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IMPLEMENTING THE CALIFORNIA ERGONOMICS STANDARD IN AGRICULTURAL OPERATIONS

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SUMMARY:

In 1997 California promulgated the Nation's first workplace ergonomics standard. It requires affected employers to implement a program to minimize repetitive motion injuries including: worksite evaluation, control of exposures causing injury and employee training. In 1998, the UC Agricultural Ergonomics Research Center launched a NIOSH-funded effort (PHS-CCU912911) to study the impact of the ergonomics program in agricultural operations. Results to date suggest that employers may have difficulty independently implementing the standard in ways that will significantly reduce targeted exposures. Barriers include: tendency to focus on marginal interventions for reasons of cost and technical difficulty; lack of off-the-shelf, proven intervention technologies for common risk factors; lack of experience with worker-management shared decision-making; and structural separation between safety and operations management.

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INTRODUCTION

On July 3, 1997, California OSHA implemented the nation's first workplace ergonomics standard. This standard was highly controversial with both labor and employers' advocates. What was less clear was what real effect it was to have on improving prevention of repetitive motion injuries or musculoskeletal disorders (MSDs). The heart of the California ergonomics standard is a requirement that subject employers implement a three-part ergonomics program. Employers experiencing two or more medically diagnosed "repetitive motion injuries" (California OSHA, 1997) in a 12-month period among workers performing the same job must:

1. conduct an evaluation of worksite ergonomic hazards;
2. implement feasible hazard exposure controls; and
3. provide employee training on repetitive motion injuries and their prevention (California OSHA, 1997).

This was the nation's first such standard and is viewed by Cal OSHA as a performance standard (as opposed to a design or specification standard). As a result, there were (and are) no clear prescriptions for compliance in detail (in particular, there are no specific controls prescribed for step 2). Instead, employers are expected implement the steps in such manner that the problem is resolved. Many employers have cited this as troublesome, and there has been concern that not being given industry-specific intervention prescriptions might lead some to decide to either not comply or to comply with minimal involvement and largely ineffective outcomes. In fact, a similar pattern of experience was observed following California OSHA's 1990 requirement that all workplaces with more than 9 employees have a formal, written injury and illness prevention program. Not having such a plan remains the most frequent basis for citation among agricultural employers, despite the eventual publication of a variety of model plans. Further, among those employers implementing plans, there is predominant emphasis on worker safety training, most often at the expense of consistent hazard identification and control efforts.

Federal OSHA has considered the feasibility of (and even attempted) a national workplace ergonomics standard for several years with substantial controversy. Observers around the country are watching the California OSHA program to see if this approach to ergonomics regulation will result in both effective injury prevention and practical demands on subject employers.

Unlike the proposed federal standard, agricultural operations are not excluded from the California standard. With respect to agricultural workplaces, many questions and concerns were voiced from the outset. Can model programs be developed which will fit the wide variability of tasks, commodities, and equipment involved in agricultural operations? Where are employers and workers to look for examples of "feasible" controls for the diverse situations in agriculture? Will such programs work effectively in the largely unorganized workplaces found in most of agriculture? What levels and types of preventive effectiveness should be expected of such programs?

In 1998 the University of California Agricultural Ergonomics Research Center (AERC) initiated a research project supported by NIOSH (PHS-CCU912911-01) with cooperating employers in differing commodity areas to begin to provide answers to some of the above questions. The project was framed as an intervention trial, using compliance with the California OSHA standard as the generic intervention. Center researchers worked with worksite ergonomics committees to implement the requirements of the standard and to assess outcomes. The goal of this project was to assess the efficacy of "best practices" designed ergonomics programs to reduce incidence of musculoskeletal disorders and their symptoms in differing agricultural operations.

Because this study is still underway and final data has not yet been collected or analyzed, the focus here is on description and analysis of how agricultural employers implemented the repetitive stress injury standard.

METHODS

The study is designed as a pre- post-intervention trial with workers serving as their own controls in the pre-intervention conditions. The project focuses on differing types of agricultural operations to explore the issues presented by the diversity of commodities, workplaces, and tasks involved in the industry. Cooperating operations were recruited with assistance from the California State Compensation Insurance Fund. Three are reported on here: a mid-sized packing house; a large cotton grower; a small strawberry grower. These operations represent the breadth of California agricultural operations with focus on those known to have histories of reported employee MSDs. Most employees are Mexican farmworkers, with the majority resident in local communities. For the most part workers involved had limited English, being fluent in Spanish. Workers participating in pre- and post-intervention studies were those identified as regularly assigned to perform the task in question. Random selection of workers was not possible since many of the tasks require special skills or experience.

High risk jobs were identified by triangulating three types of data as follow: 1) operation health and safety records (data) for jobs associated with reported sprains, strains, and MSDs; 2) jobs identified by workers and supervisors as involving high risk factor exposure; and 3) data from risk factor checksheet evaluation of all jobs in workplace. Comparison of the results allowed identification of jobs with highest reported or probable risk of MSD incidence. These high risk jobs were then videotaped and subjected to detailed risk factor analysis by Ergonomist Janowitz. The results were shared with Dr. Miles and the engineering group for use in considering risk factor control suggestions. Dr. Miles consulted with each committee and eventually a set of controls deemed feasible by operation managers were selected for intervention trial. Dr. Faucett then oversaw pre-intervention administration of pain and symptom surveys.

For the most part, actual intervention trial and post-intervention data collection occurred a year later during the same season in order to assess interventions in the same context as the pre-intervention data collection. In some cases there simply were no proven or fully adequate interventions to try. In those cases (strawberries) a variety of conceptual approaches were developed by the engineering team and subjected to field trial. In jobs where piece rate pay is a factor (strawberries), intervention occurred during the non-piece rate period.

Subsequent to each intervention trial, results were shared with cooperators and their committees undertook planning for the next cycle.

Cooperators

Three cooperators are the focus of this report.

1) A mid-sized citrus packing operation. Their work is seasonal, usually beginning in December and ending around late May. Freshly picked fruit (oranges) are brought to the facility and processed through an assembly line type of system for sorting, washing, grading, and finally packing in bags or boxes for loading on trucks. While the line is mechanically paced, workers standing at the side of conveyors perform most of the work by hand. This operation had evidence of diagnosed repetitive motion injuries (RMIs) in its health records.

2) A very large cotton growing operation. Their operation is seasonal (March/April through September) and involves ground preparation, planting, irrigation, weeding, pest control, harvest and delivery of raw cotton to cotton ginning operations. Increasingly tasks are mechanized and very large equipment is utilized in planting, harvest, etc. While machine operation jobs do involve numerous ergonomics risk factor exposures, in general they are neither as stressful nor as injury prone as manual jobs. However, some jobs remain manual. Weeding is one of these and was identified by the cooperator as the job of interest. This was supported by injury record and risk factor analyses.

3) A small strawberry growing operation. This work is highly seasonal, beginning in December and ending by June. The strawberry plants are grown in raised beds and must be replanted each season. Because of high plant disease risk, the beds are fumigated before planting. Jobs include ground preparation, planting, cultivation tasks, and harvesting. Virtually all work is performed by hand. The cooperator put very high priority on the hand harvesting job, which involves the most workers for the greatest time. This was supported by injury record and risk factor analyses.

Table 1 provides summary descriptive information on project cooperators.

Approach

Cooperating agricultural operations were volunteers, for the most part identified initially by workers' compensation insurance loss control agents working with them. No volunteering cooperator was refused, but a shared effort was made to identify cooperators representing diversity in operation size, commodity, and industry sector. Cooperators were required to appoint a special ergonomics committee with both worker and supervisorial representatives to work directly with the research team in implementing the standard. One of the intentions was to leave a trained and capable team with each cooperator upon project termination. While none of the cooperating employers resisted appointing a special ergonomics committee, none would likely have done so of their own initiative only.

Interaction with cooperator's ergonomics committees generally proceeded in 4 stages as follow:

1. Orientation and Training

This stage consisted of three meetings during which the committee was educated in the basics of ergonomics and repetitive motion injuries (RMI). During the first meeting the committee was oriented to the Cal OSHA standard and introduced to the concepts of ergonomics and ergonomics risk factors. During the second meeting the committee was introduced to the Quick Check risk factor checksheet and used it to analyze jobs at the worksite under supervision by the researchers. During the third meeting the committee was introduced to the nature of RMIs and analyzed the company's workplace safety records under the supervision of the researchers.

2. Evaluation of High Risk Jobs

In the second stage the committee reviewed three types of data in order to identify jobs with the highest risk for RMIs. First, data on workplace injuries was reviewed and jobs were ranked according to associated reported and diagnosed RMIs and for high and repeated incidence of strain and sprain injuries (these can be early stage RMIs). Second, data from the checksheet analysis of risk factor exposure was used to identify jobs with greatest exposures. Third, committee members solicited input from supervisors and workers to identify jobs that they found most physically demanding and hazardous. Jobs ranking high on each dimension were listed and those jobs appearing high on each list were identified as high risk jobs and priorities for intervention.

3. Training and Intervention

During this third phase, committees undertook design and provision of training on RMIs for workers as required. All of these cooperators utilized provided educational materials and provided worker training as part of their ongoing workplace safety program. Table 2 describes the workers involved in interventions.

Committees were also asked to meet with engineering researchers to consider various preventive intervention ideas for each of the targeted jobs. Because most high risk jobs involved exposure to multiple risk factors it was not always possible to design interventions that eliminated all problem exposures. The committees reviewed suggestions from the research team and contributed their own ideas. Once preferred intervention ideas were selected, committees communicated their suggestions to company management for approval. In those cases where no proven intervention could be readily identified, the committee and the team agreed on a set of pilot concepts to be tried. This was the case for the priority job of strawberry picker. Committees helped provide information to workers as required and helped with intervention trials. Table 3 summarizes target jobs and interventions subjected to trial.

4. Analysis of Results & Future Planning

Finally, the committees were convened to review the interventions. Committee members had their own assessments from the workers involved. The research team had its analysis of ergonomics risk factor reduction and data from the pre and post-intervention symptom surveys. Based on these data the committees were able to recommend either continuation or removal of interventions. Following this, they reviewed operation-wide risk information and determined what problems should have priority for intervention planning over the next 12 to 24 month planning period. Reports were added to written ergonomics safety records.

Materials

The research team provided all cooperators with the same educational and program implementation records materials. These informational materials are based on those used in prior cooperative ergonomics research projects. Training materials and musculoskeletal symptom surveys were translated into Spanish for use with workers.

Informational materials employ illustrated descriptions of ergonomics risk factors and examples of exposure control approaches. Specific informational sheets were developed describing the nature and development of musculoskeletal disorders and risk factors for employee training as required by the standard. An ergonomics program implementation guide and record was developed and used to orient employers and their ergonomics committees and to serve as written program records.

Cooperators' ergonomics committees were provided with and given instruction in the use of a simple workplace ergonomics risk factor screening checksheet. This checksheet has been used in all of our previous studies and yields quantitative scores that allow for ranking of multiple jobs in terms of their risk factor exposure severity. The checksheet is included as part of the ergonomics committee implementation guide.

Dr. Faucett and her team have developed a Spanish interview schedule that employs quantitative scales commonly used in pain and symptom research, but that are appropriately presented and tailored for low literacy Spanish speaking populations. The interview includes items to evaluate the severity, location, and duration of musculoskeletal symptoms and also items to assist with determining the work-relatedness of the symptoms. These instruments were used in our previous studies and were administered by trained, bi-lingual members of the research team.

Cooperators were not provided with exposure controls (with the exception of those provided for pilot testing only). Because compliance decision-making involves considerations of cost, hardware and practice changes, as well as other technology adoption factors, it was decided that cooperators must be left with the full responsibility of accepting or rejecting and paying the cost of exposure controls suggested.

Single copies of the informational materials used in this study can be requested from the lead author.

RESULTS

Because the study is not yet complete, data on the MSD preventive efficacy of interventions are not yet complete nor compiled and analyzed. However, information describing standard implementation in the three different types of operations is available.

Of special interest here is qualitative information describing management and worker response, acceptability of exposure control suggestions, observations of implementation strategies and difficulties, and initial ergonomics assessments of controls attempted. This information is strongly indicative of the types of barriers agricultural employers will face in implementing the California OSHA ergonomics standard. A summary follows presented by operation type.

Citrus Packing
Our citrus packing cooperator is a mid-sized operation. Their work is seasonal, usually beginning in December and ending around late May. Workers are paid on an hourly basis.

This committee functioned only with direct support from the research team. The company's safety manager (also personnel chief) participated in all meetings and personally took care of all communications to management. For the most part, committee members were experienced workers and usually second-generation farmworker immigrant family members who spoke excellent English. Despite their experience, committee members did not know how to function as a committee and were initially quite reticent about speaking during meetings. Even when the committee met to review results one year later, most member inputs came as responses to questions from research staff.

When the committee presented its priorities to management, the plant manager attended and declined to give a firm response about suggested exposure controls citing "reduced income" as a result of a severe freeze that season. The safety manager later relayed approval for controls to be implemented from management to the research team and committee. While the company had a physical plant maintenance crew it had no engineering staff and no one was assigned to assist with exposure control development. Maintenance staff made the physical plant changes called for, but were never provided direct interaction with either the committee or the research team. This committee has continued to function in the same mode, but continues to be dependent on the research team for agenda guidance.

Committee members did have input suggestions for reduction of some hazards. Specifically having to do with floor conduits and box sealing in the floor tech area. However, for the most part, neither the committee nor managers involved developed a good grasp of seeing tasks outside their everyday context or proved a source for innovative intervention ideas. Like the other cooperators in this study, most at this worksite tended to think of safety as a largely individual concern involving personal control of exposures to be addressed by training. The cooperator had previously instituted rotation schedules for workers on the conveyor lines, but had not explored engineering approaches to hazard reduction.

Management arranged for the training on RMIs to be provided to all employees during a regular annual orientation and safety meeting. Committee members and Mr. Janowitz presented information and Spanish language materials and translation was provided for those employees needing it. Training was based on materials provided by the research team. Some follow up training was given to work teams in the course of regular "tailgate" training sessions.

Ten jobs were identified as priorities for intervention by the committee based on job evaluations.
1) Palletizing/set off line – this job involves removing full boxes from a conveyor and hand stacking them on pallets for loading in trucks. It exposes workers to highly repetitive lifting of heavy loads (30-50 lbs), and to a repetitive reach/throw maneuver to stack. This job usually involves 10-15 workers and recorded 5 reported injuries in the 1996-1998 period;

2) Hand packing – this job involves removing fruit from gravity flow bins and placing them in paper or plastic packing sheets in boxes. It exposes workers to highly repetitive hand and upper extremity motions to reach and grasp fruit and to place fruit in boxes. This job involves 22 workers and recorded 1 injury in the 1996-98 period;

3) Grading – this job involves standing beside a conveyor filled with moving fruit, examining fruit and removing wrong-sized or blemished fruit by tossing into disposal chutes. It exposes workers to highly repetitive hand and upper extremity movements, to repetitive reaches and throwing maneuvers, and to continued standing on a hard surface. It involves 35-45 workers and recorded 17 reported injuries in the 1996-98 period;

4) Floor tech (bagging, stacking, carton preparation) – this job involves various assistive tasks to packers, primarily removal of cartons from bales and pre-forming boxes. These workers also perform stacking of full boxes. The work exposes workers to repetitive lifting, folding and reaching motions. It involves 10 workers and recorded 3 reported injuries in the 1996-98 period; and

5) Sealing (cartons) – this job involves folding carton tops and sealing with tape. It is partially mechanized with metal forms for closing and a tape applicator on a manual conveyor. This job exposes workers to repetitive upper extremity motions including reaching, grasping, pushing and shaping. It involves 2 workers and recorded no reported injuries in the 1996-98 period.

Of these, the grading job, which consists of hand sorting fruit on machine driven conveyors, exhibited the most injuries and involved the most workers.

The research team's engineering group recommended repositioning conveyors and some discard chutes on the grading line to reduce upper extremity reaches. These workers were already being rotated regularly. In addition, the committee decided to use ergonomic stools in one grading area where the conveyor was judged to be positioned too low for most workers, but could not be practically altered due to a crossing conveyor structure below. These interventions did not address exposures to highly repetitive handwork, likely the most serious risk exposure involved.

In the box sealing area, the problem focused on repositioning electrical conduits that were located on the floor. This was a priority problem identified and championed on the committee by one participant. However, this intervention did not address the repetitive postures and actions involved in the job.

No solutions were recommended as practical for the hand pack jobs (some packing machines were already in place) or for the problems in the floor tech area. While mechanical palletizing machines would be helpful, the space and physical layout available dictate against them at this time. A horizontal palletizing scheme advanced by the engineering team that would have much reduced lifting and throwing forces was rejected by management as impractical within the space requirements allowed.

One year later, the committee met to review intervention results. All of these interventions proved acceptable to both management and workers and were to be continued. Similarly, they appeared to be effective in terms of reported injuries, since none were reported in these areas during the intervention period. However, given the development period for MSDs this in itself is not conclusive and statistical comparison of pre- and post-intervention symptom data will be required to be certain if there was any preventive effect.

Cotton Production

Our cotton cooperator was one of California's largest producers. As a result much of the field operation is mechanized. While machine operation jobs do involve numerous ergonomics risk factor exposures, in general they are not as physically demanding or as injury prone as manual jobs. These workers were paid on an hourly basis

This cooperator's safety manager and committee identified hand weeding as exposing workers to the greatest risk of MSD injury. Injury records and risk factor analysis supported this. Review of injury logs for cotton weeders in this operation showed 9 reported MSDs in the 1996-98 period. Injury logs also showed 20 sprain/strain injuries among these workers in the same period. The mean number of days lost from work per MSD was 40 days (total 802 days). For comparison, the mean number of days lost from work for the sprain/strain non-MSD injuries was 13.7 days.

This committee was selected by the company safety manager and met only with his participation. All were experienced workers, most supervisors or crew leaders. Generally participants were interested and willing to speak up without invitation by the research team. All interaction with either senior company management or operations managers was accomplished through the safety manager. This committee would have continued to function with the direct administration of the safety manager.

This is high value specialty cotton, so freedom from contaminating fibers is important. Generally, female workers using hoes perform hand weeding. The job involves walking along cotton rows, cutting out weeds with a hoe. It often requires a cut 2-3 inches below the ground surface to be sure the weed is killed. Because some weeds (nightshade) regenerate easily and detract from the value of the harvested cotton, workers use shoulder bags to collect cut weeds for removal from the field. Weeders are assigned to one of several crews and number 43 in total. The job exposes workers to the following risk factors: 1) walking on uneven surfaces; 2) repetitive exertion of upper body force to hoe weeds; 3) repetitive awkward postures of the upper body and arms; 4) continuous exertion of force to carry 40-/50# weeding bags; 5) awkward postures associated with putting weeds in bags and emptying bags; 6) contact stress from continuous carrying and use of hoe; 7) discomfort as bags and clothing gets wet in early mornings (rubber pants & boots used in mornings); and 8) temperature extremes (up to 100° F).

After extended consultation with the engineering team, the committee decided to place priority on the following intervention ideas: 1) alternative hoe designs; improved footwear to prevent ankle sprains; lighter, water resistant, easier dumping weed bags; use of bib type rainwear; and experimentation with implements to reduce clodding of soil after irrigation.

This committee did contribute actively to intervention thinking, especially about alternative hoe design. However, they were largely reacting to the conceptual input of the engineering team. Generally, neither they nor management demonstrated good grasp of ergonomic vision nor proved a reliable source of intervention alternatives.

Prior to the next planting season (during which interventions would have been given field trial), the research team was advised that the management of this operation had reviewed information on the hand weeding job from the ergonomics committee and had decided to contract the job out, meaning regular seasonal employees of the company would no longer be exposed to the risk factors involved. The ergonomics committee was dismissed and this collaboration was terminated. No controlled trial of exposures was implemented and no training outside of committees was conducted.

Strawberry Production

Our strawberry production cooperator is a small operation employing 108 seasonal workers. The work is highly seasonal, beginning in December and ending by June (in Southern California). While strawberry production involves planting and cultivation (special fumigation tasks are contracted out to specialists), the primary work involves harvest of mature strawberries for fresh and processed marketing. This is performed by hand since it requires selection of mature strawberries from among many per plant. Strawberry plants produce berries continuously throughout the season.

Committee members were selected by the owner/manager and only met in his presence. Most members of the committee were either solely or primarily Spanish speaking. Research staff translated all presentations and all discussions took place in Spanish. This committee functioned only in response to questions or inquiries. Participants had little or no experience with formal group decision-making and primarily focused their inputs on issues of how tasks were performed. Priority and intervention decisions were made on the spot by the owner/manager. Committee members and participants expressed much interest in the idea of technical aides to a job they all considered demanding. However, they did not develop a good grasp of ergonomic vision nor were they able to contribute effectively to thinking about intervention ideas or alternatives except in reaction to external input.

This committee probably cannot and will not function without either external support or direct management administration.

Strawberry picking involves walking down furrows between moderately raised beds and pushing or carrying a wire cart with strawberry boxes in it. The workers must assume a stooped posture to see berries within plant foliage and must pick discriminately to select only mature berries. Berries are twisted from vine with the fingers and placed in boxes. Normally pickers remain in a stooped posture for the length of a row, which can be over 100 yards.

Injury logs showed only two reported injuries over the previous 24 months- neither an RMI. However, seventy percent (70%) of these workers reported significant pain in the mid or lower back at season end and thirty percent (30%) reported other lower extremity pain. It is clear that the most serious risk exposures in this operation involve the back.

This work exposes workers to multiple ergonomics risk factors including: 1) walking in narrow, uneven furrows; 2) sustained stooped posture with head and neck extended; 3) highly repetitive hand picking; and 4) highly repetitive extension of arms and upper extremities.

Training on RMIs was provided to workers in the course of the cooperator's regular safety training schedule. A safety consultant employed separately by the cooperator provided it. The consultant was provided with copies of the research team's informational materials.

Extensive research by the engineering team confirmed that there were no "off-the-shelf" tools or technologies which would alleviate either the stoop or the repetitive hand picking exposures which were agreed to be the most serious risk factor exposures and the foci for intervention. This left the committee and the research team with the problem of how to comply with the Cal OSHA standard requirement that "feasible hazard controls" be implemented. What is the requirement or even the most advisable approach where no practical or feasible hazard controls exist? The research team recommended that a dual approach be adopted. First, to implement increased rest and recovery breaks as an administrative control. Second, to explore the adaptation potential of alternative engineering approaches to the problem of stooped posture.

Dr. Faucett and Mr. Janowitz designed a rest and recovery protocol based on the work of Rodgers (Eastman Kodak, 1986) and others. This protocol called for an additional 5 minute rest break for every working hour in which there was no other regularly scheduled break (e.g., noon). In addition, the research team identified three engineering concepts deemed worthy of field trial. These were: 1) use of commercially available weight transfer devices (WTD – figure 1); prone position carts (figure 2); and a no-stoop handle picker. Since neither the prone position carts nor the handle picker existed, the engineering team undertook abbreviated design and development. A prone position cart was developed and submitted to field trial with workers, but no practically functional handle picker was developed.

Statistical analysis is underway regarding any effects of the increased rest and recovery protocol on workers' reported pain and symptoms. Preliminary analysis suggests that it did have a minor positive effect, but probably not enough to significantly alter the probability of chronic back injury associated with this work. Workers responded positively to the increased rest and recovery time. However, nearly half of the harvest season is conducted under piece-rate pay, and
it is clear that neither they nor managers will implement this protocol during that period.

The weight transfer devices (WTD) work by transferring body weight in the stooped position from the back to the lower extremities via often complicated spring cord and pulley arrangements. Since they are commercially available we determined that they should be evaluated. Laboratory evaluation is underway by Dr. Fathallah. Field trial of two different models from different manufacturers resulted in rejection by participating workers. The WTDs were difficult to put on, restricted body movement, and interfered with task performance.

The prone position cart was at first rejected as impractical by the owner/manager. However, when workers expressed interest in trying it, it was subjected to limited field trial by volunteers. Overall, this specific prototype was judged ineffective, but the concept remains promising and the research team's engineering group is pursuing this approach.

The committee and management determined that while the intervention trials had been interesting and promising of future assistance. Only the rest and recovery protocol for hourly work was judged acceptable at this time.

DISCUSSION

This study is subject to a number of methodological concerns, beginning with the fact that it does not employ a truly experimental design; thus results should be considered as associative at best and possibly only descriptive at worst. However, that weakness applies most directly to the data on intervention contributions to improved injury prevention. From the broader perspective, which is of most interest here (i.e., how will the regulation be implemented), the descriptive data presented should give a valid indication of industry behavior.

These companies all volunteered to participate, meaning that they were already motivated to comply with the regulation. While they all have tasks that would likely lead to being subject to the regulation sooner or later, all expressed real interest in new ideas and approaches that might lower risks. Finally, they represent a spectrum of commodity types, management styles and commercial scale common to California agriculture. From this perspective, we should see their implementation behavior as indicative of how the most responsive companies will act. We would expect lesser commitment to results and lesser investment in effort from companies not as strongly motivated.

These intervention trials were conducted with procedural similarity, by the same staff performing the same roles. The relationship between the research team and cooperators' committees was pedagogical in nature due to the very newness of the information being presented. Certainly, in this type of intervention, there was awareness on the part of participating workers that the research team was experts and had been given access by operation management at the highest levels. Additionally, the cooperators chose the workers who participated on committees.

While these factors undoubtedly influenced committee members and other workers response to the research team and to the ergonomics interventions themselves, if anything this influence should have had the effect of improving likelihood of program acceptance and success. Additionally, and perhaps more importantly, these influences were more supportive of active worker participation than would likely be found in these or similar operations without the external influence of the research team. In that sense, any resulting influence here is likely to bias results toward positive impact rather than negative.

This series of interventions was clearly and heavily biased in favor of engineering interventions over administrative or personal protection strategies. This did appear to reduce both the range of available "off-the-shelf" alternatives and the capability of cooperators to contribute effectively to intervention development. This approach was based on the demonstrated superiority of engineering interventions over all other strategies in significantly reducing hazards and hazard exposure. However, it likely deflected cooperator attention away from training as a preventive strategy or consideration of a wide range of administrative alternatives.

CONCLUSIONS

This paper offers a largely descriptive look at how volunteer, responsive agricultural employers in different commodities and of varying scales implemented the Cal OSHA repetitive motion injury standard with leadership and consultative support of the staff of the UC Agricultural Ergonomics Research Center. To that extent, this should be regarded as a description of employer implementation under the most positive of circumstances.

1) Responsive employers will make positive, "good faith" efforts at complying with both the language and the intent of the regulation. All cooperating employers in this study expressed clear concern for employee welfare and were willing to undertake efforts new to their management styles and operations in order to better understand and address ergonomics hazards.

2) These responsive employers appeared to need external consultation to develop adequate "good faith" compliance programs. Left to their own devices, most would have focused on worker training and some form of administrative control (most likely task rotation) as exposure control strategies. While no control employers were observed in a non-consultative effort, these cooperators uncertainty as to how to proceed with regulation compliance was clear throughout. It may be that some responsive employers can develop adequate programs without external consultation, but it is also clear that many, if not most, will not. The most serious problem appears to be with the need for engineering consultation to envision, find or develop, and fit appropriate exposure controls for the many different task situations involved.

3) There are not commercially available, "off-the-shelf" tools or technologies for most of the most serious ergonomics hazards found in these agricultural workplaces. Additionally, of those commercially available tools tried in these interventions, all but one (ergonomic chairs in the packing shed) was rejected as impractical by both workers and management. This is a significant obstacle to the near-term reduction of risk factor exposure in agricultural workplaces and points to the need for applied research and development in this area.

4) In general, agricultural workplaces (beyond the simple family scale) have little history or experience with active employee involvement in workplace decision-making or problem solving at the group level. While all of these cooperators had active, representative workplace safety committees, it was clear that the type of aggressively involved worker participation envisioned by many in the ergonomics community is not common in this industry. Both workers and managers had little experience with, nor much confidence in, such active worker involvement. This may be due to a history of reliance on temporary and unskilled labor and a workplace in which goals and priorities are viewed as externally driven.

5) Agricultural production operations generally experience low marginal profits. This inhibits capacity and enthusiasm for ergonomic solutions that are viewed as expensive by managers. Additionally, this outlook combined with a generally conservative approach to innovations that do not readily fit within current practices results in a climate that works against re-envisioning and re-engineering work processes. Instead, both workers and managers in this study clearly preferred to focus on interventions featuring low capital cost and that readily fit with existing work processes and practices.

6) It is not yet clear that good faith compliance with the elements of the California regulation will result in significant reduction of the most serious ergonomics hazard exposures. While early RMI symptom data results indicate that the engineering interventions put in place did reduce worker pain and symptoms, none of the most significant hazards identified in any of these workplaces was effectively addressed. In part, this was due to a lack of readily available interventions. In part, it was due to a tendency to focus on more easily addressed but marginal exposures. Finally, the cotton employer's action demonstrates a completely alternative means of addressing the regulation- transfer of risk exposure to a contractor.

In summary, it is clear from this study that agricultural employers can and will find means of complying in good faith with the state's ergonomics standard. Further, it seems clear that at minimum the standard will bring about much improved and widespread understanding of the nature and causes of RMIs, which may, in turn, lead to improved prevention in the future. But, it also seems clear that serious investment in development and testing of new engineering interventions designed to address the most egregious and common ergonomics hazards found in agricultural workplaces is badly needed. Especially needed are those associated with sustained or repetitive stooped posture and with highly repetitive handwork such as cutting or clipping.

The educational and diagnostic materials developed and tested in this study were effective in assisting employers and workers better and more quickly understand the nature of ergonomics hazards and injuries and the requirements of the California ergonomics standard. Future publication and distribution of these materials is a problem yet to be solved. Similarly, it is not clear how to best deal with the apparent need for consultative assistance for best compliance with the standard. Most often the private sector is relied upon for this type of assistance. However, if the same emphasis on worker training results from this approach as was the case in implementation of the Cal OSHA Injury and Illness Prevention Program (IIPP), we would expect significantly less eventual prevention improvement than this study indicates.

Table 1
Cooperating Employers Descriptive Information

Operation type	Total # workers	# workers in study	Operation size	# reporting MSD symptoms
Citrus Packing	106	54	424,694,460 cases packed/yr	76 (72%)
Cotton Weeding	43	20	80,000 acres	33 (77%)
Strawberry Picking	108	80	65 acres	82 (76%)

Table 2
Intervention Trial Participants

Operation type	# workers in study	# workers in intervention	AvgAge	Sex	Years experience
Citrus Packing	54	42	39.7	F=60%	13.3 yrs
Cotton Weeding	20	20	43	F=100%	17 yrs
Strawberry Picking	80	80	30.4	M=79%	5.49 yrs

Table 3
Interventions

Operation	Interventions
Citrus Packing	Sit/lean stools for hand graders
	Elect. conduit removal in palletizing area
	Conveyor height reduction in grading
Cotton	None-contracted job out
Strawberries	Weight transfer devices worn by pickers
	Prone position cart for pickers
	Increased rest & recovery breaks

Figure 1
Weight Transfer Device

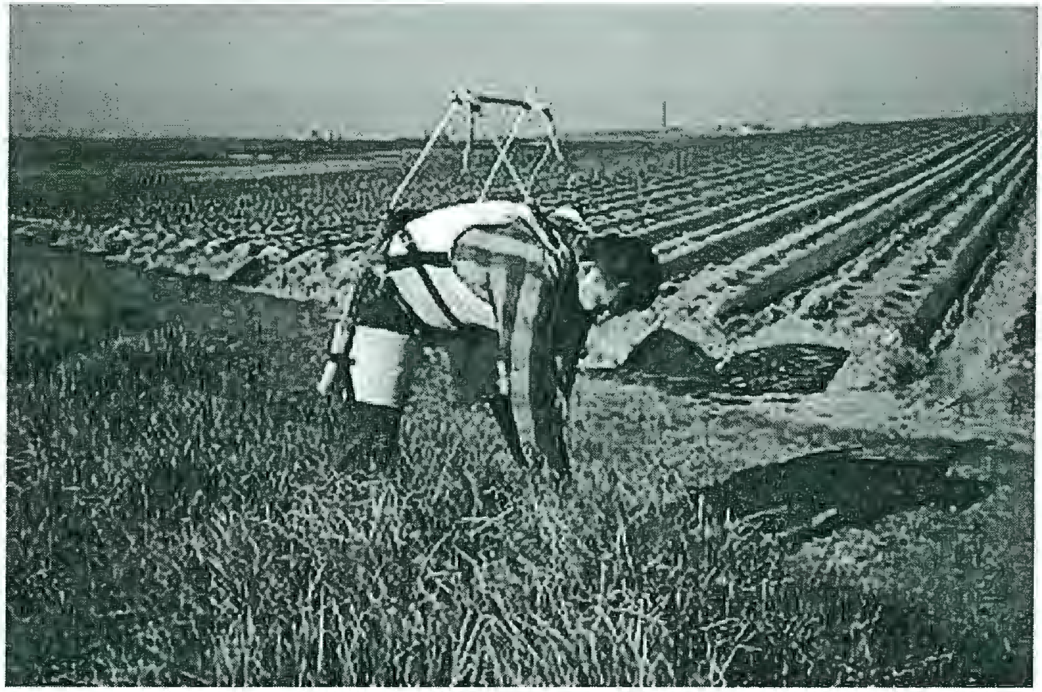

Figure 2
Strawberry Prone Position Cart

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QUICK CHECK
ERGONOMICS RISK FACTOR CHECKLIST
Instructions

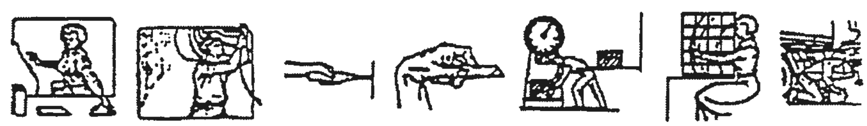
The Hazard Surveillance Checklist is a crude method of estimating the risk of developing MSDs from performing a specific job or task. Each repetitive task being performed as part of an employees job is scored separately. If more than one repetitive task is performed, the scores are additive. Employees (jobs) whose risk factors exceed a score of 10 surpass the lower risk threshold and should be considered for further ergonomic study. Following are brief explanations of each of the risk factors contained in the Quick Check List (on the following page).

A. If a motion such as striking a nail, or turning a handle is reperated more than 15 time/min (on the average) over an extended period of time the risk should be rated under "every few seconds". If the motion is repeated more than 20 times/hr then the risk should be rated under "every few minutes". Single tasks (such as driving a nail) which are completed in less than two minutes but repeated several times over periods of one or more hours should be considered "repetitive".

B. The weight of the object should be determined if possible. Potantial lifting problems should be evaluated with the NIOSH Work Practices Guide. Push & pull force is difficult to determine without a strain gauge but can be estimated by asking employees to rate difficulty of task on a scale of 1-10.

	easy			*moderate*					*heavy*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

C. The following pictorial illustrations are good examples of "awkward postures":



neck/shoulder *overheadwork* *elbow/forearm twist* *hand/wrist bend/pinch* *trunk-twist/bend* *extended reach* *knee squat/kneel*

D. Power tools impart different types of stresses to the body based on the vibration and torque they produce during use.

E. Pressure points result from the repeated or sustained contact of hand, arm or other body part with a solid object or hard surface. This may be due to the use of a poorly designed tool such as a pliers or scissors, resting an arm or palm on the edge of a desk, or repeated use of the hand as a hammer.

F. Jobs which are highly repetitive or require intense concentration may cause the worker to maintain the same posture for extended periods of time resulting in static loading of certain body parts.

G. Environmental extremes (especially cold) impair muscle and tendon function while continuous whole body vibration from operating equipment or driving fatigues muscle groups.

H. Such as pay incentives, machine, or quota paced jobs.

J. Employees (jobs) whose risk factors exceed a score of 10 surpass the lower risk threshold and should be considered for further ergonomic study.

Quick Check
Ergonomics Risk Factor Checklist

RISK FACTOR	<1hr	1-4hr	>4hr	Cause of Risk Factor	Proposed Solution	Comments
REPETITIVE						
every few seconds	0	1	3			
every few minutes	0	0	1			
LOAD/FORCE (lift)						
>5-15 lbs	0	0	1			
>15-30 lbs	1	1	2			
>30-50 lbs	2	2	2			
>50 lbs@	3	3	3			
LOAD/FORCE (Push/Pull)						
easy	0	0	1			
moderate	0	1	2			
heavy	1	2	3			
LOAD/FORCE (Carry>10 ft)						
>5-15lbs	0	0	1			
>15-30lbs	0	1	2			
>30lbs	1	2	3			
AWKWARD POSTURES:						
Neck/shoulder: overhead/bend	0	1	2			
Extended reach	0	1	2			
Elbow/forearm: twist	0	1	2			
Hand/wrist: bend/pinch	0	1	2			
Trunk: twist/bend	0	1	2			
Knee: squat/kneel	0	1	2			
USE POWER TOOLS	0	1	3			
PRESSURE POINTS	0	1	2			
SAME POSITION	0	1	2			
ENVIRONMENT cold, hot, light, glare, vibration	0	1	2			
CONTINUOUS KEYBOARD USE	0	1	2			
INCENTIVE WORK or	0	1	2			
NO WORKER CONTROL OVER JOB PACE	0	1	2			
TOTAL Score = 10 or more?						

@Single Lift > 50 lbs increases risk of low back problems