Appendix A2-11: Grant Project Reports

Adapting the North American Guidelines for Children's Agricultural Tasks (NAGCAT) for Ethnic Communities:
A Research Model (R01 4215)
John M. Shutske; Michele Schermann

Adolescent Farm Work, Fatigue and Injuries in Colorado (R21OH007744)
Loranne Stallones

Community Partners for Healthy Farming Vineyard Harvest Ergonomics Intervention Partnership Project (R01 OH003906)

Community Partners for Healthy Farming Vineyard Harvest Ergonomics Intervention Partnership Project – Trellis Systems
(R01 OH003906)
John Miles, University of California, Davis

Effectiveness of computer-based training: cTRAIN (R01 OH04193)
W. Kent Anger

Ergonomic Partnership to Address Treefruit Worker Injury (R01 OH008901)
John Miles, University of California, Davis

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Allan N. Williams, MPH, PhD

Evaluation of NAGCAT using a Case Series of Injuries (R01 OH004205)
Barbara Marlenga, Ph.D., National Children's Center for Rural and Agricultural Health and Safety

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Robin Baker, Director, LOHP

Summary of NIOSH-Funded Research in Agriculture at University of Wisconsin
Larry J. Chapman, Ph.D., Senior Scientist, University of Wisconsin

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Anne Gadomski MD, MPH, Bassett Research Institute

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(T15OH008631)
Jerry Dzugan, Alaska Marine Safety Education Association (AMSEA)

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SUMMARY OF NIOSH-FUNDED RESEARCH IN AGRICULTURE AT University of Wisconsin

Larry J. Chapman, Ph.D., Senior Scientist

1. What is the occupational safety issue that our research addresses?

In most industries, there are many managers who continue to rely on "older" production practices despite the ready availability of practices that can, at the same time, be more effective, less costly, and less hazardous to the health of the workforce but that, for various reasons, are not yet widely used. Often, what appears to stand in the way is a lack of awareness on the part of firm managers about the existence, value, and ease of use of the improved practices, at least in part attributable to the absence of convincing, comprehensive, and well-targeted interventions to optimize information flow (Rogers, 1995; Wejnert, 2002). Our research results provide evidence that better information flow is associated with often rapid, widespread adoption of safer production practices. Although they cannot replace regulation, our results suggest new directions for controlling hazards and injuries in situations where better work practices are available that can couple profits and safety.

Production practices that are both more efficient and safer are especially interesting for high hazard industries such as production agriculture, where workplace safety rules and enforcement are less effective for tens of thousands of small to mid-sized operations (Murphy, 1992). When production practices which are marginally more efficient and relatively easy to adopt become available, previous research shows that many if not most firm managers are likely to adopt them, given adequate information flow and sufficient time (Fliegel and Korsching, 2001). Although they can never be substitutes for regulation, information dissemination interventions that couple safety and profits may be able to complement traditional governmental health and safety efforts. Our work is closely aligned with the NIOSH mission: our intervention research with dairy farmers exemplifies research to practice**,** intervention effectiveness evaluation research, the diffusion of innovations, community-based participatory research, and the promotion of engineering controls.

2. What are the specific results and accomplishments from our research with dairy farmers?

Purpose: Dairy farming work is extremely hazardous with injury rates that exceed the average for production agriculture (which, as a whole, exceeds average fatal and nonfatal injury rates for all industries) (Hard et al., 2002; NIOSH, 1998; Myers, 1998). Long day barn lighting, bag silos for cattle feed storage, and a site for distributing calf feed are practices that can improve operation profits as well as reduce exposures to injury hazards (see tip sheets on the practices at http://www.bse.wisc.edu/hfhp). We investigated whether an intervention that improved the information quality and flow to dairy farm managers could persuade them to adopt these three practices (as well as others).

Methods: We conducted an intervention and a mail questionnaire, repeated measures design evaluation to independent rolling samples from a treatment group of all 4,300 dairy operations in Northeast Wisconsin (later extended to all WI dairy farms). We disseminated information about the three practices through all the information channels that WI dairy farmers were known to rely on for learning about new production practices (print media, other farmers, public events, university Extension, dealers and suppliers, Internet, etc.). We evaluated the treatment group at baseline and after each intervention year

and made use of recommendations about good evaluation practices (i.e. Robson et al., 2001). We added an "exposed control" group of Maryland or New York dairy farmers after the second through seventh year of the intervention who were likely to be exposed to the same print and Internet media but not other intervention components.

Intervention: From 1997-2005 we conducted an eight year long, community-based, participatory intervention to promote safer, more profitable work practices to all 20,000 WI dairy producers (1998 dairy operation total) under consecutive funding from a NIOSH cooperative agreement and two R01s (U05/CCU506065, 9/30/94-98; R01OH14357, 9/30/97-00; R01OHO7578, 9/1/01-05).

WI Treatment Group: Multivariate logistic regression analyses of questionnaire results after seven years of the intervention showed that the odds of adopting barn lights, silo bags and a calf feed site increased significantly among Northeast WI dairy farmers (barn lights odds ratio (OR)=10.775, 95% confidence interval (C) I=4.769-24.342, $p<0.000$, bag silos OR=2.346, CI=1.873-2.939 $p\leq 0.000$, calf care OR=1.788, CI=1.080-2.960 $p\leq 0.024$). Odds of awareness of barn lights and the calf feed sites also increased significantly (barn lights OR=2.004, CI=1.702-2.360 $p\leq 0.000$, calf care OR=1.319, CI=1.140-1.527 $p\leq 0.000$). In comparisons after the intervention, significantly more WI managers also reported getting barn lights and bag silo information from print media and from public events than at the baseline evaluation before the intervention.

Wis versus NY Comparison Group: Compared to the WI dairy farmers, the odds of the NY controls adopting barn lights and bag silos were significantly less (barn lights OR=0.398, CI=0.237-0.669 $p<0.000$, bag silos OR=0.577, CI=0.421-0.789, $p<0.001$). In addition, significantly fewer NY than WI managers reported getting information about barn lights or bag silos from public events. All the logistic regression analyses controlled for evaluation sample differences in manager age, education, and years of experience, as well as operation herd size, gross sales, and percent of operation owned debt free. Early papers describing this work have been published in a peer review journal (Chapman, Taviera et al., 2003). Others are in preparation (Chapman, Karsh et al., in preparation; Chapman, Periera et al., 2006).

Other Work: In other work not described above, but as part of the same three consecutive NIOSH awards, we conducted and published the first, and to our knowledge only comparative injury hazard assessment for the three most common cattle silage storage methods and recommended the least hazardous (Josefsson et al., 2001), 2) also in other work not described above, but as part of the same three consecutive NIOSH awards, we conducted and are in the process of publishing the most extensive survey to date of annual dairy operation work hour allocation for principal tasks that also breaks down contributions by adults, adolescents and children (Chapman, Taviera et al., in preparation).

To summarize, our intervention was associated with greater adoption and awareness of the practices we promoted. The strength of the findings was especially impressive for barn lights, where the odds of adopting increased by more than ten times. Our intervention was also associated with increased reports by farm managers of getting information from our intervention about the practices, suggesting that we were, in fact reaching our intended audience by using all the information channels that WI dairy farmers were known to rely to learn about new production practices (print media, other farmers, events, etc.).

3. What other agricultural commodity groups have we conducted intervention work with?

In 1998-99, we conducted a one year long intervention that promoted two safer, more profitable practices to 450 fresh market vegetable growers in Wisconsin (U06/CCU512940, 10/1/96-99). We evaluated the community-based participatory intervention with baseline questionnaires sent to a probability sample of half the growers before and with evaluation questionnaires sent to the other half after the intervention. The intervention sought to disseminate information about two practices (i.e. mesh bags for washing greens, standard containers for harvest and postharvest crop handling – see tip sheets at http://www.bse.wisc.edu/hfhp) to grower managers through the information sources they were already known to use to learn about new practices (i.e. other growers, print trade publications,

grower public events, university Extension). After the intervention, 1) significantly more vegetable growers reported getting information about mesh bags in trade publications (37% vs. 59%, p< 0.027) and about standard containers at public events (33% vs. 49%, p< 0.051), 2) significantly more growers reported adopting containers (38% vs. 54%, p< 0.010) and bag adoption increased (albeit nonsignificantly) (8% vs. 17%, p< 0.749) (Chapman et al., 2004). This work was published in a peer review journal. See tip sheets for the standard containers, mesh bags and other practices at http://www.bse.wisc.edu/hfhp.

Next, in 1999-2003, we conducted and evaluated a four year long, community-based participatory intervention among 2,250 fresh market vegetable growers in four US Midwest states (WI, MN, MI, IA) (R01OHO03953, 8/01/99-03). Logistic regression analyses that controlled for differences in the rolling annual questionnaire samples (i.e. age, sex, education, manager experience, gross sales, and total acreage) showed that manager-reported awareness increased with time for two of eight practices promoted (mesh bags OR= 1.426, CI= 1.003-2.029, p < 0.048, seated cart OR = 2.785, CI = 0.900-8.647, p < 0.076) and adoption increased for one (standard containers OR= 3.565, CI= 1.350-9.414, p < 0.010) (Chapman and Pereira, 2004). Papers describing this work are being prepared for submission to peer review journals. See tip sheets for the practices at http://www.bse.wisc.edu/hfhp.

In 2000-2004, we conducted a four year long, community-based participative intervention that promoted five safer more profitable practices to an estimated 1,250 berry growers in seven US Midwest states (WI, MN, IA, MI, IL, IN, OH) (R01OHO3953, 10/1/99-02). See tip sheets for the practices at http://www.bse.wisc.edu/hfhp. We used logistic regression analyses to control for differences in the rolling, annual questionnaire samples (in age, sex, education, manager experience, gross sales, and total acreage). The results showed that manager reports of getting information from trade publications increased with time for two practices (hoop houses 70% vs. 97%, p < 0.000, prone carts 17% vs. 72%, p < 0.040). Although adoption did not change, manager awareness significantly increased with time for four of the five practices (hoophouses OR=1.162, CI=0.979-1.379 p < 0.086, prone carts OR=1.193, CI=1.009-1.141 p < 0.039, portable stools OR=1.344, CI=1.068-1.692 p < 0.012, long hoes OR=1.230, CI=0.911-2.852 p < 0.053). In the comparison group of New Zealand berry growers, no adoption or awareness differences were observed. Papers describing this work are in review (Chapman, Newenhouse, et al, 2006b).

In 2003-2007, we are conducting a four year long, community-based participative intervention that is promoting eight safer more profitable practices (electronic pruners, machinery to fill pots with soil, a tree guard zipper, better tarp draping methods for trucks moving product, container stabilization systems to reduce wind damage to product, field stools, long handled hoes, and one person hitch) to an estimated 6,750 producers of field-grown nursery crops in seven states (WI, MN, IA, MI, IL, IN, OH) (U01 OH008100-04, 9/30/03-07). See tip sheets at http://www.bse.wisc.edu/hfhp. As we have for all the interventions described in this memo, we are evaluating the intervention through the use of annual mail questionnaires to rolling, probability samples (n=1200) of operations in the seven state treatment group and in the control group of New Zealand operations. Thus far, we have we have completed two years of work to disseminate information about up to eight practices acquired, entered, and checked by hand the baseline data and the data after the first intervention year for the treatment and comparison groups. The second intervention year is now being coded and we hope to present tentative results at this summer's NIFS meeting (Chapman, Newenhouse et al., 2006a)

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Adolescent Farm Work, Fatigue and Injuries in Colorado
R21OH007744
Loranne Stallones

1. Definition of the problem being addressed:

Legal and illegal child labor is common in the US despite evidence of deleterious social and health effects of work in young persons (Dunn et al., 1993, Cooper et al., 1995, Schober et al., 1988, Lemen et al., 1993, Brooks et al., 1993, Belville et al., 1993, Kinney et al., 1993, Banco et al., 1992, Dunn et al., 1998). In 1996, it was estimated that 80% of US adolescents engaged in work outside the home before leaving high school (Cohen et al., 1996). A large number of these young workers are employed in jobs prohibited by child labor laws (Dunn et al., 1998). Although legislation designed to protect workers does exist, and includes protection of minors, enforcement remains inadequate and violation of child labor laws is usual across a wide range of industries (Cooper et al., 1995, Kinney et al., 1993, Banco et al., 1992, Dunn et al., 1998). Injuries are reported to be among the most significant negative effects of early work in the US as well as in other industrialized countries (Belville et al., 1993, Jacobsson et al., 1988, Harker et al. 1992, Wolfenden et al., 1992, Schober et al., 1988, Banco et al., 1992). Work-related injuries are reported to occur in over 30,000 adolescents in this country each year (Cohen et al., 1996). One study using hospital based injury data found 24% of all injuries to adolescents aged 14-19 to be work-related (Runyan et al., 1989). The same study showed a higher incidence of injuries among working adolescents compared to both their nonworking peers and to adult workers (Runyan et al., 1989). In addition, injuries are reported to be of greater severity and lead to death more often in young workers than in adults (Dunn et al., 1993).

Work in agricultural settings is known to be more hazardous than in other occupations, particularly among young workers (Heyer et al., 1992, Wolfenden et al., 1992; Myers and Hendricks,2001). Although rates of work-related death and injury have declined in most hazardous industries by over 75%, agriculture-related deaths have only reduced by 24% in the same time period (Schulman et al., 1997). Runyan et al. (1989) estimated 4000 nonfatal injuries annually in North Carolina among adolescent farm workers aged 10-19, followed by fatal injuries occurring at a rate of 16 per 100,000, or about 186 deaths per year (Runyan et al., 1989). Myers & Hendricks (2001) estimated 32,808 youth injuries on farms with 14,590 of these work-related in nature in 1998 in the United States. Actual numbers of morbidity and mortality among teen farm workers are likely to be under reported however, since the Occupational Safety and Health Administration does not investigate work-related deaths among children working on farms (Dunn et al., 1993). Further, even though children under the age of 16 are legally prohibited from working on non-family farms, there are no age or hazard restrictions for children working on their own parents' farms (Dunn et al., 1993, Belville et al., 1993).

Because of the complex nature of farm work, including constantly changing environmental conditions, public health professionals find it difficult to assess the factors leading to injuries. In light of the dangerous nature of agricultural work and the lack of adequate laws restricting children from engaging in hazardous work on the farm, there is a strong need to identify modifiable factors contributing to farm injuries among adolescents in order to implement effective interventions to minimize their risks. Much work has been done in recent years to

elucidate the inherent dangers specific to agricultural work in order to improve work conditions. Researchers have studied a variety of factors, ranging from equipment safety to weather conditions and number of hours worked. When assessing potential risk factors, it is important to consider adolescent workers as a separate group, given the different cognitive, behavioral, motor, and perceptual competencies of children versus adults. Several studies have focused on adverse working conditions on farms with respect to children, but few have looked at the role of fatigue in the work performance of adolescents in particular. This is an area that warrants further investigation as a cause of farm-related injuries in children since fatigue has been shown to lead to diminished function and work capacity among children (Carskadon et al., 1981, Mitler et al. 1987).

Fatigue and injury risk among adolescents

The National Institutes of Health (NIH) have recognized adolescents as a high risk population because of "evidence that the prevalence of problem sleepiness is high and increasing with particularly serious consequences" (National Institutes of Health, 1997). Two recent reports (National Sleep Foundation, 2000; Wahlstrom, K, 1999) summarize the current knowledge about sleep needs and patterns in adolescents and consequences of adolescents sleep deprivation. "The most troubling consequences of sleepiness are injuries and deaths related to lapses in attention and delayed response times at critical moments, such as while driving" (National Sleep Foundation, 2000). Drivers under 25 years of age cause more than ½ of the 100,000 traffic crashes, killing more than 1,500 people in the US, injuring another 71,000, caused by falling asleep. "The same symptoms of sleepiness that contribute to traffic crashes can also play a role in non-traffic injuries, such as those associated with handling hazardous equipment in the workplace or in the home." (National Sleep Foundation, 2000)

There are three major natural patterns of sleep that occur during adolescents.

1. **The circadian sleep phase of adolescents phase delays** (Wolfson & Carskadon, 1998). The biological need for sleep starts later and ends later than in preadolescents and young adults. The typical high school student's natural time to fall asleep is 11 pm or even later.
2. **Sleep need in adolescence does not diminish.** If anything it may increase. The typical high school student requires 8.5 to 9.25 hours of sleep per night.
3. **Daytime sleepiness increases in adolescence.** Part of this is due to their not getting the amount of sleep that they need, but daytime sleepiness, especially during the mid-afternoon, increases in even adolescents who have had an optimal amount of sleep (Carskadon, Vieri, Acebo, 1993).

In addition to these natural, biological changes in sleep needs during adolescence, there are also behavioral and psychosocial factors that influence their sleep. Chronic partial sleep deprivation resulting from early school start times, jobs, farm chores, and so forth require them to be awakened well before they have obtained the sleep they biologically need. Surveys show that the average total sleep on school nights decreases from 7 hours 42 minutes at age 13 to 7 hours 4 minutes at age 19 (Wolfson & Carskadon, 1998). Over ¼ of students report usually getting 6.5 hours of sleep or less on school nights. The average high school student requires 8.5 to 9.25 hours of sleep each night. Then too, sleep onset is often delayed by demands of jobs, chores, and schoolwork as well as late night socializing and entertainment. The sleep pattern is often even more disrupted on weekends with staying up even later and then sleeping in later in the

mornings. The typical high school students natural time to fall asleep may is 11:00pm or later (Wolfson & Carskadon, 1998). This can further delay the biological sleep phase, lessen sleep quality, and result in problems in both falling asleep and awakening (Dahl and Carskadon, 1995).

All of these factors combine to have negative effects on the daytime functioning of adolescents such as an increased risk of injury. While most of the research on the effects of sleepiness has been done on adults, research on sleepy teens and clinical observations of them suggest the same effects during adolescence. These include the increased risk of unintentional injuries and deaths and negative moods and lessened emotional control. Excess sleepiness from inadequate sleep can cause lapses and "microsleeps" (Moorcroft, 1993) even without the person being aware of them (Wahlstrom, 1999). Also sleepy people have less of an ability to stay focused on a task, are more impulsive, and have memory impairments, slowed reaction times, and poor divergent thinking. Additionally they have low tolerance for frustration, are more impatient, more irritable, and are more likely to become angry or aggressive (Wahlstrom, 1999). These effects are worse when doing long, non-stimulating, repetitive tasks (Moorcroft, 1993) or tasks that require a complex sequence of steps or strategies or that require attention to 2 or more areas at the same time (Wahlstrom, 1999).

Those teens who work more than 20 hours per week have been found to be especially vulnerable (Wahlstrom, 1999). They get even less sleep and have more trouble staying awake in school.

Sleep deprivation is of particular concern among adolescents residing and working on farms, where the risk of injuries is higher than in other environments. Lack of sleep must be investigated as a potential risk factor for injuries as it is a relatively easily modifiable variable. Assessing the patterns and amount of sleep in teenagers, and understanding the relationship between fatigue and injuries is critical to the development of measures to prevent injuries on the farm.

Parental attitudes and injuries

Murphy reported that using a model of operant conditioning, farmers have unsafe behavior reinforced rather than safe behaviors (Murphy, 1980). He assumed that farmers are usually working under time constraints and some unsafe practices reduce the time required to perform necessary tasks. Additionally, since unsafe acts do not always result in injuries, the unsafe practices would be reinforced repeatedly.

In a study of dairy farmers, Aherin (1987) used the theory of reasoned action to predict and to analyze safety behavior. He reported three situations where attitudes were primary predictors of behavioral intentions: 1) extra riders on tractors; 2) 12-year old children from operating tractors, and 3) disengaging power prior to unclogging a farm machine. Contrary to safety training, farmers expressed positive attitudes toward teaching 12-year old children to drive tractors and having extra riders on tractors. In a more recent study, information on parental attitudes toward risk of injury and behavior among farm youth and the injury experience of farm youth was collected (Aherin et al., 1989). This survey was conducted using a mailed questionnaire among individuals who subscribe to Successful Farming Magazine. A sample of 377 families representing 815 children were surveyed with 190 males and 187 females returning questionnaires. In this study, 79% of parents reported a 7-9 year old should not be allowed to ride on a tractor, however, 90% of parents reported they allowed a 7-9 year old to ride on a tractor and 80% of the 7-9 year old children rode tractors as extra riders. While only 13% of

parents reported they believed a 7-9 year old operating a tractor was acceptable, 29% of the boys in that age group were reported to be operating tractors. In addition, 67% of the 10-12 year old boys and almost all of the 13-15 year old boys were operating tractors. Although girls were less likely to be operating tractors than boys, nearly 25% of those 10-12 years and 50% of those 13-15 years were. The children were also very likely (71%) to be operating tractors which did not have Roll-Over-Protection Structures (ROPS).

In Iowa, investigators reported the average age children began to ride on tractors with an adult was 3.4 years, the age they began to accompany adults on other equipment was 4.6 years, the age they began to operate equipment was 12 years, and the average age they began to drive tractors was 11.4 years (Hawk et al., 1991). Further, 40% of children operating farm equipment did so without supervision and 30% of children over age 3 years were reported to play alone in work areas. Parents were also asked at what age children were capable of operating farm equipment, the average age reported was 15 years for all equipment and 12.7 years for tractors. Children on farms appear to be put in situations which are viewed as hazardous by parents at earlier ages than parents feel they are capable of performing the tasks required. There is a need to better understand the parental attitudes and behavior in order to reduce the risk of injury among children on farms. Further, there is a great need to evaluate the risk of injury among adolescents who begin to work longer hours and in more hazardous situations. This group has not been addressed in literature related to farm injuries to any great extent.

In an effort to investigate parental attitudes and child/adolescent chore performance, Dr. Pamela Kidd (Kidd et al., 1997) conducted a qualitative study using ten focus groups; some comprised of parents, and some comprised of youth working on farms, investigating the process of chore teaching. Specifically, the ten groups were conducted to identify farm youth perceptions of farming hazards, to understand safety behaviors used by youth to protect themselves from hazards, and to explore the relationship between what parents teach about farm safety and farm youth's perception and application of knowledge gained from teaching. From this work, a number of important factors related to safety behavior were derived. Parental decision making involved similar variables for mother and fathers, however, fathers placed more emphasis on agents (equipment) used for task completion, and the complexity and economics related to potential damage to the machinery and child. Mothers placed more emphasis on the injury risk associated with the task. The youth's interest in performing tasks was influenced by sibling and peer chore completion and a desire to seek parental approval. Youth learned through direct observation with reinforcement occurring through observing the consequences of a role model's performance, direct praise and feedback by the role model about specific sub tasks performed by the child, and direct consequences from performing the tasks (e.g. properly steering a tractor or over-steering a tractor). Chore phasing was described by all participants in the same manner, beginning with verbal instructions, observations of a role model, performing the chore while supervised and progressing to independent performance. The youth received safety information during the chore phasing process, but the investigators found that negative experiences had a greater influence on safety than did safety rules. Modification of chores was initiated by parents or the children. Reducing the completion time for a chore was the primary reason for children altering a chore and parents modified chores due to weather, lack of skilled labor and labor costs. The investigators discovered that the children initiated short cuts and modified chores using an "inaccurate risk appraisal" which may result in risky or unsafe behavior. Additionally, economic factors impacted chore initiation and performance among both parents and children. The need to maintain farm productivity appeared to have a greater influence on parental decisions regarding

chore initiation than the child's physical or cognitive development. Certain farm chores were viewed as more acceptable for children (tractor driving) than others (chemical application). Farm chemical applications often would be hired out due to perception of risk. However, while parents expressed willingness to sell unsafe animals, they operated and kept equipment in disrepair or lacking safety protection. Children themselves were more likely to focus on preventing damage to agents (equipment, animal) than to preventing injuries to themselves. Children were fearful of performing some chores but would not verbalize the fear.

Summary

Adolescents learn most of their safety information by observing role models during chore performance. As they become older, they take on more responsibilities on the farm, working more independently and using more farm machinery. However, during this time of increased responsibility, they become more active in school and extracurricular activities. During this period of increased activity, research has shown that adolescents also need more sleep, which becomes challenging for those trying to meet the demands of work, school, and extracurricular activities.

2. Aims of the project:

The purpose of this study is to develop better understanding of what is occurring among farm populations which lead adolescents to be at high risk of injuries, including an emphasis on adolescent work and sleep patterns. Additional attention will be paid to the adolescent attitudes and behaviors which lead to involvement in hazardous situations around agricultural equipment and animals.

3. Partners:

Telephone interviews were conducted by the Survey Research Unit at the Colorado Department of Health and Environment. Parents were asked a set of questions and detailed questions were asked from adolescents. Informed consent for the interview was obtained from parents for their interview and for permission to interview the adolescents. Consent was also obtained from the interviewed adolescents.

4. Customers:

Researchers

5. Approach:

Materials and methods

Study sample

The target population for the study was adolescents who lived on farms in Colorado aged 13-18 years. The primary sampling unit was the farm. The sampling frame for the study was property value assessment lists from randomly selected counties in Colorado. A list of all counties in Colorado, excluding Denver County where there are a small number of farms (n=16) and Broomfield County where there are no farms, was used. Information for each county including the total number of farms in the county based on the 2003 Colorado Agricultural Statistics Report (CDA, 2003) was used to randomly select counties for inclusion until a total of 10,419 farms were identified. Names of property owners of land were derived from property value

assessment lists from each county. Parcels of land taxed as farm land were linked to owner/operator names and matched to electronic telephone lists. Hard copies of phone books from counties were obtained when needed to identify the phone numbers for the owner of the land. Telephone interviews were conducted.

6. Results/findings

Adolescents in the study were clearly at high risk of sleep deprivation using the 9.25 hours of sleep criteria described by sleep researchers. The lack of sleep was associated with higher odds of having experienced an injury if the sleep deprivation occurred on weekends or both on weeknights and weekends. This pattern was evident in the analyses controlling for sex and age. The pattern was stronger among youth aged 13-15 years. Severity of injury was not significantly associated with sleep deprivation; however, the power to detect the differences observed was low based on the sample size.

The majority of youth in the survey reported fewer than 9.25 hours of sleep during the week. Given the association between the occurrence of injuries and the lack of sleep, this is an important finding that warrants further work. The sample size needed to detect a significant difference in injury severity and sleep deprivation during the week, given the high level of exposure among the youth would have been 3,403. Similarly for the question of injury severity and sleep deprivation during the weekend and combined week nights and weekend, sample sizes of 1,286 and 1,284, respectively, would have been needed to detect a significant difference based on the odds ratios that were found.

Sleep patterns among adolescents were associated with the occurrence of injuries.

7. Outputs

Stallones, L., Beseler C., Chen P. Sleep patterns and risk of injury among adolescent farm residents. American Journal of Preventive Medicine. 30(4):300-304. 2006.

8. Outcomes

Not applicable

Ergonomic Partnership to Address Treefruit Worker Injury
R01 OH008901
John Miles
University of California, Davis

1. Definition of the problem being addressed (e.g., number of workers affected; rates of injury, illness, or fatality; hazards)

Hand harvest of treefruit crops is physically demanding and frequently performed in adverse weather conditions. Hand harvest work is almost universally performed by hired farmworkers. The work pace is fast to preserve fragile commodities and because of the incentive of piece rate pay for workers. Rest periods and days off are often ignored. Research completed by the UC Agricultural Ergonomics Research Center (AERC) documents that hand harvest places workers at high risk for back strain and other musculoskeletal problems. Data from project cooperators describes elevated risk for acute injury from falls and other hazards as well.

Along with grapes and plant nurseries, orchard products are the only California agricultural commodities increasing in acreage and employment. California hand-harvested treefruit commodities include citrus (oranges, lemons, grapefruit, & tangerines), stone fruits (peaches, plums, nectarines, cherries, apricots, & figs), and pomes (apples & pears). California is ranked either first or second in the nation for production for all but two of these treefruit crops with a 2001 value exceeding $1.6 billion. California treefruit production involves approximately 600 thousand acres and more than 50,000 workers. California treefruit producers specialize in fresh market products, but fruit is also grown for processed markets. Similar hand harvest and cultivation practices are the norm for these commodities throughout the nation.

2. Aims of the project (major objectives for the period of the work)

The project specific aims are:

1) To scientifically document and describe ergonomics risk factors involved in hand harvest of treefruit, we will:
   a) develop detailed ergonomics job descriptions of hand harvest in 12 commodities;
   b) utilize biomechanical, metabolic, and postural stress measures to describe ladder use, manual load handling, and repetitive picking in detail;
   c) assess the incidence and types of injuries associated with hand harvest risk factors.
2) To develop and evaluate field practical applications of known controls that eliminate or significantly reduce targeted hand harvest risk factors, we will:
   a) share proven concepts with cooperating workers, growers, contractors, safety practitioners, and interest groups making up the treefruit community;
   b) modify effective intervention applications to ensure field practicability;
   c) conduct cooperative controlled field trials of cooperatively selected intervention applications;
   d) statistically compare individual intervention and control conditions.
3) Because interventions are often combined in the workplace, we will scientifically test the impact of selected interventions combined together on targeted hand harvest risk factors by:
   a) conducting cooperative hand harvest intervention trials with treefruit production partners;

b) statistically comparing combined intervention conditions and control conditions in terms of ergonomics, injury symptoms, and productivity measures.

4) To improve community-based understanding of ergonomics methods and improve intervention practices in hand harvest of treefruit, we will:
   a) provide training and workplace experience with ergonomics methods to cooperating partners;
   b) provide community ergonomics information and training;
   c) assess perceived adoptability of interventions;
   d) communicate project findings to treefruit and other agricultural industry groups, to workers and community interest groups, and other safety and injury researchers.

3. Partners (participants in the project and the roles they served)

- Growers – numerous growers participated providing facilities and labor assistance.
- Farm Labor Contractors – Two large farm labor contractors are actively participating in field trials, providing advice, information and participating farm workers.
- Farm workers – Over 500 workers will have participated in the study, providing advice, applying interventions and providing health information.
- Pomology Extension Continuing Conference – an organized workgroup of Extension staff specializing in research and extension work with California treefruit industry.
- California Pear Advisory Board – Providing advice, industry communication, and financial support to field studies.
- California Avocado Commission – Providing advice and industry communication to field studies.
- California Citrus Research Board – Providing advice and industry communication to field studies.
- AgSafe – A California professional organization dedicated to improved workplace safety in agriculture. Providing advice and industry communication.
- California Farm Bureau – Providing advice and industry communication.
- California State Compensation Insurance Fund – California's largest worker's compensation insurer. Providing advice, industry communication, and financial support to field studies.

4. Customers (intended users or beneficiaries of the results)

Growers of hand harvested treefruit crops, farm labor contractors and farm workers who work with hand harvested treefruit crops.

5. Approach (tasks involved in conducting the project)

Based on preliminary discussions and meetings with members of the California treefruit production community – including growers, contractors, workers, and community groups – specific hand harvest hazards have been identified for initial focus. These include: ladder fall hazards, highly repetitive hand gripping or twisting, high force exertions (ladders and bags), and eye hazards.

Work will proceed in three phases, which may overlap around specific task and tool analysis and development. Phase one is descriptive and will result in baseline data for the intervention trials that follow. Phase two will consist of development and testing of individual intervention strategies and phase three will test combinations of interventions for their synergistic effects. In addition, work on Aim 4 will be initiated with both field cooperators and treefruit community organizations and will continue throughout the project period.

During the first phase (Year 1), Aim 1 will be accomplished using an observational longitudinal design: we will follow a cohort of 12 harvest crews (i.e., one for each of the 12 crops involved) of 20-30 workers each over at least one full work week to develop harvest job descriptions and conduct risk factor job screening on each job. We will also assess incidence, types and causes of injuries for each crop based on cooperator's reported injury records and first aid logs for at least two harvest seasons, and survey data collected from the workers. Detailed descriptive ergonomics data (biomechanical, metabolic, and postural) will be generated for three crops that are selected to be part of the intervention trials (in Aims 2 and 3). These data will guide engineering design and will be used to assess risk factor reduction efficacy of interventions.

During the second phase (Years 2-3), Aim 2 will be accomplished using a controlled pre-post-intervention design. Working in the three representative crops (one in each crop area, i.e, citrus, stone fruit, and pomes) we will develop specific adaptations of established intervention concepts for each of the targeted risk factors in each of the three trial crops. These conceptual adaptations will be worked out in full cooperation with participating workers and growers and subjected to repeated field tests to ensure practical efficacy and worker acceptance. Once accepted interventions are finalized for each crop, separate field trials for each will be cooperatively conducted, employing a cross-over design. The cross-over design has the advantage of using workers as their own controls and increasing the overall sample size available for statistical tests. At least two crews will be involved in each trial (n~60), each participating in intervention and control conditions. Crews will be randomly assigned to initiate in the intervention or the control condition. These trials are planned to last 2 weeks each. During this trial period, detailed ergonomics data will be collected (biomechanical, metabolic, and postural) for each intervention to ensure that it has preventive value. Productivity and health data will be collected to evaluate intervention efficacy.

During the third phase (Year 4), Aim 3 will be accomplished using a similar cross-over design. Again addressing three representative crops, interventions shown to be successful and acceptable in Aim 2 will be subjected to cooperative field trials that combine two or more interventions simultaneously. At least two crews will be involved in each trial (n~60). Each crew will be randomly assigned to begin in the intervention or control condition, but will complete both conditions. These trials are planned to last 4 weeks each. We will collect data on health outcomes, productivity performance, and perceived adoptability of the interventions, separately and as integrated.

Work on Aim 4 will be continuous throughout the project period. We will establish the current Treefruit Safety Research Group as a continuing community coalition with focus on participating in the proposed research and in disseminating both information and resulting injury interventions

throughout the California treefruit community through linked communication and influence to participants own commodity and agricultural organization memberships.

6. Results/Findings (preliminary or final observations and conclusions)

Project not complete.

7. Outputs (reports, publications, products, methods, etc.)

Project not complete.

8. Outcomes (how outputs have been used, e.g. change in behaviors, processes, technologies, guidelines, etc. that have made a difference in measurable endpoints related to exposures or health and safety indicators).

Project not complete

Evaluating Teen Farmworker Education
R01OH004222
Robin Baker, Director, LOHP

1. Definition of the problem being addressed (e.g., number of workers affected; rates of injury, illness, or fatality; hazards)

While childhood agricultural injury prevention has long been recognized as an important public health issue, most research has focused on family farms and there have not been many interventions or epidemiological studies targeting hired youth. In addition, there are few points of easy access to young farmworkers, and the specific health and safety needs of this worker population are often neglected by traditional agricultural youth development programs as well as by general health and safety training targeting adults. California agriculture depends heavily on a hired workforce. Statistics on the number of hired farmworkers under 18 are limited, though NAWS estimates that 3 % of farmworkers are under 18 (1998).

This project sought to evaluate an intervention targeting hired youth, mostly Latino immigrants, through high school English as a Second Language (ESL) classes. Over a two-year period, 1,669 youth in high school ESL classes in California's key agricultural regions received a six-lesson curriculum with information on occupational health and safety in the fields.

Based on a needs assessment carried out several years ago, LOHP decided to develop an ESL curriculum as a means to reach and teach teens who work in the field. A 1997 survey of ESL students in California's San Joaquin Valley found that an average of 71% of these students worked in agriculture. Farmworker youth enrolled in ESL classes are presumably at even greater risk than youth who speak fluent English, due to issues including legal documentation status and linguistic barriers to information and resources for taking action. Since this represents a potentially significant concentration of farmworker youth, these classes could prove to be a key access point. Schools in general may be one of the few sources of information available to young agricultural workers.

2. Aims of the project (major objectives for the period of the work)

The evaluation was designed to measure the effectiveness of the *Teens Working in Agriculture* curriculum on students enrolled in English as a Second Language (ESL) classes in grades 9 through 12 in three counties of California's San Joaquin Valley. The evaluation measured and compared changes in knowledge, attitudes and behaviors among students receiving the curriculum with students in five comparison counties who did not receive the curriculum.

The specific aims of the study were to assess:

1) whether students who participated in at least four of the curriculum's six sessions would demonstrate an increase in knowledge and improved attitudes and behaviors regarding agricultural health and safety, as compared with a comparison group; and,

2) whether a community-based intervention, in the form of workshops on health and safety for parents of students receiving the curriculum, would increase outcomes even further.

In addition to evaluating the curriculum, another specific aim developed in the final year of the project was:

3) to explore and pilot outreach and education methods that could be successful for reaching youth in the fields. Community outreach and education efforts carried out by CRLA in the final year of this project are described in this report.

3. Partners (participants in the project and the roles they served)

This research project involved a collaborative that included a university-based health and safety program (the Labor Occupational Health Program –LOHP– at UC Berkeley), a community organization (California Rural Legal Assistance – CRLA) and independent evaluators (Harder+Company Community Research and the California Institute for Rural Studies). LOHP served as the coordinating partner and provided overall guidance for the project, conducted the trainings for ESL teachers and the outreach to schools. CRLA was primarily involved in implementing the evaluation tools (pre- and post-tests, follow-up interviews) and also assisted with school outreach. CRLA staff also organized and carried out the parent workshops. The evaluators worked closely with the LOHP coordinator to design the evaluation plan and tools, analyze the results, and write the final report.

4. Customers (intended users or beneficiaries of the results)

The intended users for this type of intervention are high school ESL teachers and students throughout California. The beneficiaries are the teen agricultural workers who are able to receive information about health and safety and do so in a setting that encourages discussion and participation. The curriculum could be adapted for use in other states with concentrations of ESL students in agricultural regions.

5. Approach (tasks involved in conducting the project)

The project targeted young farmworkers who were enrolled in high school ESL classes in several counties of California's San Joaquin Valley. Using a quasi-experimental design, the research included three study groups consisting of over 2,000 students. One intervention group consisted of students receiving the school-based curriculum, while the second intervention group included students who received the curriculum and whose parents/guardians attended community-based workshops on health and safety. A comparison group consisted of students who were enrolled in ESL classes but who did

not receive any intervention. Changes in knowledge and attitudes were evaluated by means of pre- and post-tests that were administered to students in the intervention and comparison groups. Knowledge retention and behavior change were measured via a follow-up survey conducted with intervention and comparison group students who worked in the fields the summer following the curriculum. The quantitative data were complemented with qualitative data gathered from focus groups with students, as well as from interviews with teachers implementing the curriculum and parents attending the community-based workshops.

6. Results/Findings (preliminary or final observations and conclusions)

The study found that a school-based ESL curriculum is an effective intervention to reach and educate teen farmworkers. The research findings reveal that the curriculum has had a number of impacts with respect to the three principal outcomes. There was a significant impact in terms of increases in knowledge among students who received the curriculum, particularly in terms of their awareness of laws that protect workers' health and safety, and their ability to identify a greater number of specific health and safety problems and solutions. In terms of attitudes toward health and safety, the percentage of intervention group students who answered all attitude questions correctly increased from 37% at pre-test to 53% at post-test, with a more modest increase (37% to 42%) among the comparison group. Nearly half of the intervention group reported implementing new behaviors to protect their health and safety, compared with 33% of those in the comparison group. One student commented, "because of the classes, I spoke to my dad, and my dad spoke to the foreman and they improved the conditions in the bathrooms." Another said, "I used to get on tractors for fun, but now I don't anymore, because it's dangerous." The curriculum also had spill-over effects in the broader community, as the majority of students reported sharing the new information with others. With respect to the impact of community workshops for parents, the findings reveal virtually no association between parent participation in the workshops and student outcomes. Parents responded to the workshops with enthusiasm and the majority reported talking to their children about what they had learned. However, the organization of parent workshops was resource intensive, and there was no demonstrable impact. The research is able to suggest that ESL classes alone represent a viable approach.

This study is unique in that it targeted hired teen farmworkers, and found that a school-based ESL curriculum is a successful intervention for reaching these workers and teaching them about occupational safety and health. The fact that teachers are willing to teach new curriculum and received it enthusiastically indicates the model could be broadly disseminated. The need for this information is also evident. Only one-fourth of all students reported getting information about health and safety through other venues, such as classes, work or in the community. Moreover, the demographic findings will also contribute to creating a picture of hired youth in the fields.

7. Outputs (reports, publications, products, methods, etc.)

A final report was presented to NIOSH in early 2005. LOHP is currently developing an article for publication in a journal.

LOHP has also proposed broad dissemination of this curriculum among high schools in agricultural areas, as part of a new statewide effort in California to reduce workplace injuries and illnesses (the Worker Occupational Safety and Health Training and Education Program).

Presentations of the evaluation findings have met with enthusiastic response among farmworker advocates, who have expressed interest in adopting this curriculum in schools in their regions. Over 40 ESL teachers in California have received training and/or materials for use in their classrooms, and have demonstrated that this is a feasible approach that warrants further dissemination to the ESL instructor community.

8. Outcomes (how outputs have been used, e.g. change in behaviors, processes, technologies, guidelines, etc. that have made a difference in measurable endpoints related to exposures or health and safety indicators)

None

Evaluation of a School-Based Agricultural Health and Safety Curriculum:
Work Safe Work Smart
Allan N. Williams, MPH, PhD
NIOSH Grant R01 OH004220
2000-2003

1. Problem addressed

Farming has been consistently identified as one of Minnesota's most hazardous occupations. The Minnesota Fatality Assessment and Control Evaluation (MN FACE) program has documented serious ongoing injury hazards associated with tractor use, augers, grain bins, and manure pits in Minnesota. Farm work has also been consistently related to child injury-related deaths. From 1999 through 2000, MN FACE documented seven agricultural work related deaths in youth 10-18 years old with 88% between the ages of 13 and 18 years.

Census data indicate that approximately 100,000 adolescents between 14 and 18 years of age reside in rural Minnesota counties. In these rural counties, many adolescents live on and/or work on farms or agribusinesses and are potentially exposed to agricultural hazards. In a Minnesota Department of Health (MDH) survey of six rural Minnesota high schools, up to 45% of male high school students and 21% female students reported some farm work. In addition, many rural students also had non-farm jobs. Thus, rural Minnesota adolescents who live on a farm may have jobs on and off the farm and adolescents who do not live on a farm may be employed in farming as well as non-farming jobs. Other surveys have shown that approximately 80% of high school students work at some point during their high school years.

Despite a number of federal and state laws such as the Fair Labor Standards Act that limit the types of work that youth under age 18 can perform, adolescents are at increased risk of occupational injuries. Many contributing factors have been identified or suggested such as the types of jobs youth frequently hold, the lack of training, and lack of supervision. Although educational interventions have frequently been recommended as one approach to address this problem, surprisingly few educational interventions for teen workers have been evaluated and reported.

The development of an educational intervention for rural Minnesota youth that would encompass agricultural (and other occupational) health and safety concepts was initiated by MDH in 1997 with support from a previous NIOSH grant (NIOSH Grant R01CCR514360, 1997-2000, "Enhancing Agricultural Safety and Health Through Education"). That grant funded the Minnesota Department of Health to develop and pilot test a school-based agricultural health and safety curriculum, *Work Safe Work Smart*. This curriculum was designed for adolescents and included educational components familiar to teaching professionals in each lesson (e.g., key concepts, learner outcomes). The nine-lesson curriculum consists of topics such as agricultural hazard recognition, injury prevention strategies, child labor laws, and the communication skills needed to discuss agricultural and other work-related safety concerns (available at the MDH web page at: (http://www.health.state.mn.us/divs/hpcd/cdee/occhealth/index.html).

2. Aims of the project

NIOSH Strategic Goals call for the development, implementation and evaluation of injury prevention strategies. The National Occupational Research Agenda (NORA) calls for research to determine the efficacy and effectiveness of intervention techniques and strategies. Among the strategies recommended under NORA is "information dissemination and health communication practices" as well as "safety and health training." An increase in high quality school-based programs is called for in Healthy People 2000. The purpose of these programs is to help children acquire developmentally appropriate knowledge, attitudes, and skills, which enable them to avoid high-risk behaviors. In addition, the United States Department of Labor notes, "School-to-Work practitioners are constantly searching for new ways to address the growing and changing needs of their school-to-work systems."

The major objective of this project was to evaluate the *Work Safe Work Smart* health and safety curriculum. The primary hypothesis of this study is that a beneficial change in the predictors of safe behaviors (e.g., perceived susceptibility to injury, barriers and benefits to safe behavior) regarding agricultural work-related injury will be greater among rural youth exposed to the curriculum compared to their non-exposed peers. The underlying assumption is that these changes will lead to a reduction in preventable injury.

The specific aims of this study were to:

1. Evaluate changes in students' knowledge, attitudes and beliefs regarding agricultural/work-related safety behaviors due to the inclusion of the *Work Smart Work Safe* curriculum into existing school curricula;
2. Identify critical factors to incorporating agricultural/work health and safety training (i.e., *Work Smart Work Safe*) into school curricula; and
3. Establish ongoing statewide support for incorporating agricultural/work health and safety curricula within rural schools.

3. Partners

In addition to Minnesota Department of Health staff, several key partners participated in the design, implementation, and analysis of this evaluation. Key partners, their affiliation, and roles in this project are listed below:

Teresa Hillmer, MPH, PhD; Epidemiologist, Minneapolis, Minnesota
-Dr. Hillmer was the project director at MDH responsible for the development of the *Work Safe Work Smart* curriculum (1997-2001). She also was the co-PI for the current evaluation grant until she left the MDH in 2001, having the key role in writing the grant, recruiting the participating high schools, and teacher training. After that time, she served as a paid consultant and assisted in the analysis and interpretation.

Peter Hannan, MA, M.Stat, M.Ed; Biostatistician, University of Minnesota School of Public Health, Division of Epidemiology
-Mr. Hannan developed the sampling strategy and protocol for this group-randomized study. He also provided oversight and consultation to the project statistician during the analysis.

Deborah Hennrikus, PhD; Epidemiologist, University of Minnesota School of Public Health, Division of Epidemiology
-Dr. Hennrikus is a behavioral epidemiologist who assisted with the development and evaluation of the outcome measures (pre-tests, post-tests) used to identify changes in knowledge, attitudes, beliefs that are likely predictors of future preventative behaviors.

Principals, teachers and staff at 38 rural Minnesota high schools who agreed to participate in this study without knowing whether they would randomly be assigned to be an intervention school (teach the curriculum) or a control school (only pre-test and post-tests).

Youth at Work Advisory Group, comprised of current and former teachers, staff from the Minnesota Dept. of Education, the University of Minnesota Agricultural Extension Service, County Public Health, and the Minnesota Department of Labor and Industry. This advisory group assisted with the development of the curriculum and recruitment.

4. Customers

This curriculum was designed primarily for use in rural high schools where students may be in engaged in both agricultural and non-agricultural work, regardless of whether they reside on a farm. The primary beneficiaries would be rural adolescents, most of whom will be engaged in paid or unpaid work during their high school years.

5. Approach/Methods

A group-randomized study design was used to evaluate the curriculum. Rural high schools were randomly selected from within four agricultural regions and three categories of school size. Participating schools within each region and size class were randomly assigned to the intervention or control conditions. Although the curriculum was initially intended for 9^{th} graders, schools were allowed to choose the grade as well as the class in which to present the curriculum. The primary evaluation tool was a self-completed student questionnaire that included demographic information, work history, and components of behavior-change models such as knowledge, intention, perceived benefits, perceived barriers, perceived susceptibility, perceived severity and self-efficacy. A pre-test and two post-tests were used to evaluate outcomes. Following recruitment and teacher training, 18 intervention schools (N=2183 students) and 20 control schools (N=2568 students) agreed to participate in the evaluation. Survey items were grouped *a priori* and summed into scores for seven outcome categories for analysis (knowledge, intent, benefits, barriers, susceptibility, severity, and self-efficacy). Statistical analysis was based on mixed linear models with adjustment for baseline (pre-test) values.

6. Results/Findings

The curriculum was primarily taught in health classes (42%) and careers classes (40%). At Post-Test 1 (same school year in which the curriculum was taught), adolescents exposed to the curriculum showed a greater awareness of their risk of workplace injuries (perceived susceptibility, $p = 0.038$), reported a greater insight of potential life altering workplace injuries

(perceived severity, $p \leq 0.001$), and an increased understanding of hazard recognition, labor laws, and workplace injury prevention strategies (increased knowledge, $p = 0.004$). Two additional outcomes (intent and perceived barriers) were significantly associated with the intervention in a model that included all covariates. By the second post-test the following school year, only one of the seven outcomes (perceived severity, $p=0.025$) remained statistically significant. There was evidence of a greater intervention effect among girls, freshmen (9^{th} graders), those with a parental education beyond high school, non-Hispanics, and those with a reduced frequency of risky behaviors. Surprisingly, there was little evidence that intervention effectiveness was associated with farm residence, previous work history, previous farm work, or previous work injury. Almost identical results were found in an analysis of data from the pilot test, a large but non-randomized study involving 11 high schools in three adjacent rural Minnesota counties (these schools were not eligible for the randomized study).

7. Outputs

The final performance report for this project was submitted to NIOSH in December 2004. All participating schools were sent progress reports, summarizing findings to date, in the spring of the 2002-03 school year and again in the fall of the 2003-04 school year. The *Work Safe Work Smart* curriculum, initially only available in printed format, was converted to Adobe Acrobat (PDF) format with some added navigational tools and updated resources. The curriculum was then made available on CD-ROM and via download from the Minnesota Department of Health web page. (http://www.health.state.mn.us/divs/hpcd/cdee/occhealth/wsws.html)
The curriculum (in any format) is freely available for use and adaptation for educational purposes. A summary of the key findings is posted on the MDH web site. A manuscript is in preparation as of June 2006.

8. Outcomes

Following completion of this study, over 4,000 copies of the curriculum have been distributed on CD-ROM throughout Minnesota as well as in many other states. Between September 2003 and June 2006, the whole curriculum or various components were downloaded over 20,000 times from the MDH web site.

Title of Project: Teaching Kids Safety on the Farm: What Works
Project Timeframe: 2000 -2003

Principal Investigator: Anne Gadomski MD, MPH, Bassett Research Institute, Cooperstown, NY

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Co-investigators on the project:
Name(s) and Affiliation

1. Susan Ackerman RN, Nurse educator, New York Center for Agricultural Medicine and Health/Northeast Center (NYCAMH/NEC), Fly Creek, NY
2. Paul Jenkins PhD, Statistician, Bassett Research Institute, Cooperstown, NY
3. Patrick Burdick, MA, Programmer, Bassett Research Institute, Cooperstown, NY
4. John May, MD, Director, NYCAMH/NEC, Fly Creek, NY.

1. Definition of the problem being addressed (e.g., number of workers affected; rates of injury, illness, or fatality; hazards)

Children living or working on farms have high rates of agricultural injury on the order of about 1.7 per 100 farms and are at risk of injury while working, being present while others work, or using the farm workplace for leisure activities. A review of nonfatal childhood agricultural injury incidence and disability showed that data are sparse for evaluating childhood agricultural injury prevention strategies.[1] A systematic review of farm safety interventions found only three studies that used injury incidence as an outcome; [2] none of these studies included children. The 'Teaching Kids Safety on the Farm: What Works' study measured the impact of the active dissemination of the North American Guidelines for Children's Agricultural Tasks (NAGCAT) to farm families on the rates of childhood agricultural injury. These guidelines were developed to help parents select age-appropriate farm tasks for their children and promote farm safety for children through increased awareness, simple behavioral changes, and increased adult supervision.

2. Aims of the project (major objectives for the period of the work)

The effectiveness of NAGCAT in reducing childhood agricultural injury was not known therefore this study measured the impact of NAGCAT use on the childhood agricultural injury.

3. Partners (participants in the project and the roles they served)

Partner(s)	Affiliation
Barbara Marlenga, PhD, consultant	National Children's Center for Rural and Agricultural Health and Safety, Marshfield, WI.
William Pickett, PhD, consultant	Queen's University, Kingston, Ontario.

4. Customers (intended users or beneficiaries of the results)

NAGCAT are specifically designed to assist parents in matching a child's physical, mental, and psychosocial abilities with the requirements of certain farm jobs. The NAGCAT were created by the National Children's Center for Rural and Agricultural Health and Safety using a job hazard analysis framework, consensus development methodology and child development principles. This study measured the impact of the active dissemination of the NAGCAT to farm families during a farm visit.

5. Approach (tasks involved in conducting the project)

Our randomized controlled trial measured the efficacy of a single NAGCAT face-to-face educational encounter during a farm visit, followed by modest intervention boosters. In central New York State, 845 farm households with resident or working children were randomized to a NAGCAT intervention group or to a control group. Outreach educators visited each intervention farm household to explain, review, and leave a copy of the NAGCAT guidelines with the parent or adult employer. Control farms received a farm visit to collect baseline data only. Telephone surveillance was conducted every three months for both intervention and control farms for 21 months. Data on childhood injury, tasks and hours worked were obtained quarterly for 21 months. Injury incidence density per farm were compared between treatment and control groups using analysis of variance. All injuries were coded to assess whether adherence to the NAGCAT guideline could have prevented the injury. Cox proportional hazards modeling was used to compare time to injury and time to violation of NAGCAT age guidelines for task assignment between the intervention and control groups.

We also conducted an ecologic study design to compare trends in aggregate child work hours with national and regional economic indicators. Child work hours were obtained from quarterly surveillance data from a randomized field trial of agricultural task guidelines for children. 2,360 children living or working on 845 farms in central New York participated in the original study. The relationship between child work hours and three economic indicators: national all farm index (AFI) ratio, national fuel index, and regional milk prices was analyzed using times series plots, correlation, and multiple linear regression.

6. Results/Findings (preliminary or final observations and conclusions)

Farm visits began in January 2001 and ended in December 2001. The mean length of the intervention (review of NAGCAT) was 40 minutes with a range of 5 to 90 minutes.

810 farms completed the study representing 95.8% of our original sample. The leading reason for attrition (12.8%) was cessation of farming.

All injuries were reviewed to assess if NAGCAT were applicable (NAGCAT related) and if the specific NAGCAT guideline had been applied would it have prevented the injury (NAGCAT preventable). Of the 86 NAGCAT related injuries, 48% (41/86) could have definitely been prevented if NAGCAT were followed. Active dissemination of NAGCAT halved the incidence density of NAGCAT preventable injuries among 7-19 year olds on intervention farms (0.07) compared to control farms (0.13) but this difference was not statistically significant ($p = 0.68$). Intervention farms were less likely to violate NAGCAT age guidelines for ATV use, tractor and

haying operations than the controls. In Cox proportional hazards regression models, a significant protective effect of the intervention on NAGCAT preventable injuries was observed after adjustment for important covariates. The time to NAGCAT definitely preventable injury occurrence for 0 to 19 year-olds showed a significant difference between intervention and control farms, favoring the intervention (Hazard Ratio=0.518, 95% C.I.= [0.290,0.925], p=0.03). NAGCAT also affected important intermediate variables, such as setting limits for the amount of time a child does a task (intervention 25% vs control 16%, $p < 0.01$) and providing more supervision (intervention 42% vs control 36%, $p = 0.06$).

In our ecologic study, we found that the AFI ratio was positively correlated with child work hours ($r=0.49$, $p =0.008$) but there was no significant correlation between child work hours and fuel or milk prices. Multiple linear regression demonstrated that the relationship between AFI and child work hours is independent of a seasonal effect. Increased child work hours therefore may be associated with periods of higher farm sector productivity, rather than economic stress per se.

7. Outputs (reports, publications, products, methods, etc.)

Publications

- Gadomski AM, Ackerman S, Burdick P, Jenkins P. Efficacy of the North American Guidelines for Children's Agricultural Tasks (NAGCAT) in reducing childhood agricultural injury. Amer J Public Health April 2006; 96:722-727.
- Gadomski A, de Long R, Burdick P, Jenkins P. Do economic stresses influence child work hours on family farms? Journal of Agromedicine 2005; 10(2): 39-48.

Abstracts presented at national meetings

- Gadomski A, Burdick P, Ackerman S, Jenkins P. Preschoolers working on the farm: tasks, hours and injury rates. Pediatric Research 2003; 53(4):341, ABS 1945. Pediatric Academic Societies, Baltimore, May 2003.

- Gadomski A, Burdick P, Jenkins P, Ackerman S, May J. Randomized field trials to evaluate the effectiveness of the North American Guidelines for Children's Agricultural Injury Prevention (NAGCAT). American Public Health Association presentation, Nov 18 2003. Session 4212.0. Abstract #64051. Available at: http://apha.confex.com/apha/131am/techprogram/. Accessed on Nov 25 2003.

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NIOSH meeting presentations

- Teaching Kids Safety on the farm: What works? NIOSH presentation, Morgantown, Virginia. 9/17/02 and 9/25/03.

8. Outcomes (how outputs have been used, e.g. change in behaviors, processes, technologies, guidelines, etc. that have made a difference in measurable endpoints related to exposures or health and safety indicators)

NAGCAT reduced the rate of work related childhood agricultural injuries. The success of NAGCAT in reducing work related child agricultural injury and delaying childhood ATV use is an encouraging start, but still only addresses selected sources of childhood agricultural injury. Because half of the childhood agricultural injuries recorded in our study were not NAGCAT related, it is unlikely that NAGCAT implementation alone can decrease childhood agricultural injury. Children on farms are injured not only while working, but also while being present while others work (such as preschoolers accompanying their parents during farm work), or using the farm workplace for leisure activities. Our study found that, when adjusted for hours working, children ages 0 to 6 years had an injury incidence density of 1.45, three times higher (3.15:1) than that of children ages 7 to 19 years (0.46, p=0.02). Involving pre-school in agricultural work places them at significant risk of injury. A comprehensive public health approach is needed to reduce non-work related childhood agricultural injuries.

References:

[1] Reed DB, Claunch DT. [2000] Nonfatal farm injury incidence and disability to children: a systematic review. Am J Prev Med 18 (4S):70-79.

[2] DeRoo LA, Rautiainen RH. [2000] A systematic review of farm safety interventions. Am J Prev Med 18 (4S):51-62.

Adapting the North American Guidelines for Children's Agricultural Tasks (NAGCAT) for Ethnic Communities: A Research Model
Date: 9/30/2000 to 9/29/2004
Project Investigator: John M. Shutske
Project Director: Michele Schermann
Sponsors: CDC/National Institute for Occupational Safety and Health

Grant Number: CDC/1RO1-OHO4215-01

1. Definition of the problem being addressed (e.g., number of workers affected; rates of injury, illness, or fatality; hazards)

The Minneapolis-St. Paul, Minnesota metropolitan area has the largest urban concentration of Hmong in the United States with 41,800 according to the 2000 Census (Pfiefer, 2001) or 70,000 according to community estimates (Hmong National Development, 2003). It is impossible to know just how many Hmong are farmers because they are not ethnically identified by the Minnesota Agricultural Statistics Services (George Howse, personal communication, April 2003). Most Hmong rent the farmland they work, do not grow subsidized row-crops such as corn or soybeans, and work at primary occupations other than farming, thus, do not appear in statistical accounts of Minnesota farmers.

Hmong children work or play alongside their parents in the field and at the market. Current agricultural practices of Hmong can be described as small-scale operations that use mainly hand tools, manual labor, and local direct marketing techniques in open air markets. Specific tasks performed by children include thinning, weeding and hoeing with Hmong tools; carrying tools, buckets or baskets; using rototillers for cultivation; sales, and customer service at markets. Hmong children of various ages were assigned to all of these tasks.

Minnesota Hmong farms average 20 acres and are within 50 miles of the Minneapolis/St. Paul metropolitan area. Typically, farms include a large variety of vegetables and flowers grown for fresh market consumption. Successive plantings are common. Direct marketing of their produce yields a seasonal income for both the adults and the children.

As far as we can determine, our research team is the first to document Hmong children's agricultural work in the United States.

2. Aims of the project (major objectives for the period of the work)

Safe work practices for children in the larger context of the families' enterprise are important in efforts to reduce work-related injury and illness. The purpose of this research project was to investigate culture-specific health behavior patterns and to develop culturally-appropriate health promotion methods for Hmong farming families.
The specific aims of this research project were to:

1. Examine the extent and nature of child agricultural labor in farm families of Hmong origin in the Upper Midwest;
2. Investigate culture-specific health behavior patterns and culturally appropriate health promotion methods for farm families of Hmong origin;

3. Evaluate the North American Guidelines for Children's Agricultural Tasks (Guidelines) for applicability and appropriateness for farm families of Hmong origin;
4. Produce recommendations for adapting the Guidelines to be more culturally appropriate to Hmong farm families; and
5. Design a prototype health education vehicle that presents at least three of Guidelines through messages and in media tailored specifically for Hmong audiences.

3. Partners (participants in the project and the roles they served)

Key Partners in the Project:

Partner(s)	Affiliation
1. Nigatu Tadesse	New Immigrant Farmer Project, U of MN
2. Vang Yang	New Immigrant Farmer Project, U of MN
3. Mao Thao, Chair	Hmong Health Professionals Coalition

4. Customers (intended users or beneficiaries of the results)

The Minneapolis-St. Paul, Minnesota metropolitan area has the largest urban concentration of Hmong in the US. The number of Hmong farmers is unknown because they are not ethnically identified by the Minnesota Agricultural Statistics Services. Project aims were to examine extent and nature of child agricultural labor in Minnesota Hmong families, investigate culture-specific health behavior patterns and determine culturally appropriate health promotion methods, evaluate the NAGCAT for applicability and appropriateness and design a prototype health education vehicle of three Guidelines tailored specifically for Hmong audiences. Our research team is the first to document Hmong children's agricultural work in the US.

5. Approach (tasks involved in conducting the project)

The design for this non-experimental evaluation study combined qualitative and quantitative research methods. Research questions were addressed in the following areas related to Minnesota's Hmong community: Hmong farm population, farm child labor, child growth and development, farm family members' safety knowledge and behavior, preferred learning methods regarding health, and responses to the current guidelines. Researchers used a variety of methods, including extensive literature review and analysis of secondary data; semi-structured individual and group interviews; moderated focus groups; field observation; content analysis of texts; and height and weight measurements. Text narratives, field notes and photographs were analyzed and organized using Atlas.ti version 4.2 and numerical data (demographics) were analyzed with SPSS version 11.5.

6. Results/Findings (preliminary or final observations and conclusions)

Hmong farm children are engaged in different work tasks, roles, and responsibilities and are exposed to different hazards compared to mainstream North American farm children. Standard health and safety educational materials are not widely accepted by Minnesota Hmong farmers. Culturally and contextually appropriate materials addressing health and safety needs of Hmong children working on their family's production acreage were created. Specific needs were identified in collaboration with the Hmong farming population in Minnesota: Safe Rototiller

Operation, Hand Tool Safety (e.g. knives, machetes, etc.), Marketing Skills and Public Health Concerns (food safety, personal hygiene, ergonomics, lifting, heat stress, repetitive motion). A Safety and Health Education Development (SHED) Algorithm was developed and used to tailor existing health and safety guidelines. New guidelines were developed. The SHED Algorithm was further refined and clarified to be used to deliver information to other cultural, linguistic, or ethnic populations in the United States or abroad.

7. Outputs (reports, publications, products, methods, etc.)

Rasmussen RC, Schermann MA, Shutske JM, Olson DK [2003]. Use of the North American Guidelines for Children's Agricultural Tasks with Hmong Farm Families. Journal of Agricultural Safety and Health 4: 265-274.

Cummins HJ [2004]. A harvest of hurt: Farm work is the most dangerous summer job for young people. Minneapolis Star Tribune, Aug 5; D:1.

Yang, C. [2005]. In M. A. Schermann (Ed). Orphan Boy the Farmer (Tub Ntsuag, Tub ua Teb). St. Paul, MN: Minnesota Agricultural Experiment Station. ISBN #: 1888440287.

Rasmussen, RC. [2002]. Adapting the North American Guidelines for Children's Agricultural Tasks to the Hmong Community: Two Literature Reviews. Plan B Master of Public Health thesis.

Bartz, P. [2005]. Storytelling as a Delivery Method of Farming Safety Education for Hmong Farmers. Plan B Master of Public Health thesis.

An additional peer-reviewed article is being prepared for submission to the J of Agromedicine.

Three new prototype Guidelines were created as part of this research based on project data and community input. These Guidelines, *Tub Ntsuag, Tub ua Teb* (Orphan Boy the Farmer) use the health and safety frameworks and concepts (such as consideration of age/developmental appropriateness and use of job safety analysis) laid out in the original Guidelines, include appropriate cultural imagery and linguistic language, are intended to be delivered verbally, in a storytelling setting, cover topics that were observed as a need and requested by parents, and were written in Hmong and English. The three new prototype Guidelines include:

- Using Rototillers Safely,
- Hand-tool Safety (e.g. knives, machetes, and other tools for harvesting and preparing crops), and
- Marketing Skills and Occupational/Public Health Concerns (e.g. food safety and personal hygiene, money-handling and security, communicating with the public, ergonomics, lifting, heat stress, and repetitive motion)

8. Outcomes (how outputs have been used, e.g. change in behaviors, processes, technologies, guidelines, etc. that have made a difference in measurable endpoints related to exposures or health and safety indicators).

The primary outcome of this work was the three prototype guidelines based on the unique needs of the Hmong community as has been described above. This work has been evaluated by examining the acceptance of the prototype guidelines by members of the Hmong community in several areas including Minnesota and Wisconsin (see Bartz project cited above). Evaluation to determine behavioral change was beyond the scope of this project. As a result of interactions with this community, researchers affiliated with the project have effectively engaged the Hmong community (the general community and public health community) on a much larger array of general preparedness and public health issues including avian influenza, food safety, and community preparedness. This engagement was made possible because of the work funded by NIOSH which allowed the research team to interact heavily with the Hmong community from 2000-2004 during the time when the bulk of the research occurred.

Note that the evaluation work in Wisconsin occurred through the National Children's Center in Marshfield Wisconsin via a small pilot project grant.

Evaluation of NAGCAT using a Case Series of Injuries (R01 OH004205)

submitted by:
Barbara Marlenga, Ph.D.
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1000 North Oak Avenue
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715-389-3021

May 31, 2006

Definition of the Problem

Each year, more than 100 children are killed on farms and ranches and 22,648 children sustain injuries that limit their activity or require medical treatment. Many injuries occur because children are assigned work that is beyond their developmental capabilities.

A recent set of voluntary guidelines, the *North American Guidelines for Children's Agricultural Task* (NAGCAT), were developed to assist parents in assigning developmentally appropriate work to their children 7-16 years. The goal of this research study was to build upon the NAGCAT project by providing a field test of NAGCAT for relevance, applicability, and effectiveness.

Aims of the Project

The purpose of this study is to systematically apply NAGCAT to case descriptions of fatal and non-fatal pediatric farm injuries to: 1) identify the farm jobs covered by NAGCAT that are most commonly associated with childhood farm injury, 2) analyze the most frequent violations to NAGCAT, 3) determine the proportion of pediatric injuries than may have been prevented if NAGCAT were applied, and 4) recommend new guidelines to cover ages, jobs, and situations not covered by NAGCAT.

Partners

Co-investigator: William Pickett, PhD
Co-investigator: Robert J. Brison, MD
Senior Biostatistician: Richard L. Berg, MS
Clinical Programmer Analyst II: James Linneman, BS
Research Specialist: Jamie Zentner, MPH
Child Development Consultant: Richard Clark, PhD

Customers

Agricultural Safety Professionals
Farm Families

Approach

The study utilized a retrospective case series design. Three case series' pediatric farm injuries in the United States and Canada were assembled (fatalities, hospitalizations, and restricted activity injury) using existing registries, surveillance data, coroner/medical records, case investigation reports, and national survey data. For each case, we systematically recorded the child demographics, a description of the injury event and circumstances surrounding it, and detailed information specific to NAGCAT.

Results/Conclusions

A sample of 934 pediatric farm injury cases was identified in the United States and Canada for the years 1990-2000 and 283 (30.3%) cases involved children engaged in farm work. There was an applicable NAGCAT guideline in 64.9% of the work related cases. Leading individual guidelines applicable to the injury events were: 1) working with large animals, 2) driving a farm tractor (no implement attached), and 3) farm work

with an all-terrain vehicle. In the judgment of the research team, 59.6% of these injuries were totally preventable if the principles espoused by NAGCAT had been applied.

NAGCAT are a set of consensus guidelines aimed at the prevention of pediatric farm injuries. The findings suggest that many of the most serious farm injuries experienced by children could be prevented if NAGCAT had been available and applied (efficacy). However, work related injuries represent only a modest portion of pediatric farm injuries. This new information assists in the refinement of NAGCAT as an injury control resource and puts its potential efficacy into context.

Outputs

Manuscripts:

Brison RJ, Pickett W, Berg RL, Linneman J, Zentner J, Marlenga B. (in press) Fatal agricultural injuries in preschool children: Risks, injury patterns, and strategies for prevention. *Canadian Medical Association Journal*

Pickett W, Brison RJ, Berg RL, Linneman J, Zentner J, Marlenga B. (2005). Pediatric farm injuries involving non-working children: Five opportunities for primary prevention. *Injury Prevention*, 11 (1): 6-11.

Marlenga B**,** Brison RJ, Berg RL, Zentner J, Linneman J, Pickett W. (2004). Evaluation of the *North American Guidelines for Children's Agricultural Tasks* using a case series of injuries. *Injury Prevention*, 10 (6): 350-357.

Published Abstracts

Brison RJ, Berg RL, Zentner J, Linneman J, Pickett W, Marlenga B. (November 2005). The *North American Guidelines for Children's Agricultural Tasks:* Lessons learned from a novel evaluation. Paper presented at the 2005 Canadian Injury Prevention and Safety Promotion Conference, Halifax, NS.

Pickett W, Brison RJ, Berg RL, Linneman J, Zentner J, Marlenga B. (July 2005). Pediatric farm injuries involving non-working children Injured by a farm work hazard: Five priorities for primary prevention. Paper presented for the *Injury Prevention* Editor's Choice Online Webinar Series 2005, University of Pittsburgh, Pittsburgh, PA.

Marlenga B, Brison RJ, Berg RL, Zentner J, Linneman J, and Pickett W. The North American Guidelines for Children's Agricultural Tasks: Lessons Learned from a Novel Evaluation. American Public Health Association Meeting, Washington, District of Columbia, November 2004

Marlenga B, Brison RJ, Berg RL, Zentner J, Linneman J, and Pickett W. Evaluation of the North American Guidelines for Children's Agricultural Tasks using a case series of injuries: Interim results. American Public Health Association Meeting, San Francisco, California, November 2003

Marlenga B, Pickett W, Brison RJ, Berg RL, and Zentner J. Evaluation of the North American Guidelines for Children's Agricultural Tasks using a case series of injuries: Interim results. Fifth International Symposium, Future of Rural Peoples: Rural Economy, Healthy People, Environment, Rural Communities, Saskatoon, SK, Canada, October 2003

Brison R, Pickett W, Marlenga B, and Berg RL. Fatal farm injuries among Canadian children: There is no "Golden Hour" for young farm children. Fifth International Symposium, Future of Rural Peoples: Rural Economy, Healthy People, Environment, Rural Communities, Saskatoon, SK, Canada, October 2003

Pickett W, Marlenga B, Brison R, and Berg RL. Protecting very young children from farm work hazards: Building evidence from a national case series of pediatric deaths. American Public Health Association Meeting, Philadelphia, Pennsylvania, November 2002

Brison R, Pickett W, Marlenga B, and Berg RL. Fatal farm injuries among Canadian children: There is no "Golden Hour" for young farm kids. American Public Health Association Meeting, Philadelphia, Pennsylvania, November 2002

Farm Journal Articles

Merrill LS (May 2005). We can prevent most child injuries, deaths on farms. Hoard's Dairyman, 150 (10), 398.

Merrill LS (July 2005). Got kids? Got chores? How to keep your kids safe. Hoard's Dairyman, 150 (12), 490.

Outcomes

Results of this study were used to set priorities for the NAGCAT project for the next 5 years (2005-2010) and to enhance efforts to have farmers create safe play areas on their farms and ranches.

Effectiveness of computer-based training: cTRAIN
R01 OH04193 W. Kent Anger
04/01/01 to 3/31/05

1. Definition of the problem being addressed (e.g., number of workers affected; rates of injury, illness, or fatality; hazards)

This research examined the effectiveness of a prototypical computer-based training program, cTRAIN, as an intervention technology. Basic behavioral training principles embedded in cTRAIN were evaluated in laboratory studies targeting community respondents to newspaper ads and in worksite studies of majority and Latino workers in construction, hospitals, agriculture and education.

2. Aims of the project (major objectives for the period of the work)

- Identify optimal procedures through studies framed by the basic behavioral training principles on which cTRAIN is founded, in Caucasian and Latino workers.
- Produce 5 safety and health training programs spanning a range of diverse, technically complex issues, piloting and optimizing each with the target audience.
- Evaluate the 5 training programs in 50 workers per topic (in 4 different industries): (a) testing knowledge retention at the end of training and at 3 months later; and, (b) measuring changes in workplace behaviors the training is designed to alter, to assess intervention effectiveness.

3. Partners (participants in the project and the roles they served)

Workers in construction, agriculture, and hospitals graduate students; and community participants who answered newspaper advertisements, served as subjects in field and laboratory experiments. Drywall, orchard, hospital food services companies or departments and Portland, Oregon's International Union of Painters and Allied Trades (District Council #5) served as collaborators in the research.

4. Customers (intended users or beneficiaries of the results)

The computer-based training software evaluated in this research, and similar behaviorally-based training programs delivered on computers or the internet, can improve the safety and health performance of all working people.

5. Approach (tasks involved in conducting the project)

Workplace (field) experiments assessed the impact of computer-based training on reaction (did participants like the training), knowledge, behavior or work practices, and results (favorable impacts on the organizations). Structured laboratory experiments compared information learned pre- to post-training and across independent groups that assessed training factors such as quiz feedback.

6. Results/Findings (preliminary or final observations and conclusions)

- Food service workers and drywall finishers with a high school and lower education learned information from the cTRAIN computer-based training and their work practices also became substantially more safe.
- Latino agricultural workers with 0-15 years education can learn information from computer-based training and translate that information into changes from more to less hazardous work practices.
- Computer-based behavioral training results in substantially better and more durable learning over a 2-month period than the same information provided in booklets or on a computer screen.
- Memory for safety and health information declines rapidly if not used or practiced.
- Learners completing in multiple choice question quizzes in which the correct answers were underlined remembered the answers as well as those who took the same quizzes but without the correct answers underlined. This extended from the post test immediately after training through a repeat test at 1 month post-training.
- Open book exams produce more durable recall than closed book exams.

7. Outputs (reports, publications, products, methods, etc.)

Product

The prototype cTRAIN software used in this project was developed in the PI's laboratory. Due in part to the results from this RO1 grant, cTRAIN and the startup company formed by the PI to market the software became the subject of an NIEHS STTR Phase I award in 2004. The NIEHS award supported the re-writing of cTRAIN as a cross-platform (PC and Mac) product. The unique capability of cTRAIN computer-based training is to train workers from diverse cultures and with very limited education or none at all.

Publications

Anger WK, Rohlman DS, Kirkpatrick J, Reed, RR, Lundeen CA, Eckerman DA. cTRAIN: A computer-aided training system developed in SuperCard© for teaching skills using behavioral education principles. Behavior Research Methods, Instruments and Computers, 2001, 33: 277-281.

Eckerman DA, Lundeen CA, Steele A, Fercho HL, Ammerman RA, Anger WK. Interactive training vs. reading to teach respiratory protection. Journal of Occupational Health Psychology 2002, 7:313-323.

Newland MC, Pennypacker HS, Anger WK, Mele P. Transferring behavioral technology across applications. Neurotoxicology and Teratology, 2003, 25:529-542.

Eckerman DA, Abrahamson K, Ammerman T, Fercho H, Diane S. Rohlman DS, Anger WK. Computer-Based Training for Food Services Workers at a Hospital. Journal of Safety Research, 2004, 35:317-327.

Anger WK, Tamulinas A, Uribe A, Ayala C. Computer-Based Training for Immigrant Latinos with Limited Education. Hispanic Journal of Behavioral Sciences, 2004, 26:373-389.

Rohlman DS, Eckerman DA, Ammerman TA, Fercho HL, Lundeen CA, Blomquist C, Anger WK. Quizzing and feedback in computer-based and book-based training for workplace safety and health. Journal of Organizational Behavior Management, 2005, 24:1-26.

Anger WK, Rohlman DS, Storzbach D. Human Behavioral Neurotoxicology: Workplace and Community Assessments. In: Environmental and Occupational Medicine. 4th Ed (William N. Rom, ed.), Lippincott Williams and Wilkins, (in press 2006).
Anger WK, Stupfel J, Ammerman T, Tamulinas A, Bodner T, Rohlman DS. The Suitability of Computer-based Training for Workers with Limited Formal Education: A Case Study from the US Agricultural Sector. International Journal of Training and Development (in press 2006).

8. Outcomes (how outputs have been used, e.g. change in behaviors, processes, technologies, guidelines, etc. that have made a difference in measurable endpoints related to exposures or health and safety indicators)

In an orchard company that implemented ladder safety training on cTRAIN, the number of ladder-related accidents declined 63% during the 3-month pruning period after training compared to the same period in the previous 2 years; specifically, this was 2 ladder accidents following training vs. 5.5 ladder accidents per year during the prior two years. Whether this was a reliable change is unclear since ladder accidents had previously been lower but appeared to be on the increase in the two years prior to training.

Community Partners for Healthy Farming Vineyard Harvest Ergonomics Intervention Partnership Project – Trellis Systems
R01 OH003906
John Miles
University of California, Davis

1. Problem Definition:

The agriculture industry has been recognized as one of the Nation's most hazardous industries along with mining and construction, and California's agriculture industry is no exception. The most commonly reported injuries within California agriculture, in general, and the winegrape industry in particular, have been associated with musculoskeletal disorders (MSDs). Grape vineyards utilized for the production of wine are prominent and extensive in northern California with more than 400,000 acres situated primarily in the Sonoma and Napa valleys. Approximately half of the existing commercial wineries in the US are located in California, employing more than 31,000 workers per year with an additional 40-50,000 workers hired specifically for the harvesting season. There is currently an incomparable degree of new winegrape vineyard planting in process throughout the Western States. This is in part due to the rapid expansion of production capacity to meet growing worldwide demand.

As new plantings are made, growers face a rare opportunity to reconsider otherwise more or less fixed structures as well. Chief among these are decisions about trellising systems. Trellises are used to create a greater plant canopy surface area to receive more sunlight and increase production. Trellis systems dictate the health effects, mostly in terms of musculoskeletal disorders, on workers performing pruning and harvesting tasks. However, unfortunately, this is not a current focus in trellis system selection since little is known about these effects, and labor costs are generally cheap.

2. Aims of the project:

To address the void about the effects of trellis systems design on MSD risk factors for workers performing pruning and harvesting tasks, the study's main aims included:

1. Identify and develop detailed ergonomics measurements of risk factors for musculoskeletal disorders for each of the most commonly used winegrape trellis systems.
2. Facilitate use of information about risk factors for musculoskeletal disorders associated with most commonly used winegrape trellis systems in trellis decision-making.
3. Develop practice and design parameters for reducing ergonomics risk factors associated with most used trellis systems.
4. Add to research knowledge about the association of specific agricultural workplace ergonomics risk factors and musculoskeletal disorders and their symptoms.

3. Partners:

The following is a list of project's participants and their respective role on the project:

a. *John A Miles, Professor, Department of Biological and Agricultural Engineering, UC Davis:* Dr. Miles was the study's principal investigator. He oversaw the overall aspects of the project and provided engineering design guidance and agricultural field advice for the research team.

b. *Fadi Fathallah, Associate Professor, Department of Biological and Agricultural Engineering, UC Davis:* Dr. Fathallah was a co-investigator who was responsible for conducting the ergonomic evaluations of the trellis systems.
c. *Julia Faucett, Professor, Department of Occupational Health Nursing, UC San Francisco*: Dr. Faucett was responsible for the assessment of musculoskeletal symptoms and injuries with workers performing the selected tasks using interview survey for Spanish speaking agricultural workers developed for and refined in our previous NIOSH funded studies
d. *James M Meyers, Specialist, School of Public Health, UC Berkeley*: Dr. Meyers was responsible to providing information on both ergonomics generally as well as findings from project work through a variety of media, in both English and Spanish, to cooperators, to workers, to the wine grape industry, and to the broader workers community. Dr. Meyers is overseeing the communications program using Cooperative Extension and community resources.
e. *Ira Janowitz, Ergonomist, Ergonomics Program, UC San Francisco/Berkeley:* Mr. Janowitz assisted in the ergonomic studies conducted in this project.
f. *Rhonda Smith, Farm Advisor, Sonoma County; Ed Weber, Farm Advisor, Napa County; UC Cooperative Extension*: Ms. Smith and Mr. Weber were the main liaison with the vineyard management and owners to facilitate access to the study participants.
g. Four wine companies, one winegrape vineyard management company, and the UC Davis experimental vineyard formally participated in the this project by providing direct access to their facilities and workers.

4. Customers:
Beneficiaries of the project's results include vineyard owners and workers in California and beyond. The results of the study could be used by vineyard managers when considering the installation of trellis systems which are designed to be manually pruned and/or harvested. The workers are expected to experience less musculoskeletal disorders if the study recommendations are followed.

5. Approach:
Because the different trellis systems involved are spread across wide geographic areas and among multiple cooperators, we elected to focus our detailed ergonomics analyses on task simulations in quasi-laboratory conditions using the trellis structure developed cooperatively with the UC Davis Viticulture and Enology department. Hence, to achieve the project's primary goals, the project was divided into five main studies: 1) California Major Trellis Systems, 2) Ergonomic Evaluation: Pruning Simulation, 3) Ergonomic Evaluation: Harvest Simulation, 4) Ergonomic Evaluation: Field Observations, and 5) Field MSD Symptom Surveys. The rationale for these studies was that firstly, it is important to identify which trellis systems are the most popular in California. Secondly, since we are interested in identifying the potential effects of trellis systems on risk factors for MSDs during pruning and harvesting, it is important to conduct controlled studies looking at these effects. Thirdly, it was deemed important to conduct field observational studies to identify differences among trellis systems during actual pruning and harvesting work. Lastly, in order to obtain field confirmation of the controlled studies, field surveys were conducted to obtain both symptom surveys and ergonomic risk factors evaluation by trellis type.

6. Results/Findings:
The findings of this study could have important impact on vineyard workers health, especially for vineyards that are considering replanting or expanding into new winegrape acreage.

Based on the multiple studies conducted in this project, the following significant findings can be reported:

a) The design characteristics of the winegrape trellis system clearly affect risk factors for developing musculoskeletal disorders of the back and the upper limbs.
b) The study found that the Vertical Shoot Positioned (VSP) system to be the optimal design, which provide relatively acceptable levels of risk while pruning and harvesting.
c) The results of the biomechanical studies, corroborated with the field observational and symptom surveys, have consistently found that the VSP 4x4 trellis system clearly places the workers at increased risk of developing MSDs of the lower back, and potentially MSDs of the upper extremities
d) The Lyre system caused workers to undergo extension of the spine, which is a risk factor of low back disorders; combined with potential for developing MSDs of the shoulders. Furthermore, this system required the longest harvest cycle time and a high rate of cuts/second during pruning.
e) The Smart Dyson (and potentially the Scott Henry system) required a long harvest cycle time, which could magnify the MSD risk reported in the biomechanical studies.
f) The detailed biomechanical studies have revealed interesting, and previously not explored, interactive relationships between trunk postures and wrist postures.

7. Outputs:

The following two sections respectively list the presentations, and publications that have resulted from the study up to this point.

A. Presentations:

1. UC Division of Agricultural and Natural Resources Enology and Viticulture Work Group Annual Meeting, lecture on "Ergonomic Evaluation of Trellis Systems". March 28, 2001
2. American Society of Agricultural Engineers Annual International Meeting, lecture on "Ergonomic Evaluation of California Winegrape Trellis Systems." Chicago, IL, July 30, 2002
3. Lucien Brouha Work Physiology Symposium, lecture on “The Use of Direct Measurements to Assess MSD Risks in Manual Agricultural Work.” Sacramento, CA, September 12, 2002
4. Health and Safety in Western Agriculture Conference, lecture on “Agricultural Ergonomics Research Activities in California”, Coeur d’Alene, Idaho, September 18, 2002.
5. Invited lecture on “Ergonomics, Occupational Biomechanics and Musculoskeletal Disorders in Agricultural Environments,” at the Agricultural Health and Safety Symposium- Oregon Health Sciences University- March 18, 2002.
6. Invited lecture on "Agricultural Ergonomics Research in California," at the Ohio State University Institute for Ergonomics- Guest Lecture Series- May 31, 2002.
7. 2003 State-of-the-Art Research (STAR) Symposium: Perspectives on Musculoskeletal Disorder Causation and Control, poster presentation on “Ergonomic Interventions in Various California Agricultural Industries.” Columbus, OH, May 21, 2003
8. National Occupational Research Agenda Symposium- 2003: Working Partnerships: Applying Research to Practice, lecture on “Risks of Musculoskeletal Disorders in California Winegrape Trellis Systems.” Arlington, VA, June 23, 2003
9. Triennial Congress of the International Ergonomics Association, lecture on “Ergonomic Evaluation of Pruning and Harvesting Tasks of Winegrape Trellis Systems.” Seoul, Korea, August 26, 2003

10. Health and Safety in Western Agriculture Conference, lecture on "Ergonomics in Agriculture." San Francisco, CA, September 9, 2003
11. Western Occupational Health Conference: Cultivating New Ideas, lecture on "Agricultural/Occupational Musculoskeletal Disorders." Napa, CA, September 18, 2004.
12. University of Michigan/University of California short course on Preventing Disability in the Workplace: Ergonomic Evaluation and Design of Tools, Workstations and Tasks, lecture on "Case Studies: Workplace Design for Prevention of Low Back Pain in Agriculture." South San Francisco, CA, Dec 4, 2003
13. 2004 National Symposium on Agricultural Health and Safety: Creating Partnerships Across Multiple Disciplines, lecture on "Ergonomic Evaluation of California Winegrape Trellis Systems." Keystone, CO, June 23, 2004

B. Publications:

1. Kato, A. E., F. A. Fathallah, J. A. Miles, J. M. Meyers, J. Faucett, I. Janowitz, and E. G. Garcia (2006). Ergonomic evaluation of pruning California winegrape trellis systems. *Journal of Agricultural Safety and Health*,12(1), 17-28.
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8. Outcomes:

Implementing the recommendations that stemmed for the study's significant findings should help reduce the likelihood of developing musculoskeletal disorders of the lower back and the upper extremities among vineyard workers. It should be emphasized that these recommendations should be coupled with previous recommendations that resulted from a recently completed vineyard project by our group, which focused on finding interventions for reducing MSD risks during the lifting, carrying, and dumping phases of the harvest task. These phases are believed to pause the highest risk to workers for developing low back disorders.

Cooperating wineries and vineyard companies and their workers received information on the project and its results through participation in regular meetings. Other industry audiences were reached during the project by staff presentation at regular industry update meetings, and through several state and national industry presentations. Several industry publications have been published, or are in press, outlining the study's main findings. Throughout the project, the team met with staff of California OSHA Education and Training team and State Compensation Insurance Fund to help further disseminate the study's recommendations.

Community Partners for Healthy Farming Vineyard Harvest Ergonomics Intervention Partnership Project
R01 OH003906
John Miles
University of California, Davis

1. Definition of the problem being addressed (e.g., number of workers affected; rates of injury, illness, or fatality; hazards)

The California vineyard industry employs more than 80,000 total workers per year and their number is increasing annually. According to AgSafe (1992) vineyard workers experienced a rate for reported non-fatal injuries of about 4.3 per 100 workers per year in the 1981-1990 period. Underestimate though this may be, it still puts vineyard work will among the State's most hazardous commodities. AgSafe (1992), estimated that 42% of all reported non-fatal disabling injuries in vineyard work were sprains and strains, of which 41% were said to be back injuries. Reported causes emphasized overexertion at about 23%.

Based on this information, in 1996 the U.C. Agricultural Ergonomics Research Center initiated a general winegrape vineyard ergonomics research project with funding from the NIOSH Community Partners for Healthy Farming program. The research team reviewed cooperating vineyard's health records finding significant evidence of MSDs. Records for 3 cooperators representing 194 permanent workers showed 29 MSDs for 28 employees representing 435 lost workdays. This suggests an annual incidence rate for MSDs of 8.0 per 100 workers. Back injuries predominated type (n=20) while causes were distributed across a variety of seasonal tasks. California worker's compensation insurers report that claims and costs per payroll unit have increased steadily in recent years among vineyards for back injuries.

2. Aims of the project (major objectives for the period of the work)

Our target population for this work will be farm workers working in vineyard harvest. In doing so, the project has four overall goals, to:

a. improve prevention of musculoskeletal disorders among vineyard hand harvest workers;
b. demonstrate the efficacy of ergonomics methods to prevent injuries in field agriculture;
c. bring about acceptance and adoption of new harvest grape handling systems among both workers and owners/operators; and
d. add to research knowledge about ergonomics approaches to agricultural injury control.

3. Partners (participants in the project and the roles they served)

Four wine companies and one winegrape vineyard management company formally cooperated in this project. They provided advice, access to workers and the workplace.

Farm workers were a cooperating target group as well. Over 300 farm workers participated in project management and in all field trials and decision-making. They provided all health results data.

UC Cooperative Extension Farm Advisors in Napa and Sonoma counties participated in research design, data collection and analysis, and in providing access to grower participants. They also assisted with information dissemination to the industry.

AgSafe – A California professional organization dedicated to improved workplace safety in agriculture. Providing advice and industry communication.

California Farm Bureau – Providing advice and industry communication.

California State Compensation Insurance Fund – California's largest worker's compensation insurer. Providing advice, industry communication, and financial support to field studies.

4. Customers (intended users or beneficiaries of the results)

Farmers and farmworkers involved in winegrape hand harvest.

5. Approach (tasks involved in conducting the project)

Goal 1 Improve prevention of musculoskeletal disorders among vineyard hand harvest workers.

Specific aims under this goal included:

- Cooperatively assess the incidence of MSDs and MSD symptoms associated with harvest work among participating winegrape vineyard workers.
- Cooperatively apply biomechanical, metabolic, and postural stress analyses to manual handling of cut grapes during harvest.
- Cooperatively apply biomechanical, metabolic, and postural analysis to interventions.
- Cooperatively plan and conduct intervention trials with owner/operators and workers.
- Cooperatively measure post-intervention indication of impact of interventions on incidence of musculoskeletal disorders and symptoms with involved workers.
- Cooperatively evaluate intervention trials and compare with pre-intervention data.

Goal 2 Demonstrate the efficacy of ergonomics methods to prevent injuries in field agriculture.

Specific Aims stated under this goal included:

- Confirm cooperating partners from vineyard industry and community groups.
- Cooperatively assess productivity impacts and "adoptability" of interventions

Goal 3 Bring about acceptance of new harvest grape handling systems among both workers and owners/operators.

The Specific Aims for this goal were:

- Cooperatively plan and conduct intervention trials with owner/operators and workers.
- Cooperatively measure post-intervention indication of impact of interventions on incidence of musculoskeletal disorders and symptoms with involved workers.
- Communicate project findings to vineyard and other agricultural industry groups, to workers, and to community interests

Goal 4 Add to research knowledge about ergonomics approaches to agricultural injury control.

• Report project findings in appropriate research and professional publications.

6. Results/Findings (preliminary or final observations and conclusions)

This project had four primary goals. All were successfully achieved.

Goal 1.1 Cooperatively demonstrate application of ergonomics methods in field agriculture.
The first goal was readily achieved. Industry cooperators were found who were knowledgeable and concerned about the problem of musculoskeletal disorders in their workforce. These cooperators, more than 25 manager/supervisors and more than 200 workers, were open to the use of new methods of addressing the problem. As they came to understand the ergonomics methods being employed and to see resulting tool and task changes develop, their interest grew correspondingly and they became full participants, suggesting ideas and changes of their own. Because the project was successful in initiating change to the small picking tub, and because workers and supervisors found it to be an improved tool in practice, their acceptance of and confidence in ergonomics approaches has grown further. This is an important accomplishment within the larger agricultural industry which remains suspicious of the CAL OSHA ergonomics standard and what it often sees as an overly complicated approach to injury prevention.

This audience's confidence in the methods demonstrated in this project may be best shown in the fact that all have agreed to participate in a follow-up project to investigate alternatives to manual handling of cut grapes during harvest with the same team of investigators.

While this sample of vineyards was not randomly selected and may be not fully generalizable to the industry, still a suggested rate of incidence of MSDs of 80 per 1000 workers per year should be taken as an indication of priority need. This is well above the rates targeted by the US Public Health Service in Healthy People 2000 (Healthy People 2000, 1991; objective 10.2) of an incidence of no more than 60 per 100,000 workers. This confirms years of anecdotal evidence that field agricultural jobs are physically demanding and take a physical toll. They also confirm our belief that the large proportion of sprain/strain reported injury types and overexertion reported as injury cause are indicative of high MSD incidence. More than that, they help explain why we see so few workers performing these jobs beyond age 35. They help explain the apparent age-related migration out of field agricultural work by older workers. They also raise our concern that we will find similar indicated MSD rates in other agricultural field jobs.

Goal 1.2 Improve prevention of high risk musculoskeletal injuries among vineyard workers.
Our second goal, to improve prevention of MSDs in vineyard work, has also been successfully achieved. Manual winegrape harvest is highly strenuous and physically demanding work, involving exposure to serious risk factors for MSD development. This is shown in the large increase in pain and symptoms over the harvest period and the observation that up to 80% of workers reported MSD symptoms on the 1997 (non-intervention) post-harvest survey.

Harvest work involves all three of the priority risk factors we have observed in other agricultural work: full body stooped posture, highly repetitive hand work; and manual lifting and carrying of heavy loads (57# and up to 70# or more). The substitution of the smaller picking tub reduced

weights handled from a season average 57 pounds to a season average of 46 pounds. This resulted in an improved NIOSH Lifting Equation outcome from 3.4 to 2.4. Furthermore, it was achieved with a small decrease in the task's very high energy demand (from 47.7% to 45%). Most significantly, MSD pain and symptom development over the course of the 1998 (intervention trial) harvest was measured at levels of 50% or more reduction. Both areas of significant force application related to the tub, back and knee, showed seasonal pain and symptom reductions of 50%. Finally, use of smaller picking tubs to lighten loads lifted and carried to below 50 lbs (from 57 to 46 lbs) was shown to result in up to 5-fold reductions in workers' post-season MSD pain and symptom scores ($p<.001$).

These are large magnitude health outcomes by any measure. While the harvest job still involves serious risk factor exposures and remains a demanding job, this is a level of health outcome that proved observable to participating workers in the course of the harvest.

Equally important, the workers accept the use of the smaller tub, whose investment in such change is critical to long-term intervention success. The smaller tub does result in a 2.5% decrease in worker productivity as measured by pounds of grapes per shift. However, this was not noted by either workers or managers until identified by research staff. Because workers are paid on incentive rate rather than time, this decrease proved of minor interest to managers. Because workers prefer the smaller tub for its easier manageability and carrying ease, they did not find the productivity increase as of critical interest either.

All of the companies cooperating in this project have permanently adopted the smaller picking tub and we believe it will disseminate over time throughout the Napa and Sonoma region. These tubs are commercially available and all indications suggest that they will disseminate throughout the Napa and Sonoma Counties region over the next 3-5 years.

The results of the pilot powered pruning trial were similarly positive and with follow-up in another demonstration trial should show similar results. Despite the small trial sample, there is little question that the powered pruner eliminates repetitive hand closure and helps reduce MSD symptoms. However, use of current commercially available versions of the powered pruner requires reorganization of the pruning crew's tasks to equal productivity of hand pruning. This is a disincentive to adopt the technology despite its demonstrated health benefits. There were also questions raised in this pilot about the powered pruner's productivity effectiveness on trellised vines. Finally, at some $1400 a pair, cost remains a disincentive as well. As a result, while the powered pruner holds hope for improvement of this task, it is far too early to endorse it as a fully appropriate tool.

Goal 1.3 Increase the understanding of musculoskeletal disorders and ergonomic methods among vineyard owner/operators, workers, and the agricultural community in general.
The project's success in readily communicating the fundamentals of ergonomics and methods for approaching their application in agricultural field settings with both manager/supervisors and workers makes clear that if efforts could be expanded, progress in reducing MSD incidence among agricultural workers could be achieved with some economy. While this audience is at first often skeptical about ergonomics, and is generally opposed to regulation, practical efforts based on cooperative field demonstrations are an effective means of increasing understanding

and willingness to consider recommended job and tool changes seriously. This project was able to bring about increased understanding and improved attitudes toward ergonomics methods and approaches with over 2,000 workers, supervisors and managers. With reinforcing and follow-up communication, we believe that the small tubs will be successfully disseminated throughout the region in a very few years.

GOAL 1.4 Add to research knowledge about ergonomics approaches to agricultural injury control.

The project's are important beyond their verification that application of ergonomics methods to field agriculture is at least as effective as it has been shown to be in industrial settings in improving MSD symptom reduction or prevention without productivity costs. These results will be appropriately published. Even before the project's completion investigators and staff had made eight presentations to academic research groups at the national level. With final analysis complete, peer reviewed publications are underway.

There are at least four findings here which have importance to the research community in this area. First, we believe that this study's findings may provide the first field results supporting the emergent notion that there is a threshold effect to reduction of loads handled below 50 pounds. That is, lowering weights handled below 50 pounds appears to have more significant preventive effect than might be suggested by the amount of the actual weight reduction itself. In this study, we reduced average weights from 57 to 46 pounds. In return we achieved up to a 5-fold reduction in measured symptomatology. A result that would seem excessive in light of the mere 11 pound reduction. If there is indeed a threshold effect on the human body of loads either exceeding or below 50 pounds, this would have important implication for both policy and field practice.

Second, we believe that the results achieved here indicate that much work is needed and is readily achievable to dramatically improve prevention of musculoskeletal disorders among agricultural workers with commodity specific, cooperative efforts. There has been some tendency among funders to believe that such results can be achieved more economically through informational programs. However, the experience of this and of our previous projects continues to point to the fact that conceptually proven interventions require specific redesign or fitting to specific agricultural commodities and that doing so without commitment of engineering research resources is generally unproductive. The notion that intervention concepts will travel from other industries to agricultural practice without specific engineering modification or adaptation has proven false in our work to date.

Third, these results provide further evidence for the continuing under-realized opportunity for intervention in these jobs using small tools. For the past several decades, engineering development in agriculture has concentrated on large machines, leaving small tools used throughout the industry largely untouched and unconsidered. It is time to take another look at many of the jobs and tasks which are routine in agriculture and which are largely taken for granted as immutable.

Fourth, we believe that Dr. Faucett's innovative instrument for measuring MSD pain and symptoms is further demonstrated to provide a sensitive and reliable means of assessing MSD

health effects resulting from short term intervention trial. This is not an insignificant issue in field ergonomics research. Studies are typically funded in the three year range, which is most often too short a period to see significant reduction in reported or diagnosed MSDs. While the use of symptom surveys is not new, their successful adaptation for practical and reliable use with Spanish speaking farm workers and the extension of measured symptoms to include self treatment are both useful contributions in this area.

7. Outputs (reports, publications, products, methods, etc.)

Farm Worker Community Information

The project reached an audience of more than 2,500 farm workers and family members in the Napa-Sonoma Counties region with information on MSDs, back injuries and their prevention during the course of the project. Workers in the Napa-Sonoma Counties region were largely informed through Spanish language media and various workers' services organizations. Because the primary intervention focused on back injury hazards and harvest work, harvest periods were the targeted communication periods. In 1998 1500 copies of information on MSDs related to backs were disseminated regionally through 22 community organizations. In 1999, 1250 copies of fliers specific to the grape harvest use of smaller tubs and about MSDs of the back were disseminated through the same group of cooperating community organizations. A number of poster versions of the fliers were also made and disseminated for display. In addition, the UC Spanish Media & Broadcast Services disseminated a Spanish language statewide press release summarizing the information (160 media statewide recipients covering both print and electronic media).

Industry Community

The bi-county industry community, consisting of more than 250 wineries, was provided with regular updates on the project by Cooperativ Extension Advisors on both individual and community scales. Project investigators also participated annually at regional industry meetings. Other state and national industry presentations included:

Meyers, J, High Risk Tasks for MSD's in Agricultural Field Work (1999) Presented at NIOSH/NORA Industry Meeting, Houston, TX

Meyers, J, Ergonomics Interventions Prevent Back Injuries (1999) Presented at 9th Annual Western Migrant Stream Forum, San Diego, CA

Meyers, J, High Risk Tasks for MSD's in Agricultural Field Work (1998) Presented at 8th Annual Western Migrant Stream Forum, Sacramento, CA

Meyers, J, (1998) Ergonomics Risk Factors in Wine Grape Vineyard Work, Presented at California Agricultural Safety Institute, Cal Poly, San Luis Obispo, CA

Meyers, J, (1999) Ergonomics Approaches to Prevention of MSDs in Wine Grape Work, Presented at California Agricultural Safety Institute, Cal Poly, San Luis Obispo, CA

Miles, J, Meyers, J, (1998) Ergonomics Approaches to Tool and Task Modification in Agricultural Field Work. Presented at AgSafe, Visalia, CA

Faucett J. (2000) World Affairs Council. Women, work, health, & quality of life: Rural work. Aired on National Public Radio, September 16, 2000.

Miles, J, Meyers, J, Ergonomics in Winegrape Vineyard Work. (1998) Presented at California Farm Bureau Federation Vineyard Commodity Meeting, Sacramento, CA

Duraj, V, Janowitz, I, Tejeda, D, Vineyard Ergonomics Equipment Demonstrations (1999) COEH 12th Annual Occupational Safety & Health Institute, Division for Materials Handling Analysis & Ergonomics Interventions, Berkeley, CA

One article was publication in the industry journal, Practical Winery and Vineyard, June 2000. Another article was published in the industry journal, American Vineyar, June 2001. The project's ergonomics interventions were also featured in a NIOSH national publication, "Simple solutions, released in 2000.

Research

Twelve papers and presentations to research audiences:

Faucett, J, Miles, J, Meyers, J, Janowitz, I (1998) UE Musculoskeletal Symptoms in Agricultural Jobs. San Francisco. International Conference on Occupational Disorders of the Upper Extremities (Sponsors: UCSF/University of Michigan).

Faucett, J, Miles, J., Meyers. J., & Janowitz, I. (1998) Cultural issues in the assessment of work-related pain. International Occupational Health & Environmental Health Nurses Conference, Royal College of Nursing & American Association of Occuptional Health Nurses, Eastbourne UK.

Meyers, J, Miles, J, Faucett, J, Janowitz, J, Tejeda, D, Weber, E, Smith, R, Garcia, L. (1998) Ergonomics Risk Factors for Musculoskeletal Disorder in Wine Grape Vineyard Work. Presented at National Institute for Farm Safety, Winnipeg, Canada.

Miles JA, Meyers JM, Faucett J, Janowitz I, Tejeda DG, Weber E, Smith R, Garcia L. (1998) Ergonomics Risk Factors in Labor Intensive Agricultural Work. Presented at 4th International Symposium, Centre for Agricultural Medicine, University of Saskatchewan, Saskatoon, Canada

Meyers, J. (1998) The Problem of Musculoskeletal Disorders in Agricultural Field Work. Presented at Research, Education & Extension Service Symposium, USDA, Washington, DC

Duraj,V, Miles J and Meyers,J (1999) Development of a Conveyor-based loading System for Manual Harvest of Winegrapes Presented ASAE Toronto Canada July 18-21,1999.

Meyers, J., Faucett, J., Miles, J., Janowitz, I., Tejeda, D.,Duraj,V., Smith, R., and Weber, E. (1999). Effect of Reduced Load Weights on Musculoskeletal Disorder Symptoms in Wine Grape Harvest Work. Presented at the American Public Health Association Nov. 9.

Miles,J. (1999) Research Priorities for NORA from Agricultural Ergonomics. Presented at NIOSH/NORA Research Meeting, Houston, TX

Faucett, J. (2000) Bridging culture, education and language differences: Developing assessment tools for immigrant workers. Northern California

Association of Occupational Health Nurses, Asilomar.

Meyers, J, Miles, J, Faucett, J, Janowitz, I, Tejeda, D, Weber, E, Smith, R, Garcia, L. (2002) Priority risk factors for back injury in agricultural field work: Vineyard ergonomics. Journal of Agromedicine, (1), 37-52.

Meyers, J, Miles, J, Faucett, J, Janowitz, I, Tejeda, D, Weber, E, Smith, R, Garcia, L. (2001). Priority Risk Factors for Back Injury in Agricultural Field Work. Journal of Agromedicine. V8(1):37-52.

Faucett, J, Meyers, J, Tejeda, D, Janowitz, I, Miles, J, Kabashima, J. (2001). An Instrument to Measure Musculoskeletal Symptoms Among Immigrant Hispanic Farmworkers: Validation in the Nursery Industry. Journal of Agricultural Safety and Health. V7(3): 185-198

8. Outcomes (how outputs have been used, e.g. change in behaviors, processes, technologies, guidelines, etc. that have made a difference in measurable endpoints related to exposures or health and safety indicators)

Small winegrape picking tubs of the type used in this study have become the majority used in the Napa and Sonoma counties hand harvest in the years since the study. No follow-up study has been made to determine resulting reduction of back injury incidence.

Training Project Grant: Commercial Fishing Safety Training in Alaska: 1993- 2006
Grant Number: T15OH008631
Principal Investigator: Jerry Dzugan
Institution: Alaska Marine Safety Education Association (AMSEA)
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1. Definition of the problem being addressed (e.g., number of workers affected; rates of injury, illness, or fatality; hazards)

The problem being addressed is the high rate of fatalities among commercial fishermen in Alaska. This program has also had an impact on fishermen outside of Alaska who may also fish in Alaska waters. According to the U.S. Department of Labor, commercial fishing has had the highest fatality rates of any major occupation in the U.S., for most of the last 20 years. Commercial fishermen have fatality rates 7 times greater than the average of all industries, and higher than policemen and firemen. By the end of the 1990's, the Alaska fatality rate was 120/100,000 workers.

Approximately, 25% of fatalities are caused by man overboard, 25% from capsizings, 25% from vessel sinkings and 25% from other causes such as deck injuries, fire etc. 86% of fatalities are due to fishermen ending up in the water without protective equipment and drowning or hypothermic (Lincoln, 2000). This roughly follows the national statistics on causes and varies only slightly year to year.

In 2005, there were 10,037 licensed commercial fishing vessels fishing in Alaska waters. In this same year there were 28,267 individuals in Alaska with a commercial fishing license (Alaska Department Fish & Game website). Converted to Full Time Equivalents (FTEs) this would be a workforce of 17,500 (Lincoln, 2000). In the U.S. today, there is estimated to be about 80,000 vessels with a total of over 230,000 commercial fishermen. Many of these fishermen are part time or temporary so these are not full time equivalent positions.

The eight-year hospitalization rate for injuries to Alaska fishermen ending in 1998, was 410/100,000 FTE (Thomas, 2001). Non-hospitalized injury rates are not well documented and underreported.

The hazards fishermen are exposed to involve working for uncertain payment around industrial equipment designed to kill, cut and eviscerate fish, in a small cramped noisy boat there is no walking away from, in a cold damp environment, performing repetitive tasks on a moving platform that is subject to pitching and yawing in 25 to 45 foot seas, and working 18 to 20 hours a day for weeks at a time with no weekend or holiday off.

2. Aims of the project (major objectives for the period of the work)

The major aim of this project was to conduct Marine Safety Instructor Training (MSIT)

train-the-trainer courses to build a network of port based Marine Safety Instructors who could deliver federally required Emergency Drill Conductor (EDC) safety courses to fishermen in Alaska who are geographically far flung and who would not have had accessibility to this training. The goal was generally to train 250 fishermen in EDC courses and train 20 new Marine Safety Instructors, in every year of this project. These goals have been exceeded and to date over 6,600 EDCs have been trained over the past 13 years.

3. **Partners (participants in the project and the roles they served)**

The NIOSH Anchorage Field Station served a key role in the surveillance on this project and documenting training effectiveness and fatalities. The Coast Guard served another key role in the development and enforcement of safety training requirements as well as educating fishermen in requirements. At times, they even delivered the training

Representatives from AMSEA's Board of Directors represented commercial fishermen and agencies such as the Coast Guard, University of Alaska, Native Tribal Health Corporations and State Troopers, who gave guidance and oversight to key aspects of this project when curriculum and training materials were developed.

The Alaska Vocational Technical Center (AVTEC), Alaska Department of Public Safety, University of Alaska, Northern SE Aquaculture Association and numerous communities, provided classroom and instructional resources.

The U.S. Marine Safety Association and its marine safety retailers and service stations, provided marine safety training equipment and technical expertise. The Coast Guard airstation in Sitka and Kodiak Alaska, as well as other stations around the U.S., provided technical expertise and training using their search and rescue equipment. Scores of public and private school teachers have introduced this curriculum into their schools and have integrated it into their programs.

The National Transportation Safety Board and Coast Guard have produced casualty investigations that have been used to develop training materials and "lessons learned". Native Health Corporations have had their injury prevention staff trained to deliver parts of the marine safety curriculum to their villages. Commercial fishermen have offered their boats for use in training, and contributed their knowledge and experience to make the training both practical and relevant to other fishermen. Commercial fishing organizations have helped in the recruitment, promotion and facilitation of the training in this project.

4. **Customers (intended users or beneficiaries of the results)**

The target audience (customers) of this project are commercial fishermen. Although the primary target was commercial fishermen who fished Alaska waters, hundreds of fishermen on all U.S. coasts, including Hawaii and American Samoa, have benefited from this training at no cost to this project. These fishermen operate vessels from 18 to

500 feet in length.

5. **Approach (tasks involved in conducting the project)**

The primary task in this project was to develop a port based marine safety instructor network that could provide EDC or general marine safety workshops to fishermen who are widely dispersed in Alaska and for whom travel to a centralized training location would be expensive or prohibitive. Most fishing ports in Alaska are not connected by road. Yet the distance from the fishing ports of Ketchikan and Adak, Alaska, is the same as from Florida to California. Thus is was deemed more cost effective to develop a port based training infrastructure, and recruit fishermen or others knowledgeable about marine safety, who had local knowledge and credibility, to deliver this training.

These Marine Safety Instructors train Emergency Drill Conductors, who are responsible for conducting monthly emergency drills onboard fishing vessels covering the emergencies of man overboard, flooding, fire and abandon ship. Coast Guard, National Transportation Safety Board and survivor interviews have demonstrated that the failure to have or properly use survival equipment was a major cause of fatalities.

In addition, AMSEA developed and regularly updates a marine safety curriculum to provide current and “best” information in safety procedures. Along with this curriculum, AMSEA has developed instructional aids such as books, brochures, power point presentations, video and DVDs and other instructional tools that these instructors can use.

In addition, AMSEA keeps an inventory of larger more expensive training equipment such as liferafts and immersion suits that it sends to instructors teaching in these ports. AMSEA then maintains this gear and reissues it for training by other instructors. This greatly reduces the expense of this training for fishermen.

AMSEA also provides training guidelines to ensure that the training is conducted safely and effectively. AMSEA promotes and markets courses for fishermen and assists in troubleshooting and facilitating courses. In addition, AMSEA has a very active network of school teachers and educators who provide marine safety training in the schools, since in many of these ports, children are on commercial fishing vessel from infancy until they grow up and take over the family fishing operation themselves.

6. **Results/Findings (preliminary or final observations and conclusions)**

There is much anecdotal information obtained from survivor interviews, that demonstrates that informational and or skills learned in the training in this project, helped survivors in an emergency at sea. A study early in this project (Perkins, 1995) demonstrated that the chances of surviving an emergency at sea were much higher if the fishermen had taken the AMSEA safety training in this project (p=0.021). More recently, Lincoln in a yet unpublished study has documented that the protective value of this training is double that of persons without this training.

It is significant that Alaska has had more EDC training offered (more than 600 courses in over 60 Alaskan ports) than in any other part of the nation. It is also significant that Alaska has also seen the largest benefit in the greatest decrease of fatalities of any region in the nation: a 65% decrease from an average of 37 fatalities a year before this project started, to the latest 5 year average of 13 fatalities a year.

7. Outputs (reports, publications, products, methods, etc.)

Numerous publications have resulted from this project. The 450 page *Marine Safety Instructor-training manual* is in its 8th edition. This manual has been used to develop the national standard EDC course. The 244 page book *Beating the Odds on Northern Waters* is in its 5th edition and has been distributed to well over 10,000 fishermen. Brochures on deck safety, damage control, fishing safely with children onboard and commercial dive harvest safety have been produced and distributed. Six videos/DVDs have been produced on fishing vessel safety on immersion suit care, how to conduct safety drills, liferaft survival, helicopter rescue, stability and dive harvest safety. These DVDs have also been translated into Spanish and Vietnamese. These ethnic groups have a large representation in commercial fisheries in the U.S. The *Marine Safety Update* is distributed to over 1,500 fishermen 3 or 4 times a year with updated marine safety articles addressing specific marine safety problems to fishermen. In addition, numerous articles have been published in fishing industry journals on marine safety and a website is maintained (www.amsea.org) with articles on marine safety. Papers on fishing vessel safety have also been presented at national and international conferences.

8. Outcomes (how outputs have been used, e.g. change in behaviors, processes, technologies, guidelines, etc. that have made a difference in measurable endpoints related to exposures or health and safety indicators.

During the time of this project, a change in safety culture has occurred in commercial fishing. Previous to this project, safety drills were rarely conducted and it was normal for vessels to be lost (F/V Aleutian Enterprise, F/V Wayward Wind, F/V Uyak II) without the benefit of crew training in survival equipment or emergency procedures. In fact, even the discussion of what to do in an emergency was a topic that was avoided onboard many vessels.

Currently, at least 18% of fishery observer boats on the west coast report conducting regular monthly drills (Cullenberg, 2000). Since observers usually do not spend an entire month onboard a vessel, they are underreporting the frequency of these monthly drills. Safety drills being conducted onboard vessels in the harbor and underway are a common occurrence, and discussions of safety related matters among fishermen is no longer a topic that is avoided. During this time a change in behavior has been observed from observed behavior on the dock to the section of the Magnuson-Stevens Act which guides fisheries management and which states that safety must be a consideration when determining fisheries management regimes.

By the year 2000, a significant (p=<0.001) decrease in Alaskan commercial fishing

deaths had been evidenced (Lincoln et al, 2000). The fatality rate in the early 1990's was 200/100,000. By the end of the decade it had been reduced to 124/100,000 (Lincoln et al, 2000). Before this project, it was typical to loss 3 to 5 fishing vessels in Alaska every year with part or all of its crew. Currently, there is an average of about one vessel per year lost in Alaska with its entire crew. This reduction indicates better use of survival equipment and more familiarity with emergency procedures. Further evidence of survivability is seen by the fact that although the number of vessel losses has decreased by 50%, from the early to late 1990s, the survivability of crewmembers is even higher (66%).

Even the fact that the number of vessels that has been lost has been greatly decreased is significant. Although it is difficult to quantify a change in attitude, one of the most frequent comments written on EDC course evaluations, is the changes the participant plans to make in the safety of the vessel, either by conducting more thorough emergency drills and/or through the addition of new safety equipment.

Over 6,600 commercial fishermen have been given and practiced guidelines in conducting effective emergency drills through the hands on training in this project. Thousands of other fishermen have been exposed to the publications and videos that this project has produced. Scores of anecdotal incidents in which survivors have stated how the training helped them in an emergency, or helped them avoid an emergency, have been collected during interviews with fishermen. The AMSEA model that this project has supported has been solicited by the state of Maine, and by other areas of the nation, as a model for a successful intervention method to bring safety training to other fishing ports of the U.S. so that they can benefit as Alaska has from a decrease in fatalities.

The work in this project is not over, however. There are new entrants into fisheries and management regimes change, which bring in new and often unanticipated safety problems. Emerging fisheries in western Alaska include smaller boats working further from shore in hazardous waters. However a safety training network is now in place, and these new fisheries are taking advantage of the safety training in this project, and a safety culture is emerging along with these new fisheries. Perhaps the most important outcome of this project however, is that safety training has been positively embraced by most commercial fishermen in Alaska, and fishermen are more open to improvements in safety than this author has seen in the 26 years he has been involved in commercial fishing. The lessening of the fatality rate over the term of this project bears witness to this positive change in safety culture in the commercial fishing industry.