of Association Between Dairy Farm Injury & Illness rates and OHSMS Programming Level for Each Revised OSHA Form 33 Attribute

Revised OSHA Form 33 Attribute	Response Rate[a] (%)	TRC	DART
A comprehensive, baseline hazard survey has been conducted within the past five (5) years. (n=10)	22	-0.28	-0.02
Effective [S&H] self-inspections are performed regularly. (n=44)	98	-0.18	-0.09
Effective surveillance of established hazard controls is conducted. (n=42)	93	0.10	0.01
An effective hazard reporting system exists. (n=44)	98	-0.14	-0.19
Change analysis is performed whenever a change in facilities, equipment, materials, or processes occurs. (n=5)	11	-0.89*	-0.65
Accidents are investigated for root causes. (n=43)	96	-0.17	-0.06
[MSDSs] are used to reveal potential hazards associated with chemical products in the workplace. (n=10)	22	0.03	0.07
Effective job hazard analysis is performed. (n=7)	16	-0.46	-0.46
Expert hazard analysis is performed. (n=2)	4	NA[c]	NA[c]
Incidents are investigated for root causes. (n=3)[b]	7	NA[c]	NA[c]
Feasible engineering controls are in place. (n=9)	20	-0.59	-0.59
Effective [S&H] rules & work practices are in place. (n=45)	100	-0.21	-0.14
Applicable OSHA-mandated programs are effectively in place. (n=44)	98	-0.14	-0.16
Personal protective equipment is effectively used. (n=9)	20	-0.37	-0.33
Housekeeping is properly maintained. (n=28)	62	-0.33	-0.33
The organization is properly prepared for emergency situations. (n=10)	22	-0.39	-0.37
[The org. has a plan] for providing [emergency] medical care to employees & others present at the site. (n=5)	11	0.00	0.00
Effective preventive maintenance is performed. (n=3)[b]	7	NA[c]	NA[c]
An effective procedure for tracking hazard correction is in place. (n=43)	96	-0.03	-0.03
Workplace injury/illness data are effectively analyzed. (n=29)	64	-0.22	-0.14

[a]Numeric response rate to the attribute out of 45 Revised OSHA Form 33 observations

[b]Revised OSHA Form 33 stretch attribute

[c]All numeric scores for these attributes were the same and a correlation coefficient could not be computed

*Correlation was significant (P-value < 0.05)

[Edited for space]

TRC, Total Recordable Case Rate

DART, Days Away, Restricted, or Transferred Rate

Table 3.6b Spearman Correlation Coefficients for the Strength of Association Between Dairy Farm Injury & Illness rates and OHSMS Programming Level for Each Revised OSHA Form 33 Attribute

Revised OSHA Form 33 Attribute	Response Rate[a](%)	TRC	DART
Hazard incidence data are effectively analyzed. (n=5)	11	-0.89*	-0.30
A [S&H] goal & supporting objectives exist. (n=40)	89	-0.37*	-0.28
An action plan designed to accomplish the organizations [S&H] objectives is in place. (n=39)	87	-0.06	0.04
A review of in-place OSHA-mandated programs is conducted at least annually. (n=28)	62	0.21	0.25
A review of the overall [S&H] management system is conducted at least annually. (n=5)[b]	11	0.14	0.75
[S&H] program tasks are each specifically assigned to a person or position for performance or coordination. (n=8)	18	0.68	0.64
Each assignment of [S&H] responsibility is clearly communicated. (n=7)	16	-0.25	-0.25
An accountability mechanism is included with each assignment of [S&H] responsibility. (n=37)[b]	82	-0.20	-0.35*
[Ind. w/ S&H] responsibilities have the necessary knowledge, skills, & timely information to [do their job]. (n=41)	91	-0.36*	-0.36*
Individuals with assigned [S&H] responsibilities have the authority to perform their duties. (n=40)	89	-0.34*	-0.27
Individuals with assigned [S&H] responsibilities have the resources to perform their duties. (n=22)	49	-0.46*	-0.44*
Organizational policies promote the performance of [S&H] responsibilities. (n=4)	9	0.58	0.58
Organizational policies result in correction of non-performance of [S&H] responsibilities. (n=41)	91	-0.03	-0.11
Employees receive appropriate [S&H] training. (n=44)	98	-0.30*	-0.21
New employee orientation includes applicable [S&H] information. (n=29)	64	-0.27	-0.31
Supervisors receive appropriate [S&H] training. (n=43)	96	-0.21	-0.11
Supervisors receive training that covers the supervisory aspects of their [S&H] responsibilities. (n=38)[b]	84	-0.22	-0.13
[S&H] training is provided to managers. (n=4)	9	NA[c]	NA[c]
Relevant [S&H] aspects are integrated into management training. (n=2)[b]	4	NA[c]	NA[c]
Top management policy establishes clear priority for [S&H]. (n=6)	13	0.00	0.00

[a]Numeric response rate to the attribute out of 45 Revised OSHA Form 33 observations

[b]Revised OSHA Form 33 stretch attribute

[c]All numeric scores for these attributes were the same and a correlation coefficient could not be computed

*Correlation was significant (P-value < 0.05)

[Edited for space]

TRC, Total Recordable Case Rate

DART, Days Away, Restricted, or Transferred Rate

Table 3.6c Spearman Correlation Coefficients for the Strength of Association Between Dairy Farm Injury & Illness rates and OHSMS Programming Level for Each Revised OSHA Form 33 Attribute

Revised OSHA Form 33 Attribute	Response Rate[a](%)	TRC	DART
Top management considers [S&H] to be a line rather than a staff function. (n=20)	44	-0.35	-0.42
Top management provides competent [S&H] staff support to line managers & supervisors. (n=2)[b]	4	NA[c]	NA[c]
Managers personally follow [S&H] rules. (n=34)	76	-0.41*	-0.42*
Managers delegate [authority] for personnel to carry out their assigned [S&H] responsibilities effectively. (n=1)	2	NA[c]	NA[c]
Managers allocate the resources needed to properly support the organizations [S&H] system. (n=3)	7	NA[c]	NA[c]
Managers assure that appropriate [S&H] training is provided. (n=22)	49	-0.21	-0.32
Managers support fair and effective policies that promote [S&H] performance. (n=2)	4	NA[c]	NA[c]
Top management is involved in the planning & evaluation of [S&H] performance. (n=3)	7	-0.87	-0.87
Top management values employee involvement & participation in [S&H] issues. (n=7)	16	-0.02	-0.30
There is an effective process to involve employees in [S&H] issues. (n=44)	98	-0.23	-0.28
Employees are involved in organizational decision making in regard to [S&H] policy. (n=39)	87	-0.04	-0.17
Employees are involved in organizational decision making in regard to the allocation of [S&H] resources. (n=2)	4	NA[c]	NA[c]
Employees are involved in organizational decision making in regard to [S&H] training. (n=4)	9	-0.06	-0.06
Employees participate in hazard detection activities. (n=45)	100	-0.23	-0.24
Employees participate in hazard prevention & control activities. (n=42)	93	-0.06	0.04
Employees participate in the [S&H] training of co-workers. (n=8)[b]	18	-0.89*	-0.87*
Employees participate in [S&H] planning activities. (n=3)	7	NA[c]	NA[c]
Employees participate in the evaluation of [S&H] performance. (n=3)	7	NA[c]	NA[c]

[a]Numeric response rate to the attribute out of 45 Revised OSHA Form 33 observations

[b]Revised OSHA Form 33 stretch attribute

[c]All numeric scores for these attributes were the same and a correlation coefficient could not be computed

*Correlation was significant (P-value < 0.05)

[Edited for space]

TRC, Total Recordable Case Rate

DART, Days Away, Restricted, or Transferred Rate

Discussion:

The level of OHSMS programming, as measured by the Revised OSHA Form 33, was associated with reduced injury and illness rates for dairy workers. The strength of association and the number of statistically significant associations for each OSHMS component increased considerably when only those forms were included where 50 percent or more Revised OSHA Form 33 attributes were assigned a numeric score. These findings suggest that when more attributes are scored by a consultant, there is a clearer association between Revised OSHA Form 33 scores and injury rates. However, there are many reasons why a consultant may not be able to assess many of the OHSMS attributes on the Revised OSHA Form 33. OSHA consultants have a number of important responsibilities when providing services to small business clients. Aside from OHSMS assistance and recordkeeping from the OSHA Form 300 log, consultants need to inspect facilities and interview workers and management to identify hazards and assess compliance with OSHA regulations (OSHA, 2008a). In addition, many visits may not be comprehensive in nature and may only warrant scoring those components of the Revised OSHA Form 33 relevant to the scope of consultation. Consultants also conduct a limited number of visits to each establishment, and key personnel for assessing particular attributes may not always be present during these visits. Except for SHARP participants, who often have long-term relationships with OSHA consultants that develop over a number of years, there may often be insufficient time to uncover all of the necessary indicators to assess a particular attribute. Despite these challenges, the Revised OSHA Form 33 attribute scores and comments can provide valuable feedback to an organization about OHSMS performance and what changes may lead to improvements. Given the value of Revised OSHA Form 33 to clients and the apparent

associations between OHSMS programming and reduced injury and illnesses, prioritizing the completion of the Revised OSHA Form 33 may be beneficial for consultation visits in the dairy industry.

Associations between injury/illness rates and individual Revised OSHA Form 33 attribute scores were highly variable. On average, most of the associations were in the expected direction and were weak to moderate. Several of the attributes had no variability in the numeric responses (i.e., each Revised OSHA Form 33 observation for that attribute was assigned the same numeric score). The numeric response rates for the individual attributes also varied widely and were often less than 20 percent. Thus, it was difficult to draw many conclusions about the correlations between injury/illness rates and many individual attributes. Still, the results provide some indication of individual contributions to the overall associations of the relevant OHSMS components and the overall Revised OSHA Form 33 scores.

Change analysis when major work environment or process changes occur and effective job hazard analysis were the two Revised OSHA Form 33 attributes that had the strongest associations with lower injury and illness rates in the Hazard Anticipation and Detection OHSMS component. This suggests that dairy managers may benefit from training and education on these management practices. The use of feasible engineering controls was the individual attribute in the Hazard Prevention and Control component that had the strongest negative association, although almost all of the attributes in this component had 20 percent or greater response rates and low to moderate negative associations. Under the Management Leadership OHSMS component, the attribute with the highest response rate and a moderate, significant

association with reduced injuries and illnesses was the assessment of whether managers personally followed safety and health rules. It can be concluded that management providing a good example for safe work practices may indeed influence worker adoption of expected safety behaviors and ultimately reduce injuries and illness rates. The individual Revised OSHA Form 33 attribute with the strongest and statistically significant association with lower TRC and DART rates was a stretch item that assessed if employees participate in the safety and health training of co-workers. In 2006, Román-Muñiz et al. found a similarly protective effect of safety training delivered by fellow employees against self-reported injuries among Colorado dairy workers. Employee participation, particularly in the safety and health training of fellow workers, may therefore represent an important priority for OHSMS interventions in the dairy industry.

There was a significant, positive association between the number of workers employed by a dairy and level of OHSMS programming, but there was no significant association between the number of dairy workers and a farm's injury and illness rates. These findings are similar to those reported by Akbar-Khanzadeh and Wagner (2001), who suggested that the greater number of employees serve to keep the rate of regulatory violations stable while improving the overall OHSMS. In contrast, the lack of association between the number of workers and injury rates are contrary to those reported by Douphrate et al. (2009) who found an association between smaller organizations and increased livestock handling injuries. Means testing results also indicated that injury and illness rates were not significantly different between small and large dairy organizations. However, the dairy records in this project were from relatively large, commercial operations with an approximate range of 250 to 5,500 milking cows assuming a 1:80-100 worker-to-cow ratio (Douphrate, Hagevoort, et al., 2013). Therefore, there may not have been

sufficient representation of smaller dairies to elucidate potential differences between the injury rates of dairies with different workforce sizes.

Limitations:

The OSHA consultation data used in this study were not collected for research purposes. Instead, the data were collected and stored for internal evaluation purposes and to generate norms (OSHA, 2008a). As such, the data may not be representative of all injuries and illnesses suffered by dairy workers (e.g., minor injuries that were not recordable would not likely be included), nor of the entire scope of OHSMS programming in place at these organizations. There were fewer (n=167) than expected (n=220) OSHA consultation records for the dairy industry with either OHSMS or injury data. This could be because older records included in the estimate were no longer available or that some of the records did not have any relevant data.

The OSHA consultation records for the dairy industry included in this study represented only five U.S. states, and 90 percent of the records were from California dairies. Although California is the leading dairy producing state in the U.S. (by total milk weight), 15 of the top 20 dairy producing states have no representation in this analysis (NASS, 2014b). However, the five states that are included in this study account for 45 percent of all hired dairy farm workers in the U.S. (NASS, 2012a). Another potential disparity in the representation of dairies is that commercial dairies in California are required to comply with Section 3203 of the California OSHA regulations by establishing and maintaining an OHSMS (California Department of Industrial Relations, 1991). The California OHSMS regulations may explain why the vast

majority of OSHA consultations resulting in Revised OSHA Form 33 scores are from California. It is also reasonable to suspect that OHSMS programming levels may be higher on California dairies than on dairies in other states because of these regulatory requirements. To evaluate this potential difference, a Wilcoxon signed-rank test was completed comparing the mean, overall Revised OSHA Form 33 scores from California records (n=149) and those from other states (n=17). There was no statistically significant difference between the mean OHSMS programming levels of the two groups.

The mean number of workers employed by the dairies in this study was considerably higher than the number employed by most dairies in the U.S. There were an estimated 64,098 farms with milk cows in the U.S. in 2012, and 60,484 of those farms (94 percent) had fewer than 500 milk cows according to the most recent U.S. census data (NASS, 2012a). However, there were only 27,744 farms with hired labor classified as dairies in NAICS, and of those, 10,215 dairies (37 percent) had 500 or more milk cows (NASS, 2012a). In 2013, Douphrate et al. reported a 1:80-100 worker-to-cow ratio for large dairy operations. Two-thirds of the milk produced in the U.S. in 2011 came from farms with greater than 500 cows in 2012 (NASS, 2012b). While many small farms with at least some dairy cows may not be represented here, the results of this project should be relevant for large herd, commercial dairies that house the most dairy cows, produce the most milk, and employ a large proportion of U.S. dairy workers.

A relatively small number of consultants performed the site visits for dairies whose data was included in this study. While this may offer some degree of confidence in the lack of inter-rater differences, as suggested by Akbar-Khanzadeh and Wagner (2001), it may also indicate

some uncertainty in the Revised OSHA Form 33 scores due to individual biases. For instance, if a single consultant tended to always score high on the form and that consultant was the one conducting most of the dairy visits for that state, it stands to reason that the dairies for that state may have higher than expected overall Revised OSHA Form 33 scores. The nature or magnitude of these potential scorer effects cannot be estimated or controlled for in our current analysis. While this is an important potential limitation, all OSHA consultants do receive the same rigorous training that includes strategies for minimizing low or high scoring errors (OSHA, 2012b).

Of the 167 total dairy industry consultation records, only 45 records had both Revised OSHA Form 33 scores and injury/illness rates that could be paired for an individual organization. A Wilcoxon sign-ranked test between the mean, overall Revised OSHA Form 33 scores of dairy records with paired injury rates (n=45) and without paired injury rates (n=122) indicated that the average level of OHSMS programming was significantly higher in the group with paired injury data (P-value < 0.01). This finding suggests that the dairies included in our correlation analysis may have had better OHSMS than those that were not included. Thus, the reported associations may not be as applicable to those dairies with lower levels of OHSMS programming. In addition, dairies that received OSHA consultation visits may differ from those that did not receive services. Dairy farm managers who sought out consultation services indicated some level of awareness and concern for worker safety and may have had better OHS performance than those who did not contact OSHA. Alternatively, those dairy managers who contacted OSHA may have been doing so in response to an incident or OHS compliance visit and may therefore have had worse OHS performance. Furthermore, the measures of association

presented here lack atemporal relationship because client OHSMS are assessed during a consultation visit and the injury rates included in this study only included those incidents that occurred in the time leading up to the consultation visit. Additional injury and illness data and Revised OSHA Form 33 scores for a period following the initial visit would be necessary to draw conclusions about the effects of the OSHA consultation visit as an OHSMS intervention.

The mean, numeric completion rate for the Revised OSHA Form 33 attributes was less than 50 percent in both the records with paired injuries and illnesses (n=45) and those that were not paired (n=166). Even when the stretch attributes were excluded, the numeric completion remained quite low. This suggests that the Revised OSHA Form 33 scores in this study may not reflect the entire OHSMS of the client dairies. Furthermore, only seven files included Revised OSHA Form 33 records where 50 percent or more of the attributes were given a numeric score. A Wilcoxon signed-rank test was performed to compare the mean, overall Revised OSHA Form 33 scores and the mean TRC and DART rates of the seven paired records with $\geq$ 50 percent numeric scoring and the remaining 38 records with less than 50 percent of attributes scored. There was no significant difference between the two groups, suggesting that the smaller, higher-completion subset may be somewhat representative of the larger, paired sample.

Management Leadership was the OHSMS component with the lowest numeric completion rate, by far, on the Revised OSHA Form 33 (13 percent). Management leadership is often cited as one of the critical determinants of OHSMS success, and the component is tied for the largest number of attributes on the Revised OSHA Form 33 (10 of 58 attributes) (OSHA, 2001b). Given that the correlation results of this study indicated that higher scores in the

Management Leadership component were more strongly associated with lower injury and illness rates than any other OHSMS component, the low numeric response rate was concerning. It may have been that the attributes in this component took longer to evaluate, and thus the attributes were not evaluated as often as those in other OHSMS components. This conforms to the requirements that consultants should avoid guessing and score only those attributes for which they have sufficient information (OSHA, 2008a). In addition, Management Leadership on dairy farms may be particularly difficult for consultants to evaluate because of several factors. Workforce and environmental characteristics, including language barriers; shift length and times; work pacing; and geographical distribution of workers and work areas present potential challenges for consultants interviewing and observing workers to assess the Management Leadership component.

The use of Revised OSHA Form 33 data itself is another important limitation of this study. Most of the research that used Revised OSHA Form 33 data, or evaluated the use of Revised OSHA Form 33, utilized previous versions of the instrument (Akbar-Khanzadeh & Wagner, 2001; Weems, 1998, 2000). This is the first study known to incorporate the use of OHSMS programming data from the current version of the Revised OSHA Form 33. As such, questions remain regarding the reliability, validity, repeatability, and predictability of the Revised OSHA Form 33 for scientific research and how the scores relate to OHS and business outcomes in dairy and in other industries. However, the associations found between Revised OSHA Form 33 scores and injury rates in this study and the findings in previous research suggest, in general, that OSHA Form 33 results may be associated with better OHS performance. The potential limitations of using TRC and DART rates also warrant some discussion. Dairy

management may over- or under-report worker injuries on the OSHA Form 300 because of misunderstanding or misusing recording requirements. In a 1995 study, researchers concluded that relatively low injury rates observed in small businesses were due to underreporting of injuries (Oleinick, Gluck, & Guire, 1995). However, OSHA consultants are trained to look for mistakes on the OSHA Form 300 logs of clients and provide assistance in proper recordkeeping (OSHA, 2012b). Thus, recordkeeping errors may be less likely in this study.

There is considerable uncertainty in these results due the limitations described in section 4.1. The observational nature of this study and the constraints of the data limit the control of experimental variables. One way to assess whether these findings are valid is to apply the same methods to a second dataset to see if similar associations are observed. In a follow-up study, the authors will apply the same research protocol to OSHA consultation records from a different U.S. agriculture industry, that includes data from different regions than those presented here.

Conclusions:

There was a low to moderate, negative correlation between OHSMS programming level and dairy farm injury and illness rates. Higher levels of OHSMS programing in the Hazard Anticipation and Detection and Management Leadership OHSMS components were significantly associated with reduced injury and illness rates. When the Revised OSHA Form 33 was at least half-completed, the overall OHSMS and all by-component associations were strong and statistically significant. The Management Leadership OHSMS component had the strongest association with lower TRC and DART rates, despite being the component with the lowest

completion rate. The Revised OSHA Form 33 attribute that assessed whether workers participated in the safety training of co-workers had the strongest correlation with lower injury rates. Larger dairy farm workforces were associated with higher OHSMS programming levels, but there was no significant association between workforce size and injury/illness rates. Limited research on the Revised OSHA Form 33 is publicly available, but these and other findings suggest that the Revised OSHA Form 33 is useful in evaluating OHS aspects of small businesses and that the OHS aspects being measured by the form may influence occupational injuries and illnesses; a relationship that may be most evident when more attributes are assessed. More research is needed to determine if these associations persist in different experimental application. Overall, this research indicates that OHSMS assistance provided by the OSHA On-Site Consultation service may help commercial dairies reduce worker injuries and illnesses.

Recommendations:

1. Research into potential OHSMS interventions for U.S. commercial dairies is warranted to develop effective OHS management solutions for the dairy industry. A preliminary OHSMS needs assessment gathering dairy management and worker perspectives is currently underway.

2. Management at commercial dairy farms should consider requesting comprehensive OHSMS assistance for the OSHA On-Site consultation service in their state as a means to improve OHS performance and reduce regulatory liability.

3. OSHA consultants should prioritize the assessment of as many Revised OSHA Form 33 attributes as there is sufficient information to evaluate and give dairy industry clients feedback on how to improve areas of weakness.

4. Additional research is needed to evaluate the use of Revised OSHA Form 33 in other industries and for purposes other than voluntary small business consultation. The second part of this study will evaluate the potential relationship between OHSMS programming and injury rates in a different agriculture industry.

CHAPTER 4: EVALUATING OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEM PROGRAMMING IN ANIMAL PRODUCTION AGRICULTURE BUSINESSES AS MEASURED BY OSHA ON-SITE CONSULTATION: PART 2 – THE U.S. POULTRY PRODUCTION INDUSTRY[2]

Summary:

In this follow-up study, injury and illness rates on U.S. poultry growing operations were compared to the operations' occupational health and safety management system (OHSMS) programming level, as measured by Occupational Safety and Health Administration (OSHA) consultants. Spearman Rank-Order correlation was used to determine the strength and significance of the associations between injury rates, workforce size, and OHSMS programming level. A total of 58 poultry growing operation records were obtained from an OSHA database. Thirty-two of those records had both injury rate and OHSMS data. There was a negative correlation between OHSMS programming level and injury illness rates, both for the overall OHSMS and by most OHSMS components. Consistent with a previous study of dairy producers, Management Leadership was again the OHSMS component with the strongest correlation to lower injury rates. In contrast, there was a positive and significant relationship between the number of poultry workers employed by an operation and injury and illness rates, and no significant association between workforce size and OHSMS programming level. Research

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regarding the establishment and effectiveness of OHSMS interventions for U.S. animal production agriculture industries is warranted to reduce the high rates of injuries and illnesses in this sector.

Introduction:

In the U.S., small businesses (typically those with fewer than 250 employees) can request free Occupational Safety and Health Administration (OSHA) consultation services funded by the Federal Government. OSHA consultants provide small businesses with a variety of professional occupational health and safety services, including assistance establishing an occupational health and safety management system (OHSMS) (OSHA, 2008a). The Safety and Health Program Assessment Worksheet (Revised OSHA Form 33) is the tool used to assess the OHSMS of an organization and provide feedback to clients on their OHSMS (OSHA, 2001b). The Revised OSHA Form 33 measures 58 OHSMS attributes on a scale from zero (attribute not addressed) to three (attribute fully implemented) (OSHA, 2001b). The form is divided into seven components: hazard anticipation and detection; hazard prevention and control; planning and evaluation; administration and supervision; safety and health training; management leadership; and employee participation (OSHA, 2001b). The seven OHSMS components on the Revised OSHA Form 33 align closely with many of the sections specified in the American National Standard for Occupational Health and Safety Management Systems published by the American Society of Safety Engineers (ANSI/ASSE, 2012). Data from OSHA consultation programs in all 50 U.S. states are stored in an OSHA database, along with other client data, including the number of employees and rates of occupational injuries and illnesses for each organization (OSHA, 1995).

Two specific injury and illnesses rates are recorded during the OSHA consultation process. The Total Recordable Case (TRC) rate is a relative measure of all the work-related injuries and illnesses on record for an employer, while the Days Away, Restricted, and Transferred (DART) rate is a measure of only the most severe injuries and illnesses (OSHA, 2008a). Further information about the purpose and use of OSHA consultation data is detailed in Part 1 of this study.

Workers in the U.S. poultry and egg production industry suffer occupational injuries and illnesses at rates higher than the national average (U.S. Bureau of Labor Statistics [BLS], 2012). Most of the published literature involving worker health in poultry growing operations has focused on airborne exposures to chemical and biological agents and respiratory health (Kirychuk et al., 2006; Kirychuk et al., 2010; Kirychuk et al., 2003; S. J. Reynolds, Parker, Vesley, Janni, & McJilton, 1994; S. J. Reynolds, Parker, Vesley, Smith, & Woellner, 1993; Simpson et al., 1998). In 2003, researchers reported that poultry confinement workers in Canada were more likely to suffer respiratory symptoms and have impaired lung function as compared to grain farmers and a control population (Kirychuk et al., 2003). However, poultry production workers also suffer traumatic injuries at unacceptable rates. According to a National Institute for Occupational Safety and Health report, the most common activity that resulted in injury was farm maintenance followed by machine maintenance and fieldwork (National Institute for Occupational Safety and Health [NIOSH], 1997). Animal handling activities were associated with injuries in fewer than six percent of cases (NIOSH, 1997). In contrast, over 36 percent of injuries were caused by contact with animals in the dairy industry (NIOSH, 1997). Thus, the risk profile for poultry production workers is different than for workers in other animal production

industries, but all animal production industries have stubbornly high rates of injuries and illnesses. Poultry processing is a related industry that has received much attention in the scientific literature related to worker health, safety, and welfare, but the current project is limited to poultry production only, including turkey, chicken, and duck growing and egg production.

OSHA regulators believe that OHSMS are an effective means for businesses to prevent injuries, illnesses, and fatalities, and OSHA compliance officers use OHSMS as evidence of employers' good faith in providing a safe work environment (OSHA, 2009). There is also evidence that voluntary OHSMS interventions can improve an organization's OHS performance (Alsop & LeCouteur, 1999; Bunn III et al., 2001; LaMontagne et al., 2004). In the most comprehensive review of OHSMS interventions to-date, the authors found that most of the studies included in the review showed positive changes resulting from OHSMS interventions, but that there were insufficient data in the published literature to recommend any such interventions (Robson et al., 2007). No previous studies were found that have specifically evaluated OHSMS interventions in agriculture. However, the International Labour Organization has included OHSMS guidelines in their most recent *Code of Practice on Safety and Health in Agriculture* (International Labour Organization, 2010). In the U.S. poultry production industry, farm management practices may influence occupational exposures to airborne dusts and chemicals. Indoor concentrations of airborne ammonia are influenced by feed composition, management of manure, and facility configuration and ventilation (Ritz, Fairchild, & Lacy, 2004). Researchers have also found statistically significant differences in respiratory symptoms, lung function, dust levels, and endotoxin levels between floor-housed and caged-housed poultry confinement facilities in Canada (Kirychuk et al., 2006; Kirychuk et al., 2010). Unfortunately,

poultry producers face a paradox when considering either to reduce indoor ammonia levels via exhaust ventilation for worker and animal health reasons vs. trying to decrease greenhouse gas emissions for environmental reasons (Ritz et al., 2004). No studies were found that linked management interventions to improved health and safety outcomes in poultry growing operations.

There is a paucity of published research evaluating OHSMS using OSHA Form 33 data. In a 1998 government report, Weems and Smitherman described the results of reliability and validity testing of a previous version of the OSHA Form 33 and concluded that OHSMS components and attributes on the form were valid measures of OHSMS programming level. The authors then reported the results of a follow-up predictability study in which they concluded that performance on a newer version of the OSHA Form 33 was predictive of reduced injuries and illnesses in a representative sample of small, high-hazard businesses (Weems, 2000). Based on these findings, the OSHA Form 33 was revised again in 2001 to the 58 item version that is in use today (OSHA, 2001b).

To date, Part 1 of this study is the only known published report that has evaluated the relationship between Revised OSHA Form 33 scores and injury and illness rates. In the first part of this study, the relationship between OHSMS programming level, as measured using the Revised OSHA Form 33, and worker injury and illness rates on dairy farms was evaluated. There was a negative association between Revised OSHA Form 33 scores, and both TRC and DART rates for overall OHSMS and each of the seven OHSMS components measured on the form. It was also found that forms with at least 50 percent or more attributes scored were more strongly

associated with lower injury and illness rates. The results from Part 1 of this study were largely in agreement with those reported by Akbar-Khanzadeh and Wagner (2001), who compared the Revised OSHA Form 33 scores of 107 Ohio OSHA consultation clients in a variety of industries to the number of OSHA violations observed in the client businesses and found a negative correlation between the number of OSHA violations and the level of OHSMS programming; a positive correlation between the number of employees and Revised OSHA Form 33 scores; and no apparent relationship between the number of employees and the number of OSHA violations.

An important limitation in the previous study was the possibility that a third, unknown factor other than OHSMS programming or injury rates was responsible for the observed associations. In this follow-up study, the aim was to apply the same methodology to a different industry within the U.S. animal production sector to determine if similar relationships exist between OHSMS programming and injury rates. The poultry and egg production industry was selected for study because, like the dairy industry, workers in poultry production suffer injuries and illnesses at rates substantially higher than the national average (BLS, 2012). However, the risk profile of poultry workers is different, with a lower risk of acute injury due to contact with animals and a greater risk of respiratory illness due to airborne exposures. The geographical distribution of poultry growing operations and average number of workers employed by each farm are also different from the dairy industry, whose records were limited to only a few dairy producing states in the first part of this study. In addition, there are several distinctions in the way poultry growing operations and dairy farms are organized. Commercial dairy farms tend to have a large, enclosed milking parlor, and fewer other fully enclosed structures. Cows are constantly being moved from bedding areas to the milking facility and back again. Many dairy

workers who are not working in the parlor likely spend more of their time outdoors and operating heavy machinery than workers in poultry and egg farming. Workers on poultry growing operations are more likely to spend most of their time indoors, in one of many poultry grow houses belonging to a single organization. Thousands of birds are typically housed in each building, and they may occupy individual cages (such as is typical in egg production) or they may be housed in communal areas, typically on the floor of a house on a bed of organic litter. Poultry and egg farms are also more likely to be a part of a larger corporation, while dairy farms are more often independent organizations. A larger percentage of workers in the poultry growing industry may therefore not be covered by free OSHA consultation assistance.

Methods:

The methods used in this follow-up study are the same as those previously applied to OSHA consultation records of the U.S. dairy industry, as described in the first part of this project. An important limitation of correlation studies is that observed relationships may be due to some unknown additional element not addressed by the study. By applying the same methodology to a second, similar industry with many different characteristics, findings in agreement may bolster the argument that the observed relationships are indeed attributable to organizational OHSMS programming and not some unknown factor.

Data:

An authorized OSHA representative from the Office of Information Technology Solutions provided OSHA consultation data for the poultry and egg production industry (NAICS 1123), including Revised OSHA Form 33 scores and injury/illness rates from WebIMIS. There was insufficient data to divide the OSHA records by product type, e.g., turkeys, broilers, or chicken eggs. Injury and illness data were limited to TRC and DART rates; additional information about the number, type, and severity of the injuries and illnesses was not available. The consultation records also included the state in which the poultry growing operations were located and the number of workers employed by each facility. A nondescript OSHA reference number was used to pair the demographic, OHSMS, and rate data for a particular poultry farm. The OSHA official provided no information that would enable the identification of a specific poultry producer whose information was included in the data. A consultant code was also included with the data, which could be used to determine if the same consultant entered OHSMS and injury/illness data into WebIMIS for all of the poultry production consultations in a particular state. All data received from OSHA was managed according to the requirements of the Research Integrity and Compliance Review Office (RICRO) at Colorado State University and the WebIMIS Rules of Behavior (Colorado State University, 2014; OSHA, 2005b).

Analysis:

Spearman's Rank-Order Correlation test was used to assess the strength of association between average, overall Revised OSHA Form 33 scores for each poultry growing operation and

their paired average TRC and DART rates. Correlation was also tested between TRC/DART rates and the average Revised OHSMS Form 33 scores for each of the seven OHSMS components. The non-parametric Spearman alternative to linear correlation was used because the assumptions for linear correlation were not supported. Specifically, the injury/illness rates and Revised OSHA Form 33 scores were not normally distributed, the potential relationships were not all convincingly linear, and there were some significant outliers that could not be omitted from the analysis. The assumption of linearity was assessed using a Lack of Fit test and the assumption of normality was tested using a Shapiro-Wilk test. Diagnostic plots were also visually inspected in conjunction with the statistical tests to support or reject the assumptions for linear correlation. This approach allowed the relationship between OHSMS programming level and injury and illness rates to be assessed without dividing the observations into high and low rate categories when considering the overall Revised OSHA Form 33 scores and the scores by OHSMS component. The strength of association between injury rates and OHSMS programming level was also assessed using Spearman correlation for each individual attribute on the Revised OSHA Form 33.

To evaluate the strength of association between Revised OSHA Form 33 scores with higher completion percentages and poultry production worker injury/illness rates, Spearman's Rank-Order Correlation testing was repeated using a sub-set of the OHSMS observations consisting of only those observations where 50 percent or more attributes had been scored on the Revised OSHA Form 33. The higher completion rate Revised OSHA Form 33 analysis was conducted for the overall OHSMS programming level and by each OHSMS component.

Spearman correlation testing was also conducted to assess the relationship between the number of workers at a poultry growing operation and the level of OHSMS programming. The correlation tests were completed for two samples, the first consisting of the observations that were included in the previous analyses by virtue of having paired OHSMS and rate data. In addition, the larger sample of observations that had OHSMS scores, but did not necessarily have paired injury and illness rate data, were also evaluated because average TRC and DART rates were not necessary to evaluate the relationship between workforce size and OHSMS level. Spearman's Rank-Order Correlation test was again used to evaluate the strength of association between the number of poultry employees and worker injury and illness rates.

The poultry production consultation records were also divided into two groups based on the number of poultry workers employed by each organization. The group consisting of records with fewer workers was considered the small organization group, and the one with more poultry workers was considered the large organization group. The cutoff between large and small organizations was chosen to produce approximately equal group sizes. The mean, overall Revised OSHA Form 33 score, and the mean TRC and DART rates were compared for the two groups using a Wilcoxon signed-rank test to determine if the mean outcomes were significantly greater in the larger organizations as compared to the smaller organizations.

Data analysis for this project was conducted using SAS software, Version 9.2 of the SAS System for Windows. Copyright, SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.

The questions regarding the coverage of OHSMS assistance for the poultry production industry and the number of consultants who are providing this assistance are descriptive in nature. The number of consultation visits for each state that resulted in an OHSMS assessment was compared to the number of commercial poultry growing operations in each state using the most recent U.S. census of agriculture data (National Agricultural Statistics Service [NASS], 2012a). The number of unique consultation codes for each state were counted and compared to the total number of Revised OSHA Form 33 entries to determine if poultry farms typically received OHSMS assistance from a single consultant in each state. The proportion of scored Revised OSHA Form 33 attributes was computed for each OHSMS component to determine which OHSMS components were being assessed less frequently by OSHA consultants. Finally, the completion percentage of each attribute was determined to ascertain which of the Revised OSHA Form 33 attributes were often not being evaluated for the poultry production industry.

Results:

Sample Characteristics:

Fifty-eight (58) OSHA consultation records were found for the poultry and egg production industry (NAICS 1123). Thirty-two of 58 (55 percent) had both Revised OSHA Form 33 scores and TRC/DART rates that could be paired. The OSHA records for each observation also included the state where the poultry growing operation was located, the number of workers employed by the facility, and a consultant code. None of the 58 records had two sets of Revised OSHA Form 33 scores, indicating that the poultry records included in this study represented the

initial OHSMS evaluation for each operation, and that none had a follow-up assessment. The OSHA records were created between 2003 and 2013. A summary of the major study variables is provided in Table 4.1.

Table 4.1 Summary of Poultry and Egg Production Industry Data from 32 OSHA On-Site Consultation Service Records with Revised OSHA Form 33 Scores and TRC & DART rates

Variable	Median	Mean (SD)	Min-Max
Number of Employees	32	42.6 (47.4)	2-225
TRC Rate	6.3	8.0 (7.5)	0-36.6
DART Rate	4.6	4.8 (4.5)	0-20.9
Revised OSHA Form 33 Scores[a]	**Median**	**Mean (SD)**	**Min-Max**
Overall	2.1	2.1 (0.6)	0.6-3.0
Hazard Anticipation and Protection	2.0	1.9 (0.7)	0-3.0
Hazard Prevention and Control	2.0	2.0 (0.8)	0-3.0
Planning and Evaluation	1.3	1.2 (1.0)	0-3.0
Administration and Supervision	2.0	2.0 (1.0)	0-3.0
Safety and Health Training	1.6	1.5 (1.0)	0-3.0
Management Leadership	1.9	1.4 (1.2)	0-3.0
Employee Participation	1.0	1.2 (0.9)	0-2.0

[a]Possible Scores for Revised OSHA Form 33 Attributes Range from 0 (attribute not present) to 3 (attribute fully implemented)
OSHA – Occupational Safety and Health Administration

All of the 58 poultry production industry consultation records were from 18 U.S. states. These states represent nine of the ten OSHA regions, excluding region eight. Sixteen states were represented among the 32 poultry industry records that had both Revised OSHA Form 33 scores and injury and illness rates.

Six of the top 10 states in U.S. egg production are represented in the poultry industry consultation records, including the top two egg producing states (Iowa and Ohio) (NASS, 2014c). The distribution of poultry industry consultation records by state to U.S. egg production

is illustrated in Figure 4.1. In addition, three of the top five states in broiler and turkey production (in pounds produced) are represented in the OSHA consultation records (NASS, 2014c). The data used in this study did not allow for differentiation of poultry and egg farm records by the type of food produced.

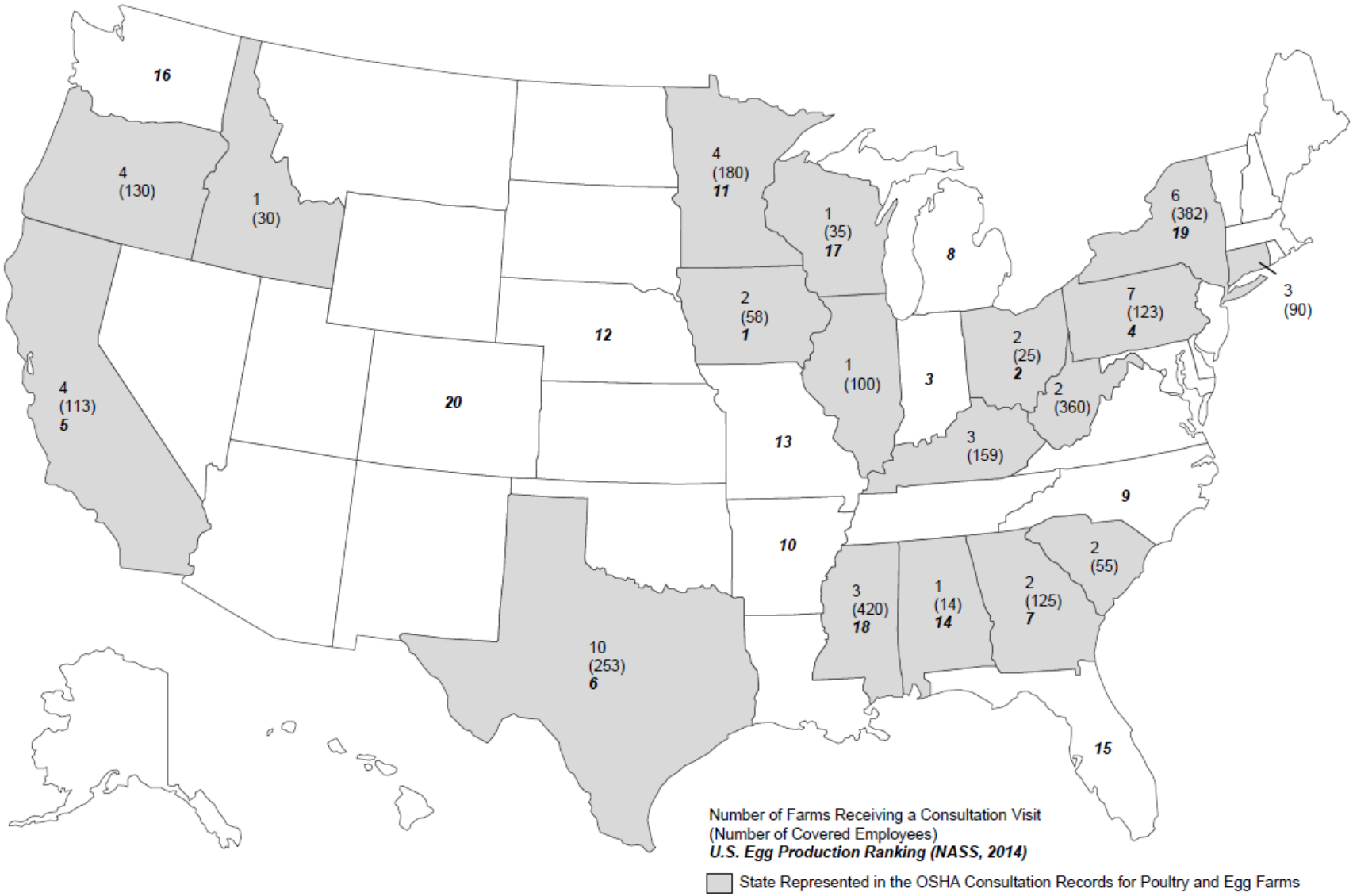

Figure 4.1 Ranking of the Top 20 Egg Producing States and the Number of Poultry Industry Consultations and Covered Dairy Workers by State

The number of poultry workers employed by the 58 poultry and egg farms with OSHA consultation records was 2,652. The mean number of workers per operation was 46. Only six of 58 farms (10 percent) employed fewer than 10 workers. Of the 32 poultry production industry consultation records with paired injury/illness rates and Revised OSHA Form 33 scores, the mean number of workers per operation was 33 and the total number of workers represented was 1,364.

The 58 OSHA consultation records for poultry and egg production facilities were input into WebIMIS by 34 consultants. All of the states with more than two consultation records for poultry production had more than one consultant input those records into WebIMIS.

The mean numeric completion rate (not scored NE) for all of the Revised OSHA Form 33 records was 45 percent, ranging from a low of 9 percent to a high of 100 percent. The one record with 100 percent completion may have been from a SHARP participant because 55 of the 58 attributes on the Revised OSHA Form 33 received a score of two or higher. The mean response rate per Revised OSHA Form 33 attribute was 48 percent, ranging from 13 to 84 percent. When the eight optional SHARP attributes were not considered, the mean numeric response rate was 49 percent, with a range of 25 to 84 percent. The mean response rate per stretch attribute was 26 percent, ranging from 13 to 44 percent. The numeric response rates to Revised OSHA Form 33 attributes by overall OSHA Form 33 and OHSMS components are presented in Table 4.2.

Table 4.2 Consultation Numeric Response Rate for Revised OSHA Form 33 and Each OHSMS Component

OHSMS Component	Total No. Attributes	Mean No. Scored Attributes	Overall Numeric Response Rate (%)
Overall Revised OSHA Form 33	58	26.2	45
Hazard Anticipation and Detection	10	5.5	55
Hazard Prevention and Control	9	5.8	64
Planning and Evaluation	6	2.4	40
Administration and Supervision	8	4.2	52
Safety and Health Training	6	2.6	43
Management Leadership	10	3.8	38
Employee Participation	9	3.5	39

OHSMS – Occupational Health and Safety Management System
OSHA – Occupational Safety and Health Administration

Measures of Association:

No statistically significant association was found between overall OHSMS programming level and TRC or DART rates. However, a moderate and statistically significant negative association was found between both TRC and DART rates and the Administration and Supervision OHSMS component. There was a significant positive association between the Safety and Health Training component and DART rates. The results of the Spearman's Rank-Order Correlation analysis for OHSMS programming level and injury/illness rates for the 32 paired poultry production records are provided in Table 4.3.

Table 4.3 Spearman Correlation Coefficients for the Strength of Association Between Injury & Illness rates and OHSMS Programming Level (n=32)

OHSMS Element	TRC	DART
Overall	-0.01	-0.12
Hazard Anticipation and Detection	-0.10	-0.12
Hazard Prevention and Control	0.02	0.02
Planning and Evaluation	0.03	0.19
Administration and Supervision	-0.41*	-0.44*
Safety and Health Training	0.23	0.40*
Management Leadership	-0.24	-0.07
Employee Participation	-0.06	-0.03

*Correlation was significant ($P < 0.05$)

OHSMS – Occupational Health and Safety Management System
OSHA – Occupational Safety and Health Administration

Twenty-one of 32 paired poultry production industry records (66 percent) had Revised OSHA Form 33 entries where fewer than half of the 58 attributes were assigned a numeric score. 11 of 32 (34 percent) paired observations were included in a secondary correlation analysis because they included Revised OSHA Form 33 records where at least half or more of the attributes were assigned a numeric score. When the smaller subset of more complete Revised OSHA Form 33 records were included, a strong negative association was found between overall OHSMS programming and injury and illness rates. Strong to moderate negative associations were also found between each of the seven OHSMS components and TRC/DART rates, except the Safety and Health Training OHSMS component, which had a positive association that was not statistically significant. Management Leadership was the OHSMS component with the strongest association with reduced injuries and illnesses. The results of this secondary analysis are included in Table 4.4.

Table 4.4 Spearman Correlation Coefficients for the Strength of Association Between Injury & Illness rates and OHSMS Programming Level with Revised OSHA Form 33 Completion Rates ≥ 50% (n=11)

OHSMS Element	TRC	DART
Overall	-0.53	-0.57
Hazard Anticipation and Detection	-0.54	-0.57*
Hazard Prevention and Control	-0.47	-0.52
Planning and Evaluation	-0.17	-0.22
Administration and Supervision	-0.64*	-0.66*
Safety and Health Training	0.26	0.21
Management Leadership	-0.71*	-0.68*
Employee Participation	-0.38	-0.13

*Correlation was significant ($P < 0.05$)

OHSMS – Occupational Health and Safety Management System
OSHA – Occupational Safety and Health Administration

Nonparametric correlation analysis between the number of workers and injury/illness rates was conducted for the paired (n=32) and unpaired (n=35) OHSA consultation records with injury data. The number of poultry production workers was positively associated with the injury and illness rates when examining either sample, and all associations were statistically significant. No significant associations were found between the number of poultry workers and overall Revised OSHA Form 33 scores when both the paired (n=32) and unpaired (n=55) records with Revised OSHA Form 33 scores were included. The results of the correlation analysis for the number of poultry workers are provided in Table 4.5.

Table 4.5 Spearman Correlation Coefficients for the Strength of Association Between the Number of Employees on a Poultry Growing Operation, OHSMS Programming Level, and Injury & Illness Rates

	Correlations for Workforce Size	
Sample	**ρ[a]**	**P-value**
TRC Rate, *Paired* (n=32)	0.53	<0.01
DART Rate, *Paired* (n=32)	0.48	<0.01
TRC Rate, *Unpaired* (n=35)	0.53	<0.01
DART Rate, *Unpaired* (n=35)	0.48	<0.01
OSHA Form 33 Scores, *Paired* (n=32)	-0.08	0.66
OSHA Form 33 Scores, *Unpaired* (n=55)	0.14	0.18

[a]Spearman's rank-order correlation coefficient
OHSMS – Occupational Health and Safety Management System
OSHA – Occupational Safety and Health Administration

For the 55 poultry industry consultation records with Revised OSHA Form 33 scores, the mean number of workers in the small organization group was 13 (n=26) and the mean number of workers in the large organization group was 72 (n=29). There was no significant difference between the mean, overall Revised OSHA Form 33 scores of the two groups. For the 35 poultry industry consultation records with injury and illness rate data, the mean number of workers in the small organization group was 16 (n=17) and the mean number of workers in the large organization group was 73 (n=18). Both the TRC and DART rates were significantly higher in the large organization group than the small organization group (P-value < 0.01).

When considering associations between individual Revised OHSM Form 33 attributes and injury/illness rates, thirteen of 58 attributes (22 percent) had statistically significant associations with both TRC and DART rates. Another six of 58 attributes (10 percent) had significant associations with only one of the either the TRC rate or the DART rate. Most of the associations were weak to moderate and in the expected (negative) direction. A summary of the

associations for poultry worker injury/illness rates and individual OSHA Form 33 attributes is provided in Tables 4.6a, 4.6b, and 4.6c.

Table 4.6a Spearman Correlation Coefficients for the Strength of Association Between Poultry Farm Injury & Illness rates and OHSMS Programming Level for Each Revised OSHA Form 33 Attribute

Revised OSHA Form 33 Attribute	Response Rate[a] (%)	TRC	DART
A comprehensive, baseline hazard survey has been conducted within the past five (5) years. (n=25)	78	-0.21	-0.14
Effective [S&H] self-inspections are performed regularly. (n=27)	84	-0.01	-0.06
Effective surveillance of established hazard controls is conducted. (n=20)	63	-0.18	-0.39
An effective hazard reporting system exists. (n=22)	69	-0.16	-0.36
Change analysis is performed whenever a change in facilities, equipment, materials, or process occur. (n=13)	41	-0.61*	-0.63*
Accidents are investigated for root causes. (n=16)	50	-0.34	-0.24
[MSDSs] are used to reveal potential hazards associated with chemical products in the workplace. (n=19)	59	-0.21	-0.26
Effective job hazard analysis is performed. (n=15)	47	-0.61*	-0.61*
Expert hazard analysis is performed. (n=10)	31	-0.31	-0.37
Incidents are investigated for root causes. (n=7)[b]	22	-0.53	-0.40
Feasible engineering controls are in place. (n=19)	59	0.12	0.09
Effective [S&H] rules & work practices are in place. (n=24)	75	-0.05	-0.19
Applicable OSHA-mandated programs are effectively in place. (n=25)	78	0.44*	0.36
Personal protective equipment is effectively used. (n=23)	72	-0.13	-0.27
Housekeeping is properly maintained. (n=26)	81	-0.05	-0.12
The organization is properly prepared for emergency situations. (n=24)	75	-0.16	-0.25
[The org. has a plan] for providing [emerg.] medical care to employees & others present at the site. (n=18)	56	-0.29	-0.35
Effective preventive maintenance is performed. (n=9)[b]	28	-0.46	-0.64
An effective procedure for tracking hazard correction is in place. (n=17)	53	-0.53*	-0.49*
Workplace injury/illness data are effectively analyzed. (n=17)	53	-0.53*	-0.52*

[a]Numeric response rate to the attribute out of 45 Revised OSHA Form 33 observations

[b]Revised OSHA Form 33 stretch attribute

*Correlation was significant (P-value < 0.05)
[Edited for space]
TRC, Total Recordable Case Rate
DART, Days Away, Restricted, or Transferred Rate

Table 4.6b Spearman Correlation Coefficients for the Strength of Association Between Poultry Farm Injury & Illness rates and OHSMS Programming Level for Each Revised OSHA Form 33 Attribute

Revised OSHA Form 33 Attribute	Response Rate[a] (%)	TRC	DART
Hazard incidence data are effectively analyzed. (n=10)	31	-0.83*	-0.79*
A [S&H] goal & supporting objectives exist. (n=16)	50	0.18	0.13
An action plan designed to accomplish the organizations [S&H] objectives is in place. (n=10)	31	0.28	0.28
A review of in-place OSHA-mandated programs is conducted at least annually. (n=16)	50	0.55*	0.49
A review of the overall [S&H] management system is conducted at least annually. (n=7)[b]	22	0.16	0.00
[S&H] program tasks are specifically assigned to a person or position for performance or coordination (n=23)	72	-0.41*	-0.45*
Each assignment of [S&H] responsibility is clearly communicated. (n=15)	47	-0.53*	-0.50
An accountability mechanism is included with each assignment of [S&H] responsibility. (n=14)[b]	44	-0.03	-0.02
[Ind. w/ S&H] responsibilities have the knowledge, skills, & timely information to [do their job]. (n=20)	63	-0.07	-0.16
Individuals with assigned [S&H] responsibilities have the authority to perform their duties. (n=18)	56	-0.49*	-0.41
Individuals with assigned [S&H] responsibilities have the resources to perform their duties. (n=15)	47	-0.57*	-0.48
Organizational policies promote the performance of [S&H] responsibilities. (n=14)	44	-0.69*	-0.71*
Organizational policies result in correction of non-performance of [S&H] responsibilities. (n=15)	47	-0.04	-0.01
Employees receive appropriate [S&H] training. (n=26)	81	0.35	0.35
New employee orientation includes applicable [S&H] information. (n=18)	56	0.08	0.08
Supervisors receive appropriate [S&H] training. (n=15)	47	0.26	0.27
Supervisors receive training that covers the supervisory aspects of their [S&H] responsibilities. (n=8)[b]	25	0.55	0.55
[S&H] training is provided to managers. (n=11)	34	0.29	0.34
Relevant [S&H] aspects are integrated into management training. (n=4)[b]	13	0.63	0.63
Top management policy establishes clear priority for [S&H]. (n=19)	59	-0.50*	-0.50

[a]Numeric response rate to the attribute out of 45 Revised OSHA Form 33 observations

[b]Revised OSHA Form 33 stretch attribute

*Correlation was significant (P-value < 0.05)

[Edited for space]

TRC, Total Recordable Case Rate

DART, Days Away, Restricted, or Transferred Rate

Table 4.6c Spearman Correlation Coefficients for the Strength of Association Between Poultry Farm Injury & Illness rates and OHSMS Programming Level for Each Revised OSHA Form 33 Attribute

Revised OSHA Form 33 Attribute	Response Rate[a] (%)	TRC	DART
Top management considers [S&H] to be a line rather than a staff function. (n=12)	38	-0.67*	-0.67*
Top management provides competent [S&H] staff support to line managers & supervisors. (n=9)[b]	28	-0.57	-0.57
Managers personally follow [S&H] rules. (n=14)	44	-0.45	-0.42
Managers delegate [authority] for personnel to carry out their assigned [S&H] responsibilities. (n=9)	28	-0.83*	-0.83*
Managers allocate the resources needed to properly support the organizations [S&H] system. (n=12)	38	-0.67*	-0.67*
Managers assure that appropriate [S&H] training is provided. (n=10)	31	0.43	0.36
Managers support fair and effective policies that promote [S&H] performance. (n=10)	31	-0.65*	-0.65*
Top management is involved in the planning & evaluation of [S&H] performance. (n=12)	38	-0.62*	-0.59*
Top management values employee involvement & participation in [S&H] issues. (n=13)	41	-0.70*	-0.70*
There is an effective process to involve employees in [S&H] issues. (n=23)	72	-0.17	-0.16
Employees are involved in organizational decision making in regard to [S&H] policy. (n=13)	41	-0.26	-0.23
Employees are involved in organizational decision making in regard to allocation of [S&H] resources. (n=8)	25	-0.55	-0.47
Employees are involved in organizational decision making in regard to [S&H] training. (n=9)	28	-0.24	-0.05
Employees participate in hazard detection activities. (n=19)	59	-0.03	-0.12
Employees participate in hazard prevention & control activities. (n=14)	44	-0.26	-0.24
Employees participate in the [S&H] training of co-workers. (n=8)[b]	25	0.33	0.33
Employees participate in [S&H] planning activities. (n=8)	25	-0.37	-0.25
Employees participate in the evaluation of [S&H] performance. (n=9)	28	-0.40	-0.29

[a]Numeric response rate to the attribute out of 45 Revised OSHA Form 33 observations

[b]Revised OSHA Form 33 stretch attribute

*Correlation was significant (P-value < 0.05)

[Edited for space]

TRC, Total Recordable Case Rate

DART, Days Away, Restricted, or Transferred Rate

Discussion:

The level of OHSMS programming, as measured by the Revised OSHA Form 33, was associated with reduced injury and illness rates for poultry workers. Similar to the findings in Part 1 of this study, the strength of association and the number of statistically significant associations for the overall OHSMS and OSHMS components increased considerably when only those forms were included where 50 percent or more Revised OSHA Form 33 attributes were assigned a numeric score. This reinforces the idea that when more attributes are scored by a consultant, there is a clearer association between Revised OSHA Form 33 scores and injury rates. In Chapter 5, 97 percent of respondents to a survey of OSHA consultation clients in Colorado reported that the Revised OSHA Form 33 was accurate and that the results were helpful for improving their organization's OHSMS. In addition, most responding OSHA consultation clients reported that the comments on the form were helpful for improving their OHSMS. Given the value of Revised OSHA Form 33 to clients and the apparent associations between OHSMS programming and reduced injury and illnesses in animal production agriculture, prioritizing the completion of the Revised OSHA Form 33 may be beneficial for consultation visits in the U.S. poultry and egg production industry.

Unlike the previous study of U.S. dairy industry producers, the Safety and Health Training component scores for poultry production were positively associated with injuries and illnesses, although the association was not statistically significant. The positive association persisted, but decreased in strength, when only the most complete Revised OSHA Form 33 scores were considered. Further, every individual attribute in the Safety and Health Training

component was also positively associated with TRC and DART rates. The numeric response rates for these attributes were typical as compared to other Revised OSHA Form 33 attributes and components. One possible explanation for the association between higher levels of OHSMS programming in the Safety and Health Training component and higher injury rates could be that poultry and egg producers have basic safety training programs in place, but that the training is not effective. In 2008, Hagel et al. found that education alone had no significant effect on farm worker injuries on Canadian farms. The authors suggested that this may be due to the poor efficacy of education as a sole modality to influence outcomes (Hagel et al., 2008).

Similar to the results presented in Part one of this study, Management Leadership was the OHSMS component with the strongest association with lower TRC and DART rates. Interestingly, all of the individual Revised OSHA Form 33 attributes in the Management and Leadership OHSMS component had moderate-to-strong negative associations with TRC and DART rates with one noteworthy exception for the poultry and egg production industry. That attribute, "Managers assure that appropriate safety and health training is provided," was positively associated with injury rates. This finding is consistent with the positive associations observed between the Safety and Health Training component and higher injury and illness rates in the poultry production industry. Administration and Supervision was the OHSMS component with the second highest level of association. This held true when both the entire sample and the subsample with the highest numeric completion rates were considered.

Within the Management Leadership OHSMS component, the two attributes with the strongest associations with reduced injuries and illnesses were the one that addresses delegation

of authority for workers to perform safety and health responsibilities, and the attribute that assesses if top management values employee involvement in safety and health issues. These topics should thus provide a good starting point for addressing management leadership-focused OHSMS interventions for poultry production managers.

There was no significant association between the number of workers employed by a poultry growing operation and level of OHSMS programming, but there was significant positive associations between the number of poultry production workers and an operation's injury and illness rates. These findings are in contrast to those described in the first part of this study, and those reported by Akbar-Khanzadeh and Wagner (2001), who suggested that the greater number of employees serve to keep the number of regulatory violations stable while improving the overall OHSMS. This may indicate that in poultry growing operations, as the number of workers increase, so do the number and/or magnitude of workplace hazards. In contrast, as dairy farm workforces grow, the level of OHSMS programming grows as well, which may keep injury and illness rates in check. There are differences in the way dairy farms and poultry growing operations are organized, which may potentially explain the differences increasing workforce size had on injury rates and OHSMS programming level between the two industries. In poultry growing operations, a fixed number of employees can generally manage a poultry house. If additional houses are added, a fixed number of new workers can be recruited and there is not necessarily any more or less interaction between poultry workers on larger or smaller operations. In contrast, the number of workers required to manage a growing dairy farm is not as fixed or compartmentalized. Larger herds require additional handlers and milkers, and there may therefore be an increase in employee interaction as the organization grows. This difference in the

level of interaction between employees may explain why OHSMS programming level improves significantly as workforce size increases, without any significant change in TRC and DART rate. In contrast, as poultry growing workforces increase, the level of interaction between workers remains stable, leading to an increase in injuries without any significant change in the OHSMS programming level of the operation.

Limitations:

The OSHA consultation data used in this study were not collected for research purposes. Instead, the data were collected and stored for internal evaluation purposes and to generate norms (OSHA, 2008a). As such, the data may not be representative of all injuries and illnesses suffered by poultry workers (e.g., minor injuries that were not recordable would not likely be included), nor of the entire scope of OHSMS programming in place at these organizations. Only one of the 32 poultry production records with paired OHSMS and injury data may have been a SHARP client. Many of the other records likely represented limited-scope visits where full completion of the Revised OSHA Form 33 was impossible. None of the records had multiple Revised OSHA Form 33 records, indicating the scores were likely the result of the initial consultation without further OHSMS assessment during any subsequent visits.

A Wilcoxon sign-ranked test between the mean, overall Revised OSHA Form 33 scores of poultry production records with paired injury rates (n=32) and without paired injury rates (n=26) indicated that there was no significant difference in the average level of OHSMS programming for either group. This suggests that the poultry growing operations included in our

correlation analysis may be representative of the entire sample. The mean, numeric completion rate for the Revised OSHA Form 33 attributes was less than 50 percent in both the records with paired injuries and illnesses (n=32) and those that were not paired (n=55). Even when the stretch attributes were excluded, the numeric completion remained quite low. Furthermore, only eleven files included Revised OSHA Form 33 records where 50 percent or more of the attributes were given a numeric score. A Wilcoxon signed-rank test was performed to compare the mean, overall Revised OSHA Form 33 scores and the mean TRC and DART rates of the 11 paired records with ≥ 50 percent numeric scoring and the remaining 21 records with less than 50 percent of attributes scored. There was no significant difference between to the two groups, suggesting that the smaller, higher-completion subset may be representative of the larger, paired sample.

Management Leadership was once again the OHSMS component with the lowest numeric completion rate, on the Revised OSHA Form 33 (38 percent). Because Management Leadership is considered one of the most critical of the OHSMS components, OSHA consultants should prioritize the assessment of these attributes. The two OHSMS components with the next lowest numeric completion rate were Employee Participation (39 percent) and Planning & Evaluation (40 percent). Neither of these components had particularly high correlations with injury rates, suggesting that the observed relationships between Management Leadership attributes and fewer injuries and illnesses was not simply a function of low form completion rates.

The use of Revised OSHA Form 33 data itself is another potential limitation of this study. Most of the previous research that used Revised OSHA Form 33 data, or evaluated the use of

Revised OSHA Form 33, utilized older versions of the instrument (Akbar-Khanzadeh & Wagner, 2001; Weems, 1998, 2000). This is the second published report known to incorporate the use of OHSMS programming data from the current version of the Revised OSHA Form 33. Because similar associations were observed when applying the same experimental methodology to a different animal production industry, there is additional confidence that the Revised OSHA Form 33 is indeed measuring OHSMS programming attributes that are relevant to OHS outcomes. The potential limitations of using TRC and DART rates also warrant some discussion. Poultry production management may over- or under-report worker injuries on the OSHA Form 300 because of misunderstanding or misusing the OSHA Form 300 logs. In a 1995 study, researchers concluded that relatively low injury rates observed in small businesses were due to underreporting of injuries (Oleinick et al., 1995). However, OSHA consultants are trained to look for mistakes on the OSHA Form 300 logs of clients and provide assistance in proper recordkeeping (OSHA, 2012b). Thus, recordkeeping errors may be less likely in this study.

Conclusions:

There was a negative correlation between OHSMS programming level and injury and illness rates on poultry growing operations. Management Leadership was the OHSMS component that was most strongly associated with lower injury and illness rates, which was in agreement with findings previously presented in Part 1 of this study. In contrast, larger poultry production workforces were not associated with higher levels of OHSMS programming and they were associated with higher rates of injuries and illnesses. Further, the Safety and Health Training OHSMS component was positively associated with injuries and illnesses, suggesting

safety training alone was not protective in poultry growing operations and appears to have been problematic. The findings in both parts of this study indicate that OHSMS programming interventions may represent a novel means to reduce the stubbornly high rates of injuries and illness suffered by workers in U.S. animal production agriculture industries. Future research on the effectiveness of OHSMS interventions in animal production agriculture is warranted.

Recommendations:

1. OSHA officials should not exempt agriculture from the OHSMS regulations under development for U.S. businesses because OHSMS programming is associated with lower injury and illness rates and there are an unacceptably high number of work-related injuries, illnesses, and fatalities in the U.S. agriculture sector.

2. Management at commercial poultry growing operations with fewer than 250 employees should consider requesting comprehensive OHSMS assistance from the OSHA On-Site consultation service in their state as a means to improve OHS performance and reduce regulatory liability.

3. Management at poultry and egg production facilities should be provided with the knowledge and skills necessary to evaluate and improve the effectiveness of employee safety training.

4. When evaluating a client's OHSMS, OSHA consultants should assess as many Revised OSHA Form 33 attributes as feasible and give clients detailed feedback on how to improve areas of weakness.

5. Researchers should consider developing and evaluating OHSMS interventions as a potential avenue to improve OHS in animal production agriculture. Interventions should include measurement of OHSMS programming, injury and illness rates, economic outcomes, and leading indicators, including worker perceptions and the presence of workplace hazards.

CHAPTER 5: CLIENT PERCEPTIONS OF OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEM ASSISTANCE PROVIDED BY OSHA ON-SITE CONSULTATION: RESULTS OF A SURVEY OF COLORADO SMALL BUSINESS CONSULTATION CLIENTS[3]

Summary:

The Occupational Safety and Health Administration (OSHA) On-Site Consultation Service provides assistance establishing occupational health and safety management systems (OHSMS) to small businesses. The Safety and Health Program Assessment Worksheet (Revised OSHA Form 33) is the instrument used by consultants to assess an organization's OHSMS and provide feedback on how to improve a system. A survey was developed to determine the usefulness of the Revised OSHA Form 33 from the perspective of Colorado OSHA consultation clients. One hundred and seven clients who had received consultation services within a six-year period responded to the survey. The vast majority of respondents indicated that the Revised OSHA Form 33 accurately reflected their OHSMS and that information provided on the Revised OSHA Form 33 was helpful for improving their systems. Specific outcomes reported by the

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respondents included increased safety awareness, reduced injuries, and improved morale. The results indicate that the OHSMS assistance provided by OSHA consultation is beneficial for clients and that the Revised OSHA Form 33 can be an effective tool for assessing and communicating OHSMS results to business management. Detailed comments and suggestions provided on the Revised OSHA Form 33 are helpful for clients to improve their OHSMS.

Introduction:

Occupational Health and Safety Management Systems (OHSMS) are a set of interrelated policies and procedures that specify how an organization will manage workplace safety and health. OHSMS vary in content by organization and application, but common elements often include a health and safety policy; hazard detection and correction processes; safety training; methods of employee involvement; and management review. OHSMS are recognized by Occupational Safety and Health Administration (OSHA) officials as an effective business strategy to reduce the number and magnitude of occupational injuries and illnesses (OSHA, 2014). The OSHA On-Site Consultation Program provides small and medium size businesses with professional safety and health services, including assistance in establishing an OHSMS. Consultation programs are voluntary for participating businesses, and the program is funded primarily by the federal government and is managed by individual states. The Safety and Health Program Assessment Worksheet (Revised OSHA Form 33) is the tool used to measure the level of OHSMS programming for a participating business. Small businesses with exemplary OHSMS (as measured by relatively high scores on the Revised OSHA Form 33) and low rates of occupational injuries and illnesses are recognized by OSHA through the Safety and Health

Achievement Recognition Program (SHARP). As the primary tool for assessing OHSMS and providing feedback for system improvement, the Revised OSHA Form 33 should be an effective means of communicating OHSMS deficiencies and potential remedies to employers.

The purpose of this research was to evaluate the usefulness of OHSMS assistance and the information provided on the Revised OSHA Form 33 to recipients of OSHA consultation services from the clients' perspective. Client perceptions of the Revised OSHA Form 33 were requested, along with information on any OHS improvements and any observed outcomes that resulted from the OHSMS assistance provided by OSHA consultants. Colorado small business clients of OSHA's On-Site Consultation Program were solicited for participation in this research. All OSHA On-Site consultation visits in the state of Colorado originate from the Colorado State University OSHA Consultation Program in Fort Collins, Colorado.

Background:

Small businesses (less than 250 employees) account for a majority of occupational fatalities in the U.S. (Mendeloff, 2006), and the nationally published non-fatal injury and illness rates may be underreported in these companies (Oleinick et al., 1995). It has been reported that an effective OHSMS may reduce the risk of injuries and illnesses in an organization (Bunn III et al., 2001; Koda & Ohara, 1999; Torp et al., 2000). Organizational occupational health and safety (OHS) interventions may be less effective in small businesses as compared to larger organizations, due in part to limited knowledge and resources (Eakin, Lamm, & Limborg, 2000). However, the results of a 1998 Norwegian study indicated that organization size had no effect on the

implementation of mandatory Internal Control regulations, which require companies to adopt a systematic approach to health, environmental, and safety activities, including requirements for documented safety objectives, risk assessments, hazard control, and system review (Nytrø et al., 1998). In a 2001 study of OSHA consultation clients in a Midwestern state, researchers found that higher OSHA Form 33 scores (using an older version of the instrument) were associated with fewer safety and health violations (Akbar-Khanzadeh & Wagner, 2001). More recently, Spanish researchers reported that small and medium sized Spanish manufacturers with OHSMS had significantly lower accident rates than those without, and those firms with the most advanced systems (as characterized by survey responses indicating above average performance on 12 OHSMS elements) had the lowest accident rates as compared to those with less comprehensive systems (Arocena & Núñez, 2010). Thus, OHSMS may be a feasible means for small businesses to reduce the risk of occupational injuries and illnesses.

The Revised OSHA Form 33 consists of 58 attributes that are scored on a scale from 0 (attribute not addressed) to 3 (attribute fully implemented) by OSHA consultants to measure the level of implementation of OHSMS attributes, as shown in APPENDIX A. The attributes are divided into seven OHSMS elements that include hazard anticipation and detection; hazard prevention and control; planning and evaluation; administration and supervision; safety and health training; management leadership; and employee participation. The Revised OSHA Form 33 also includes space for consultants to provide comments about each attribute scored on the form. A copy of the completed Revised OSHA Form 33 and a written report are provided to Colorado consultation clients to help them establish and improve their OHSMS and to correct any hazards identified by the consultant.

OSHA Consultants also provide recordkeeping assistance and record the injury and illness rates of their clients for a period of three years prior to the consultation visit, if three years of data are available (OSHA, 2008a). However, fewer years may be used for new businesses who have not been in operation for three years (OSHA, 2008a). Client injury and illness rates are computed using the Log of Work-Related Injuries and Illnesses (OSHA Form 300) (OSHA, 2005a). Two rates are recorded by the consultant. The first, Total Recordable Case rate, is computed by multiplying the total number of injuries and illnesses recorded on the OSHA Form 300 by 200,000 (the nominal number of hours worked by a 100 full-time employees in a single year) and then dividing the product by the total number of hours worked by employees of that organization in a year (OSHA, 2005a). This provides a normalized rate of injuries and illnesses that can be compared across employers of varying sizes and work schedules. The second injury and illness rate recorded by OSHA consultants is the so-called Days Away, Restricted, and Transferred (DART) rate. The DART rate is computed in the same manner as the TRC rate, except the only injuries and illnesses counted from the OSHA Form 300 are those that resulted in the employee missing work, being transferred to a different job requiring different abilities, or working with restrictions (OSHA, 2005a). No previous studies were found that examined if consultation clients viewed OHSMS assistance provided by the OSHA On-Site Consultation Service as beneficial or what changes clients have made based on the assistance provided.

Methods:

Subject Selection and Data Collection:

The study population included management at Colorado businesses that received an OSHA consultation site visit from 2002 to 2007, consisting of a total of 942 closed consultation files. In 2008, every third, closed OSHA On-Site Consultation file in that time period was selected using an internal case file number for a total of 314 closed consultation files. A questionnaire was designed and validated to assess client perceptions about the Revised OSHA Form 33 and to determine what changes were made as a result of the feedback provided on the form. The validation process included a review by a panel of subject matter experts and by pilot testing of the instrument. Business demographic information was obtained from the selected consultation files. The questionnaire was mailed to the 314 former clients, along with a copy of their most recent Revised OSHA Form 33 for reference. A recruitment letter explaining the study and an informed consent document were included in the mailings. Subjects were also asked if they recalled receiving the Revised OSHA Form 33 and about their position in the organization. The mean, overall Revised OSHA Form 33 score and the mean score for each OHSMS element was determined for each potential subject. If a file had multiple Revised OSHA Form 33 records, such as in the case of some SHARP clients who received more than one OHSMS assessment, only the scores from the most recent form were used.

A follow-up questionnaire was sent to non-respondents eight weeks after the initial mailing and a follow-up telephone interview using the same questions was administered to a random

sample of the remaining non-respondents 12 weeks after the initial mailing. An additional telephone interview was administered to 10 percent of respondents to verify questionnaire results. All aspects of this study were completed in accordance with procedures approved by the Colorado State University Institutional Review Board and the Research Integrity and Compliance Review Office. All statistical analyses were performed using Statistical Analysis System (SAS) software version 9.2 (Cary, North Carolina).

Questionnaire Data:

Subjects were asked eight 'yes' or 'no' questions about the usefulness of the information provided on the Revised OSHA Form 33. Each survey question was followed by an open-ended question for respondents to provide additional information based on their responses to the survey item. Responses to follow-up questions were reviewed by the research team and grouped into relevant categories for descriptive analysis. The complete survey is provided in Appendix B.

Subjects were also asked about OHS improvements that were made and about outcomes that resulted from the OHSMS assistance they received. Reported OHSMS outcomes were grouped into the following categories: reduced injuries and illnesses; improved overall OHSMS; increased awareness, knowledge and/or involvement; increased morale and peace of mind; decreased costs, better quality product and/or increased productivity.

Results:

Response Rates and Business Characteristics:

The overall questionnaire response rate was 107 of 314 (34 percent). An additional 25 of 314 (eight percent) clients solicited were no longer in business, making them ineligible to participate. The effective response rate among potentially eligible participants was 107 of 289 (37 percent). Fifty-one of 107 responding companies (48 percent) were identified using National American Industry Classification System (NAICS) codes as manufacturing companies, 13 of 107 (12 percent) were in the construction industry, and 43 of 107 (40 percent) were classified as other industries. Of the responding companies, 12 of 107 (11 percent) had participated in the OSHA SHARP program. Ninety-two respondents provided a job description and indicated whether they recalled receiving the Revised Form 33. Thirty-one of 92 (31 percent) indicated they were a safety or environmental supervisor/manager and another 31 indicated that they were another type of supervisor/manager. Eighteen of 92 (20 percent) identified themselves as the owner/president and 12 (13 percent) were categorized as other, which included jobs such as operator, human resources generalist, and engineer. Eighty-four of 92 responding subjects (91 percent) indicated that they recalled receiving the Revised OSHA Form 33, suggesting that the person completing the survey was working for the organization during the time of the original OHSMS assessment. The mean DART rate of each business recorded by the OSHA consultant was 3.5 (range 0 to 31) from the 58 responding businesses that had injury/illness rate data on file, and the mean TRC rate was 7 with the same range.

The mean, overall Revised OSHA Form 33 score for the 107 respondents was 2 (range 0.3 to 3). The mean, overall Revised OSHA Form 33 score for the 12 responding SHARP participants was 2.8 (range 2.5 to 3). The mean number of attributes assigned a numeric score was 42 out of 58 possible attributes for all respondents, and the mean number of attributes scored for SHARP participants was 49. A summary of Revised OSHA Form 33 scores and numeric response rates for each OHSMS element is provided in Table 5.1.

Questionnaire Results:

The results of the survey on client perceptions of OHSMS usefulness are provided in Table 5.2. One hundred of 102 (98 percent) subjects that responded to the question indicated that the Form 33 scoring was accurate and that the attributes on the Form 33 made sense. Ninety-eight of 102 (96 percent) respondents indicated that the Form 33 was easy to understand, and 99 of 102 (97 percent) respondents indicated that the Form 33 was useful in improving the company's OHSMS.

A smaller proportion of subjects answered the follow-up questions on the survey that came after each initial 'yes' or 'no' question. Only three of the eight open-ended questions received any responses. Of the three questions with responses, a total of 153 open-ended answers were received. The follow-up item for question four asked if the information provided on the Revised OSHA Form 33 was not useful for improving OHSMS, then what specific aspects of the form were not useful. The two comments received indicated that most attributes were not evaluated in one case and that no detailed information was provided on how to improve the OHSMS in the

other case. The follow-up to question seven asked what types of comments were most helpful if the comments/suggestions on the Revised OSHA Form 33 were useful to the client. This question received 17 open-ended responses. Five of the 17 subjects (29 percent) who answered indicated that all of the comments on the Revised OSHA Form 33 were helpful. Another five of 17 (29 percent) stated that the more specific or detailed comments were the most helpful, and seven of 17 (41 percent) thought comments that offered specific information on how to improve an attribute were the most helpful.

The final survey question about making changes as a result of the Revised OSHA Form 33 had a three-part follow-up question, one part for respondents who answered 'no' to the question, and two for those who answered 'yes'. Of the four open-ended responses from subjects who answered 'no' and did not make any changes based on the suggestions provided on the Form 33, two indicated that there were insufficient resources to make the changes, and the other two indicated no changes were required or specified on the form. Seventy-five subjects provided additional information on changes made based on the Revised OSHA Form 33. Twenty-three reported implementing new or updated safety programs, 18 reported improved PPE use and/or hazard reduction, 11 indicated increased employee involvement in OHS activities, eight indicated additional worker and/or manager safety training, and 15 reported that all indicated changes or multiple OHS improvements were made. Finally, 55 subjects provided details about observed outcomes as a result of OHS changes made. Of these subjects, 22 indicated improved safety knowledge, reporting, and awareness, 15 reported reduced injuries or incidents, 12 indicated improved employee morale and peace of mind, four reported decreased operational

costs, and two reported improved productivity or product quality. The complete client survey including follow-up questions is included in APPENDIX B.

Discussion:

The vast majority of respondents provided positive responses to all questions on the eight-item survey. Most clients believed that the Revised OSHA Form 33 was accurate, understandable, and useful for improving their OHSMS. The comments and suggestions provided on the form were largely viewed as helpful and most clients followed the suggestions to make changes in the workplace. Fewer respondents answered the open-ended questions, but the majority who did reported positive experiences and changes. The most frequently reported change was implementing or improving safety programs and the most frequently cited outcome was improved safety knowledge, reporting, and awareness followed by reduced injuries and illnesses. The few negative reports indicated that some clients did not feel there was sufficient information provided on the form or that there were insufficient resources to enact changes.

The comments and suggestions provided by consultants are likely more useful to clients than only a score of an individual attribute. The attribute score may help identify an area of strength or weakness, but an explanation of why a score was given and suggested changes are critical to convey information about how to improve the OHSMS. Clients indicated that consultant comments were helpful to improve their OHSMS, and detailed comments that offered suggestions for improvement were specifically cited.

Limitations:

There are some important limitations to consider when interpreting these survey results. The study population was limited to consultation clients of a single state, and these subject perceptions may not necessarily reflect the perceptions of OSHA consultation clients nationally. Further, the Program Manager for the Colorado OSHA Consultation Program is one of the authors of the training manual provided to all OSHA consultants in the U.S. (OSHA, 2012b). Thus, scoring more attributes of the Revised OSHA Form 33 or providing detailed comments to clients may be a higher priority for consultants in Colorado than in other states.

Subject recall may be another important consideration because the subjects were asked to remember details about a consultation visit that occurred up to six years prior to receiving the survey. To aid in the recall of the consultation visit, participants were provided with a copy of their OSHA Form 33 to reference when completing the survey. To determine if length of time since consultation resulted in different response rates, all 314 selected files were divided by date into two equal groups. The first group had received the survey within two years and 11 months since their consultation file was closed (n=157). The second group received the survey between three and six years after their consultation file was closed (n=157). The proportion of survey respondents in the two groups, relatively "long" and "short" elapsed time since file closure, were compared using a Pearson chi-squared test. There was no significant difference in the proportion of responders in the two groups (32 and 36 percent, respectively) indicating that those subjects who had more time since receiving a consultation visit were equally likely to respond to the survey as those with less time elapsed since their consultation visit.

The low overall response rate to the survey was another important limitation. After the initial mailing, follow-up mailing, and the follow-up telephone call, the effective response rate was only 37 percent, well below what is considered necessary for generalizability of experimental findings in epidemiological research (Rose & Barker, 1978). However, a response rate of 30 percent has been proposed as reasonable for mailed patient satisfaction surveys (Press & Ganey, 1989). Regardless, it is important to consider potential non-response bias in the context of this study, as non-responders may have had less favorable experiences with the consultation process or the Revised OSHA Form 33. One way to assess potential differences between responders and non-responders is to compare the overall Revised OSHA Form 33 scores of both groups. Using the OSHA consultation files of the 314 closed consultation files initially selected for this study, a Wilcoxon Sign-Ranked Test was conducted to determine if there was a significant difference in the mean, overall Revised OSHA Form 33 score of the respondent and non-responding groups. There was a small but significant difference in the mean overall Revised OSHA Form 33 scores (P-value < 0.001), which suggests that the non-responding group had lower levels of OHSMS programming, and thus may not have received similar consultation experiences. A non-parametric test was used because the Revised OSHA Form 33 scores for both groups were not normally distributed. Further testing between responders and non-responder OHSMS scores had similar results, with the non-responding group scoring, on average, slightly but significantly lower on all seven of the OHSMS elements on the Revised OSHA Form 33.

Another way to assess whether the respondents were representative of the sample population is to compare the industries represented among responders and non-responders, and to compare the injury and illness rates of both groups. A smaller proportion of non-responding companies

were in the manufacturing industry as compared to responders (33 percent and 48 percent, respectively) and a higher proportion of non-responders were in the construction industry (22 percent vs. 12 percent). The mean DART and TRC rates of non-responding companies (4.5 and 8.4, respectively) were higher than the average injury and illness rates of responding companies (3.5 and 7). However, the differences in injury and illness rates were not higher by a statistically significant margin when compared using a Wilcoxon Sign-Ranked Test (P-value = 0.40 and 0.35 for TRC and DART rates, respectively). Still, these differences in industry type and injury rates further suggest that survey respondents were not completely representative of the sample population and may therefore not reflect the views of all Colorado OSHA consultation clients. Survey response rates and study participation may be improved in future studies by soliciting interest in participation just after services are rendered and by incentivizing participation.

Conclusions and Recommendations:

The findings of this study indicate that many OSHA On-Site consultation clients in Colorado valued the OHSMS assistance they received and felt that the Revised OSHA Form 33 was helpful for improving their OHSMS. However, the low survey response rates achieved and lack of representativeness of respondents limit the generalizability of these findings. Survey respondents reported that the comments and suggestions provided on the Revised OSHA Form 33 were useful, and most clients used those comments to implement changes in the workplace. Many positive outcomes were reported by respondents, including reduced injuries and illnesses, improved morale, and decreased operational costs. OSHA consultants should make all reasonable efforts to provide detailed comments and suggestions to clients when completing an

OHSMS assessment, particularly for low scoring attributes that need improvement. Further research is needed to determine if OSHA consultation clients in other states have similar experiences. Additional study is warranted to determine how Revised OSHA Form 33 scores are related to the OHS outcomes reported by the survey respondents, specifically improved economic outcomes and reduced injuries.

Table 5.1 Revised OSHA Form 33 Scores and Numeric Response Rates by OHSMS Element for Survey Responders and Non-Responders

	Revised OSHA Form 33 Scores[A]			
	Responders (n=107)		Non-Responders (n=207)	
Revised OSHA Form 33 Element	Mean (SD)	Response Rate[B]	Mean (SD)	Response Rate[B]
Overall	2.0*(0.6)	72 %	1.7*(0.5)	63 %
Hazard Anticipation and Protection	1.8 (0.7)	82 %	1.5 (0.6)	73 %
Hazard Prevention and Control	2.1 (0.6)	87 %	1.9 (0.5)	81 %
Planning and Evaluation	1.4 (1.0)	75 %	1.0 (0.8)	66 %
Administration and Supervision	2.1 (0.6)	75 %	1.9 (0.6)	65 %
Safety and Health Training	2.0 (0.6)	58 %	1.8 (0.6)	52 %
Management Leadership	2.1 (0.6)	67 %	1.9 (0.6)	55 %
Employee Participation	1.9 (0.6)	58 %	1.7 (0.7)	46 %

[A]Possible scores for Revised OSHA Form 33 attributes range from 0 (not present) to 3 (fully implemented)

[B]Number of attributes that received a numeric score divided by the total number of attributes

*There was a significant difference (P-value < 0.001) between the mean, overall Revised OSHA Form 33 Score of Responders and Non-Responders

OSHA – Occupational Safety and Health Administration

OHSMS – Occupational Health and Safety Management System

Table 5.2 Survey Responses from Colorado OSHA Consultation Clients About Revised OSHA Form 33 Usefulness

Survey Question	No. of Responses	Resp. Rate[A]	No. of 'Yes' Answers	Proportion of Resp.[B]
1. Did the Form 33 accurately represent your OHSMS at the time it was evaluated?	102	95%	100	98%
2. Was the Form 33 easily understood?	102	95%	98	96%
3. Did the attributes on the Form 33 make sense?	102	95%	100	98%
4. Was the information in the Form 33 useful in improving your OHSMS?	102	95%	99	97%
5. Did the attributes on the Form 33 cover all aspects of a comprehensive OHSMS?	99	93%	98	99%
6. Did the scoring system on the Form 33 adequately measure each OHSMS element?	99	93%	91	92%
7. Were the comments/suggestions provided useful and helpful in improving your OHSMS?	99	93%	98	99%
8. Did you follow and use the comments or suggestions to make any changes?	98	92%	92	94%

[A]Number of responses to the question divided by the number of responses to the survey
[B]Number of 'yes' responses divided by the total number of responses to the question
OSHA – Occupational Safety and Health Administration

CHAPTER 6: SUMMARY

This project investigated potential relationships between OHSMS programming and injury and illness rates on dairy farms using OSHA consultation data. The results indicated that there was generally a negative association, suggesting that higher levels of OHSMS programming may be protective for farm workers. The results, however, were not convincingly strong or significant unless only those records with the most complete picture of a farm's OHSMS were analyzed.

Two major potential limitations were addressed through the use of other small studies within the overall project. To determine if the observed relationships were due to the OHSMS programming and injury rates alone, and not some unknown third factor, the same methodology was applied to data from a related but distinct animal production industry; the poultry production industry. For example, training and experience in animal stockmanship could be an unaccounted variable that may explain the association between OHSMS programming and lower injury rates, because farms with better stockmanship training may score higher on training aspects of the Revised OSHA Form 33 and may also have fewer injuries associated with animal handling. In poultry production, this specific unaccounted variable would not be a concern. Although there is always the potential for other variables beyond the study parameters to influence correlations, by applying the method to a separate datasets, the concern about those potential effects are diminished. The results of the follow-up study of poultry production industry data suggested that the relationships were indeed explained by the study variables because the associations were quite similar. In both industries, the overall and by-component association between OHSMS and

injury rates were generally negative, and strengthened when only the most complete Revised OSHA Form 33 records were considered. In both industries, the Management Leadership component showed the strongest association, and the Employee Participation component was weaker and not statistically significant. The relationships between workforce size, OHSMS programming, and injury and illness rates were, however, reversed for the two industries. It is not clear whether this distinction is important, and whether it is due to differences in how the two industries are organized. The compartmentalized nature of poultry growing operations compared to the less-defined operation expansion of dairy farms may explain this discrepancy.

Another important limitation was the lack of temporality in the OSHA consultation data for the dairy and poultry production industries. During a consultation visit, OSHA consultants record the injury and illness from up to the last three years of data from an employer's Log of Work-Related Injuries and Illnesses. If the log has not been kept, or is incomplete, the OSHA consultants provide recordkeeping assistance and estimate the injuries for up to the last three years prior to the visit (OSHA, 2008a). Information is also gathered to assess a client's OHSMS during the same visit (OSHA, 2008a). Thus, there is typically no data on injury and illness rates after the OHSMS assistance has been provided by the OSHA consultation, because the vast majority of consultation visits (and all of the records used in this project) consist of only a single visit and OHSMS assessment. Another small study, this time using survey data of OSHA small business consultation clients in Colorado, was used to determine what resultant changes and effects occurred because of the OHSMS assistance provided by OSHA consultants.

Three hundred and fourteen former OSHA consultation clients from across a wide range of industries in Colorado were surveyed about their impressions of the OHSMS assistance they received and the usefulness of the Revised OSHA Form 33. The overwhelming majority of respondents (n=107) had favorable perceptions of the OHSMS assistance they received and found the information on the Revised OSHA Form 33 helpful for making safety and health changes. The reported changes included new and updated safety programs, hazard reduction, and additional safety training. The reported effects of these changes included improved employee morale, reduced injuries and illnesses, and decreased costs. Thus, it is expected that OHSMS assistance provided to animal production agriculture industries would yield similar results, although there were insufficient data to evaluate changes directly.

Overall, the results of this project indicate that OHSMS interventions may be beneficial to reduce work-related injuries and illnesses in U.S. animal production industries. Therefore, research into the development, implementation, and evaluation of OHSMS interventions is warranted. Unfortunately, other occupational health and safety research efforts in agriculture have proven difficult in the past. Farmers and farm workers may be unable or unwilling to enact changes to improve health and safety, even if research evidence demonstrates that changes could likely be effective. Although it has been reported that agriculture producers are interested in OHSMS approaches, there is no known published research on farmer and farm worker attitudes, behaviors, and interests about systematic health and safety activities (Lee & Hair, 2011).

Two needs assessment questionnaires were developed to evaluate how dairy workers and owners/managers view OHSMS-related activities and determine the level of interest to learn

more about and participate in these activities. The first section of the questionnaire asked how much participants agreed or disagreed with statements related to systematic approaches to occupational health and safety, on a four-point scale where 1 = strongly disagree, 2 = somewhat disagree, 3 = somewhat agree, and 4 = strongly agree. The second section asked 'yes' or 'no' questions about participants' behaviors and experiences in the past year related to OHSMS activities. The third and final section of the questionnaire assessed the level of interest in learning about and participating in OHSMS-related activities. The questionnaires were produced in English and translated into Spanish. Face validity for the questionnaires was established using a panel of expert reviewers, including OHSMS researchers, dairy researchers, dairy owners, and dairy workers. The translated version was also verified and validated. The questionnaires were administered to dairy workers and owners/managers in Colorado by a bi-lingual interviewer (English and Spanish) as part of a larger study on safety training effectiveness in the dairy industry. Demographic information, including the age, sex, and country of origin of participants was also collected. English versions of the two questionnaires are provided in Appendix C and Appendix D. All of the research procedures and materials for this needs assessment study were approved by the Colorado State University Institutional Review Board and the Research Integrity and Compliance Review Office.

The needs assessment study is ongoing and there are still many interviews to conduct. To date, 20 dairy workers have been interviewed. More worker interviews are in progress and the owner/manager interviews have not yet been conducted. However, preliminary results from participating dairy workers indicate that the majority of workers agree with systematic

approaches to health and safety and are interested in participating in many aspects of a comprehensive OHSMS.

Generally, the overwhelming majority of dairy workers indicated agreement with statements related to systematic approaches to health and safety. Between 18 and 19 of the 20 total respondents (90 to 95 percent) indicated agreement that health and safety is better addressed at the system level rather than at the level of the individual; that injury prevention is everyone's responsibility on a dairy farm, and that there is a relationship between worker safety and work quality. The responses to the worker survey questions in section 1 (attitudes toward systematic approaches to OHS) are summarized in Table 6.1.

Table 6.1 Survey Responses of Colorado Dairy Workers' Attitudes Toward Systematic Occupational Health and Safety Management (n=20)

Statement	No. in Agreement	Proportion in Agreement [A]
Safety is better addressed at the organization level rather than at the level of the individual	18	90%
Safer environments for workers are also safer environments for livestock	18	90%
Injury prevention is everyone's responsibility on a dairy farm rather than one person's responsibility	19	95%
There is a relationship between worker safety and work quality	18	95%
There is a relationship between worker safety and worker productivity	16	80%
Worker safety needs improvement on my farm	15	75%
I know where to find information on workplace safety issues	12	60%
Worker safety represents a significant challenge to dairy farming	15	75%

[A]Number of responses indicating agreement, divided by the total number of responses

This sample population demonstrated a high level of agreement for systematic approaches to OHS management, suggesting that implementation of an OHSMS approach would likely be accepted by the dairy workforce. Only a little more than half agreed that they knew where to find information on safety issues, suggesting that the management at some dairies is not adequately communicating these issues to their employees. The second section of the questionnaire addressed OHSMS-related behaviors. Fewer than half of respondents indicated that in the past year they participated in farm safety inspections (15 percent), suffered a workplace injury (25 percent), or reported a workplace incident to their supervisor (35 percent).

However, more than half of respondents indicated that they performed preventive maintenance (55 percent), found and fixed workplace hazards (65 percent), received safety training (90 percent), and discussed farm safety concerns with co-workers (55 percent) in the past year. The findings suggest that there are OHSMS-related behaviors already occurring on Colorado dairy farms, but that there is ample room for improvement, particularly in getting dairy workers involved in farm safety inspections and reporting incidents to their supervisors.

The level of interest in participating in OHSMS-related activities was also assessed during the dairy worker interviews. All of the respondents (100 percent) indicated that they were interested in learning more about identifying unsafe working conditions. This is an important finding considering that so few workers reported participating in workplace safety inspections. Greater than 70 percent of respondents indicated interest in learning about other OHSMS activities. The results of this last section of the questionnaire are provided in Table 6.2.

Table 6.2 Survey Responses of Colorado Dairy Workers' Interest in Participating in Occupational Health and Safety Management System Activities (n=18)

OHSMS Activity	No. Interested in Participating	Proportion Interested [A]
Creating a safety policy for your farm	13	72%
Creating safety goals and objectives for your farm	13	72%
Identifying unsafe working conditions on your farm	18	100%
Correcting workplace safety hazards on your farm	16	89%
Receiving safety training and education	17	95%
Investigating the causes of workplace injuries	10	56%
Emergency preparedness and response	16	89%

[A]Number of responses indicating interest, divided by the total number of responses

The preliminary results of these worker interviews indicate that there is considerable interest on the part of dairy workers to participate in a comprehensive OHSMS. Again, these data are not complete, as the results of more worker interviews and all of the interviews with dairy owners/managers are still forthcoming. However, should these results prove representative of all sampled dairy workers, then the evidence in support of an OHSMS approach for dairies is supported from the workers' perspective. The results of the management interviews will determine if dairy owners/managers share these views.

The results of all four of the studies included in this project indicate that OHSMS interventions may be a viable approach to reduce the stubbornly high rates of injuries and

illnesses in U.S. animal production agriculture. Research into the development, implementation, and evaluation of such interventions is warranted. The Revised OSHA Form 33 is a reasonable tool to assess changes in OHSMS programming level in an intervention study, provided that the assessors are properly trained and that as many attributes as possible are evaluated to give the most complete picture of a farm's OHSMS. Few scored attributes and sparse comments do not provide employers with sufficient information to enact changes. A focus on the Management Leadership aspects of an OHSMS is indicated given the strong relationship between these components and lower injury and illness rates. Intervention studies should be prospective or retrospective, to assess changes in OHS outcomes that occur as a result of the establishment of an OHSMS. Efforts to evaluate economic outcomes are also necessary, because economic incentives can drive the adoption of OHSMS approaches animal production industries.

The OHSMS assessment training that OSHA consultants receive should be updated as soon as possible. Research that demonstrates the importance of assessing as many Revised OSHA Form 33 attributes as possible should be emphasized, as well as the importance of providing comments and suggestions on how to improve an attribute. Determining a more complete picture of clients' OHSMS is important because more complete forms are associated more strongly with lower rates of injury and illnesses. Comments and suggestions, particularly on low scoring attributes, are critical because they provide clients with information on how to improve their OHSMS. Incomplete Revised OSHA Form 33 records also may skew the industry norms computed in WebIMIS and provided on industry comparative reports. In addition, OSHA has transitioned to a different information management database, but the training consultants receive still reflects the older WebIMIS procedures. Furthermore, OSHA officials should ensure

that Revised OSHA Form 33 data in the new system is being used to update industry norms, and a means for consultants to generate ICRs in the new system should be established and included in the updated training. Follow-up refresher training should also be considered, and the long-term retention rates for consultants should be evaluated. Refresher training could include industry-specific training, for consultants who specialize in certain industries, e.g., health care, manufacturing, and agriculture.

OSHA officials should also consider using the Revised OSHA Form 33 as the primary assessment method for forthcoming Injury and Illness Prevention Program legislation. Although more involved than the Program Evaluation Profile proposed in the defunct 1996 safety and health program standard, the Revised OSHA Form 33 is supported by published research and scores from the form are associated with fewer workplace hazards and lower rates of injuries and illnesses; both primary goals of an Injury and Illness Prevention Program. Further, the form includes space for comments and suggestions for improvement, which are critical for employers to improve their OHSMS and effectively self-regulate. Supported by publicly available scientific research and benefiting from existing OSHA data and expertise, the Revised OSHA Form 33 should be strongly considered for use in I2P2 compliance assessment. There is also a need for additional study on the current version of the form, to determine alignment with established national and international OHSMS standards, to further verify and improve inter-rater reliability, and to evaluate the relationship between consultation-measured OHSMS programming and economic outcomes. Existing OSHA data may be useful in establishing some preliminary data to address these questions.

Training to help agriculture producers establish, maintain, and self-evaluate their own OHSMS is needed. The OSHA consultation service can only help a tiny proportion of agriculture producers, and the majority of producers will not request a consultation. The Pork Producers Safety System (PPSS) represents a promising attempt at such an approach, and could be used as a model for other training (Lee & Hair, 2011). The PPSS includes training videos and materials, and was developed by a team of stakeholders in the pork production industry and health and safety. The approach has been well received by agriculture partners, but research evidence about the effectiveness of the PPSS is lacking. OHSMS training for agriculture producers should include a means and method for evaluating and continually improving their OHSMS. Positive outcomes of OHSMS adoption, including fewer hazards, improved morale, and decreased injuries should be emphasized in the training.

Ultimately, research on the effectiveness of OHSMS approaches is growing, and the results of this project demonstrate the importance of systematic health and safety approaches for the high-hazard animal production agriculture industries. Further research is needed, but current evidence supports the use of OHSMS interventions to address high rates of injuries and illnesses. The assessment of OHSMS programming by OSHA consultants using the Revised OSHA Form 33 is most effective when a majority of attributes are scored and comments and suggestions are provided on the form. New and updated training is needed for OSHA consultants to maximize the effectiveness of their OHSMS assistance. There is a research basis for considering the Revised OSHA Form 33 as a compliance instrument for the proposed I2P2 regulations. Industry training can help producers adopt OHSMS approaches without assistance from consultation services.

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APPENDIX A: SAFETY AND HEALTH PROGRAM ASSESSMENT WORKSHEET
(REVISED OSHA FORM 33)

Hazard Anticipation and Detection						
	0	1	2	3	NA	NE
1. A comprehensive, baseline hazard survey has been conducted within the past five (5) years.						
Comments:						
2. Effective safety and health self-inspections are performed regularly.						
Comments:						
3. Effective surveillance of established hazard controls is conducted.						
Comments:						
4. An effective hazard reporting system exists.						
Comments:						
5. Change analysis is performed whenever a change in facilities, equipment, materials, or processes occurs.						
Comments:						
6. Accidents are investigated for root causes.						
Comments:						
7. Material Safety Data Sheets are used to reveal potential hazards associated with chemical products in the workplace.						
Comments:						
8. Effective job hazard analysis is performed.						
Comments:						

9. Expert hazard analysis is performed.						
Comments:						
10. *Incidents are investigated for root causes.						
Comments:						

Hazard Prevention and Control

	0	1	2	3	NA	NE
11. Feasible engineering controls are in place.						
Comments:						
12. Effective safety and health rules and work practices are in place.						
Comments:						
13. Applicable OSHA-mandated programs are effectively in place.						
Comments:						
14. Personal protective equipment is effectively used.						
Comments:						
15. Housekeeping is properly maintained.						
Comments:						
16. The organization is properly prepared for emergency situations.						
Comments:						
17. The organization has an effective plan for providing competent emergency medical care to employees and others present at the site.						
Comments:						
18. *Effective preventive maintenance is performed.						
Comments:						

19. An effective procedure for tracking hazard correction is in place.						
Comments:						

Planning and Evaluation

	0	1	2	3	NA	NE
20. Workplace injury/illness data are effectively analyzed.						
Comments:						
21. Hazard incidence data are effectively analyzed.						
Comments:						
22. A safety and health goal and supporting objectives exist.						
Comments:						
23. An action plan designed to accomplish the organizations safety and health objectives is in place.						
Comments:						
24. A review of in-place OSHA-mandated programs is conducted at least annually.						
Comments:						
25. *A review of the overall safety and health management system is conducted at least annually.						
Comments:						

Administration and Supervision

	0	1	2	3	NA	NE
26. Safety and health program tasks are each specifically assigned to a person or position for performance or coordination.						
Comments:						
27. Each assignment of safety and health responsibility is clearly communicated.						

Comments:						
28. *An accountability mechanism is included with each assignment of safety and health responsibility.						
Comments:						
29. Individuals with assigned safety and health responsibilities have the necessary knowledge, skills, and timely information to perform their duties.						
Comments:						
30. Individuals with assigned safety and health responsibilities have the authority to perform their duties.						
Comments:						
31. Individuals with assigned safety and health responsibilities have the resources to perform their duties.						
Comments:						
32. Organizational policies promote the performance of safety and health responsibilities.						
Comments:						
33. Organizational policies result in correction of non-performance of safety and health responsibilities.						
Comments:						

Safety and Health Training

	0	1	2	3	NA	NE
34. Employees receive appropriate safety and health training.						
Comments:						
35. New employee orientation includes applicable safety and health information.						
Comments:						
36. Supervisors receive appropriate safety and health training.						

Comments:						
37. *Supervisors receive training that covers the supervisory aspects of their safety and health responsibilities.						
Comments:						
38. Safety and health training is provided to managers.						
Comments:						
39. *Relevant safety and health aspects are integrated into management training.						
Comments:						

Management Leadership

	0	1	2	3	NA	NE
40. Top management policy establishes clear priority for safety and health.						
Comments:						
41. Top management considers safety and health to be a line rather than a staff function.						
Comments:						
42. *Top management provides competent safety and health staff support to line managers and supervisors.						
Comments:						
43. Managers personally follow safety and health rules.						
Comments:						
44. Managers delegate the authority necessary for personnel to carry out their assigned safety and health responsibilities effectively.						
Comments:						
45. Managers allocate the resources needed to properly support the organizations safety and health system.						

Comments:						
46. Managers assure that appropriate safety and health training is provided.						
Comments:						
47. Managers support fair and effective policies that promote safety and health performance.						
Comments:						
48. Top management is involved in the planning and evaluation of safety and health performance.						
Comments:						
49. Top management values employee involvement and participation in safety and health issues.						
Comments:						

Employee Participation

	0	1	2	3	NA	NE
50. There is an effective process to involve employees in safety and health issues.						
Comments:						
51. Employees are involved in organizational decision making in regard to safety and health policy.						
Comments:						
52. Employees are involved in organizational decision making in regard to the allocation of safety and health resources.						
Comments:						
53. Employees are involved in organizational decision making in regard to safety and health training.						
Comments:						
54. Employees participate in hazard detection activities.						

Comments:						
55. Employees participate in hazard prevention and control activities.						
Comments:						
56. *Employees participate in the safety and health training of co-workers.						
Comments:						
57. Employees participate in safety and health planning activities.						
Comments:						
58. Employees participate in the evaluation of safety and health performance.						
Comments:						

APPENDIX B: COLORADO SMALL BUSINESS OHSMS PERCEPTIONS SURVEY

1. Did the Form 33 accurately represent your Occupational Health and Safety Management System at the time it was evaluated?

☐ YES ☐ NO

If NO, please explain:_____

_____

2. Was the Form 33 easily understood?

☐ YES ☐ NO

If NO, please advise us as to how the form could be improved:_____

_____

3. Did the items (attributes) on the Form 33 make sense?

☐ YES ☐ NO

If NO, which aspects of the Form 33 did not make sense?

_____

_____

4. Was the information in the Form 33 useful in improving your Occupational Health and Safety Management System?

☐ YES ☐ NO

If NO, which aspects of the Form 33 were not useful?

_____

_____

5. Did the items (attributes) on the Form 33 cover all aspects of a comprehensive Occupational Health and Safety Management System?

☐ YES ☐ NO

If NO, what are the Safety and Health Program aspects that are not measured by the Form 33? Please list:

_____

_____

6. Did the scoring system on the Form 33 adequately measure each Occupational Health and Safety Management System element?

☐ YES ☐ NO

If NO, please advise us as to how you would improve the scoring system:

_____

_____

7. Were the comments/suggestions provided useful and helpful in improving your Occupational Health and Safety Management System?

☐ YES ☐ NO

What types of comments were most helpful?

_____

_____

8. Did you follow and use the comments/suggestions to make any changes?

☐ YES ☐ NO

If NO, please list major obstacles that prevented you from following these suggestions:

_____

_____

If YES, what types of changes did you implement as a result of the comments/suggestions on your assessment?

_____

_____

If YES, what were the effects or outcomes of your changes? (Example: reduced incidence of on the job injuries, changes in Workers Compensation premium expenses, better morale in the workplace, reduced turnover of employees, better product quality, etc.) Please list any outcomes

that you experienced due to changes made to your Occupational Health and Safety Management System:

_____

_____

_____

APPENDIX C: DAIRY WORKER QUESTIONNAIRE AND DATA SHEET

1. How strongly do you agree or disagree with the following statements:

A. Safety is better addressed at the organization level rather than at the level of the individual.
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

B. Safer environments for workers are also safer environments for livestock.
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

C. Injury prevention is everyone's responsibility on a dairy farm rather than one person's responsibility (e.g., worker or supervisor)
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

D. There is a relationship between worker safety and work quality.
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

E. There is a relationship between worker safety and worker productivity.
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

F. Worker safety needs improvement on my farm.
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

G. I know where to find information about workplace safety issues.
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

H. Worker safety represents a significant challenge to dairy farming.
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

2. In the past year, have you....

A. performed preventive maintenance on farm equipment?
❑ Yes ❑ No

B. found and fixed any workplace safety hazards?
❑ Yes ❑ No

C. participated in farm safety inspections?
❑ Yes ❑ No

D. received safety training?
❑ Yes ❑ No

E. suffered a workplace injury?

❑ Yes ❑ No

F. reported a workplace injury to your supervisor?

❑ Yes ❑ No

G. reported safety concerns to your supervisor?

❑ Yes ❑ No

H. discussed farm safety concerns with other workers?

❑ Yes ❑ No

3. How interested are you in participating in the following activities:

A. Creating a safety policy for your farm

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

B. Creating safety goals and objectives for your farm

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

C. Identifying unsafe working conditions on your farm

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

D. Correcting workplace safety hazards on your farm

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

E. Receiving safety training and education

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

F. Investigating the causes of a workplace injury

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

G. Emergency preparedness and response

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

APPENDIX D: DAIRY OWNER/MANAGER QUESTIONNAIRE AND DATA SHEET

1. How strongly do you agree or disagree with the following statements:

A. Safety is better addressed at the system (organization) level than at the level of the individual.
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

B. Safer environments for workers are also safer environments for livestock.
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

C. Injury prevention is everyone's responsibility on a dairy farm rather than one person's responsibility (e.g., manager or supervisor)
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

D. There is a relationship between worker safety and work quality.
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

E. There is a relationship between worker safety and worker productivity.
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

F. Worker safety needs improvement on my farm(s).
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

G. I know where to get information about workplace safety issues.
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

H. Worker safety represents a significant challenge to dairy farming.
❑ Strongly Agree ❑ Slightly Agree ❑ Slightly Disagree ❑ Strongly Disagree

2. In the past year, have you....

A. attended training programs or conferences on farm worker safety?
❑ Yes ❑ No

B. identified and controlled any workplace safety hazards?
❑ Yes ❑ No

C. conducted farm safety inspections?
❑ Yes ❑ No

D. provided safety training to workers?
❑ Yes ❑ No

E. documented a workplace injury (e.g., for worker's compensation insurance claims or for legal requirements)?

❑ Yes ❑ No

F. communicated safety concerns to workers?

❑ Yes ❑ No

G. discussed farm safety concerns with colleagues and/or supervisors?

❑ Yes ❑ No

H. created safety goals and objectives for your farm(s)?

❑ Yes ❑ No

3. How interested are you in learning more about the following topics:

A. Creating a safety policy for your dairy farm

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

B. How to demonstrate to your workers that you support worker safety

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

C. How to get workers involved with farm safety

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

D. Creating safety goals and objectives

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

E. Identifying workplace safety hazards

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

F. Correcting workplace safety hazards

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

G. Worker safety training and education

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

H. Safety documentation and recordkeeping

❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

I. Injury investigations
❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

J. Emergency preparedness and response
❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

K. Contractor safety
❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

L. OSHA safety regulations
❑ Very interested ❑ Somewhat interested ❑ Somewhat disinterested ❑ Very disinterested

4. How concerned are you about OSHA regulations and inspections?

❑ Very Concerned ❑ Somewhat Concerned ❑ A Little Concerned ❑ Not at all Concerned