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COMMENTARY

Farm Safety Research to Practice: The Long Road From the Laboratory to the Farm

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ABSTRACT. *Research to Practice* is a critically important component in the Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health (CDC/NIOSH) mission of conducting applied research in support of worker health and safety. All of the excellent research in the world will not help workers if the products of that research are not effectively integrated into widespread use in industry. For this reason, Research to Practice has been a major program emphasis within NIOSH. Although success stories can be found, few come from agriculture, the authors maintain, because of a range of unique economic and regulatory factors present in this sector. The purpose of this commentary is to discuss the major factors standing in the way of bringing proven agricultural safety innovations into commercial production, and to outline a range of possible solutions to these structural challenges.

KEYWORDS. Agriculture, farm worker, injury prevention, r2p, Research to Practice

INTRODUCTION

Research to Practice, or r2p, as it is often called, is a concept that has been embraced by the Centers for Disease Control and Prevention (CDC) and the National Institute for Occupational Safety and Health (NIOSH).

The NIOSH r2p initiative was established in 2004 to facilitate the translation of NIOSH-generated research into the workplace to prevent injury and illness. Since that time, a range of Research to Practice studies and demonstration projects have been initiated. Two of the best-known examples are the hand wipe

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methods for detecting lead (SKC Full Disclosure Wipe Kit) and methamphetamines (MethAlert wipes). Collaboration between NIOSH and SKC, Incorporated (Eighty Four, PA), resulted in these innovative products successfully reaching the marketplace.¹ Unfortunately, these types of commercially successful safety innovations are generally uncommon, and are particularly rare within agriculture.

CHALLENGES FOR *r2p* IN AGRICULTURE

The transference of safety innovations from research into wide use within industry can usually only occur when there is demand from industry. For this demand to exist, industry must believe there is a reasonable likelihood of serious worker injury and that the innovation will significantly reduce that risk. In addition, the industry must possess sufficient resources to acquire the innovation. Alternatively, the Occupational Safety and Health Administration (OSHA) may increase demand for safety products. OSHA enforcement increases the perceived risk to a business of not investing in safety by adding the possibility of fines, even if a serious incident does not occur. However, in the United States most agricultural operations are small (fewer than 10 employees), and exempt from OSHA enforcement. This exemption, small profit margins, and a wide range of diverse farm hazards all combine to effectively suppress demand for farm safety innovations.

Effective safety innovations are both commercially available *and* in demand by business owners. In this discussion we focus mainly on the first step: getting proven farm safety innovations into commercial production. Since a range of factors have combined to prevent new products from reaching this initial manufacturing stage, we must take the precarious step of developing and manufacturing safety products without fully knowing the extent of future adoption. Agricultural safety and health professionals will need to overcome several key barriers to get new safety products into the marketplace.

Evidence of the overall lack of success of the translation of research into practice in

farm safety can be found in several published reviews of agricultural interventions. Kirkhorn et al. addressed current research on ergonomic solutions in musculoskeletal disorders (MSDs) involving tools, carts, equipment, and practices.² Lehtola et al. compared the effectiveness of interventions in the prevention of occupational injuries in agricultural workers.³ DeRoo and Rautiainen's review of farm injury prevention considered educational, audit, environmental, and equipment interventions.⁴ All together, these reviews identified 16 agricultural safety interventions in the United States that required a new or modified product to be created; however, only one reached the marketplace. A University of California study conducted by Duraj et al. created a crawler that mechanically loaded wine grape containers, greatly reducing the risk factors for lower back injuries. In considering the commercial viability of the product, the authors commented, "The additional hardware, the high number of picking containers, and the harvest management issues are not insignificant. They may not be necessarily interesting when inexpensive, low overhead, manual labor is available."⁵⁽¹⁰⁾

The United States Department of Labor directive titled "Enforcement Exemptions and Limitations under The Appropriations Act" (CPL 02-00-051) describes the exemption given to farming operations that employ 10 or fewer employees from OSHA inspections or review.⁶ According to the 2007 Census of Agriculture, there are currently 2.2 million farms in the United States, of which 78% are worked by operators alone or with the help of unpaid family members.⁷ Even among the 22% of farms that employ workers, the proportion large enough to be subject to OSHA enforcement is very small. In 2007, there were 43,113 US farms that employed 10 or more workers, making them subject to OSHA regulation.⁸ One of the purposes of enforcement is to refocus the threat toward something that is less susceptible to denial (such as an OSHA citation) than a farm fatality would be.⁹ According to OSHA, since 1970 workplace fatalities have been reduced by more than 65% and occupational injury and illness rates have declined by 67%. At the same time, US employment has almost doubled.¹⁰

The fact that fatality rates in regulated industries have dropped significantly whereas rates in agriculture have not suggests that regulatory enforcement may influence the a business's decision to purchase safety innovations.

Many agricultural operations are under severe financial stress, and do not feel that they are able to invest in safety. The 2007 Census of Agriculture found that the 600,000 farms with an average gross income of \$10,000 to \$249,000 had net earnings of just \$2,615.¹¹ Moreover, even if farms do have cash on hand, fatality statistics in the order of 24 deaths per 100,000 workers per year,¹² applied to one individual farm with a small number of employees, makes the chances seems very remote.¹³ This is true even if these rates are much higher than fatality rates in other industries.

Agriculture is less repetitive and mechanized than manufacturing and many other industries. This translates to fewer workers per operation and fewer overall hours using the same piece of equipment. Therefore, safety innovations, once in place, tend to protect workers for a smaller percentage of the work shift than in most other industries. Moreover, the seasonal nature of farming increases this variability. Spring planting requires a completely different type of work and equipment than fall harvest, and may require entirely different safety equipment. Thus, fully protecting an agricultural operation may require multiple investments. Purchasing safety equipment for a task only performed a few weeks out of the year may be difficult to accept, even if these activities are among the most hazardous. Moreover, in order to survive financially, many farms have diversified. Many agricultural operations grow a variety of crops and livestock. Even during a single day, a worker may be exposed to variety of risks from machinery, animals, and nature. Each of these tasks may require different types of safety equipment; personal protective equipment, shielding, rollover protection structures, or animal barriers.

The best manufacturing investments are typically those that have potential for consumption across a broad segment of the population. Because setup costs are so high, manufacturers can only achieve a low unit cost with a very large volume. This is another problem for

agriculture, as it makes up only about 2% of the population.¹⁴ Furthermore, many of the safety innovations are specific to certain commodity groups and specific tasks within those groups, which makes the potential market even smaller. Unless there is something that can balance out the small market for commodity-specific safety innovations (such as an up-front commitment by a trade group or purchasing cooperative), manufacturers and retailers are unlikely to be interested in producing and selling the innovation.

Other characteristics of manufacturing further impact development of agricultural innovations. Many manufacturers follow the "job shop" model. These companies simply take an order for a component and are paid on a per-unit basis. They have no interest in being part of product development. This is a common approach in all industries, particularly among smaller manufacturers. Under this model, molds or tools required for production are paid for in advance by the retailer or designer. Production has also become more specialized, so that different materials used in a safety innovation would need to be produced by different manufacturers in many cases. For instance, the molds in which metal or plastic components are created can cost from \$3,000 to \$30,000. Multiple components and different materials can easily cost \$100,000 in tooling costs before one unit is even created. Should design changes be required, these molds often have to be completely recreated. These preproduction costs are averaged into the retail sales price. With a large production run, the costs can be very reasonable per unit; however, averaging these costs into small production batches often places safety products out of the reach of farmers.

POSSIBLE SOLUTIONS TO AGRICULTURE'S r2p DILEMMA

Fundamentally, successful Research to Practice translation requires strong demand, and it is clear that among agricultural operations, demand for safety-related products is weak. However, there are some success stories that suggest promising solutions, as well as untested new ideas that may be effective for

making Research to Practice more successful in agriculture.

1. *Target key groups within agriculture.* First, the agriculture industry is extremely diverse, and this could be used to target opportunities where r2p has the best potential for success. For example, safety innovations could be targeted to the US farms where OSHA is a presence, and where economies of scale make safety purchases more appealing. These farms represent only a small percent of agriculture, yet they employ over 1.5 million workers.⁸ One example of this is OSHA's development of the Heat Smartphone App. The "app" allows workers and supervisors to calculate the heat index for their worksite and, based on the heat index, displays a risk level to outdoor workers. They get reminders about the protective measures that should be taken at that risk level to protect workers from heat-related illness. Such reminders about drinking enough fluids, scheduling rest breaks, planning for and knowing what to do in an emergency, adjusting work operations, gradually building up the workload for new workers, training on heat illness signs and symptoms, and monitoring each other for signs and symptoms of heat-related illness.¹⁵ The "app" has been downloaded over 54,000 times.¹⁶

In addition to large farms, other segments of agriculture could be identified that have a greater stake in safety, and would provide a willing market. For example, in New York State, researchers identified the subpopulation of farms with children that were more motivated to retrofit older tractors with rollover protection structures (ROPS).¹⁷ Operators on these farms had a high level of concern about the likelihood of a rollover when a youth might be operating the tractor. Another opportunity that warrants further exploration are small organic or direct to market operations, which are a growing population in many regions. Many operators in this group are new to agriculture, are in the process of setting up new operations, and are purchasing equipment. Because behaviors are not entirely ingrained and a range of investments is currently being made, this might be an opportunity to develop a safety equipment market.

2. *Look for opportunities to utilize products that have applications both within agriculture*

and in other industries. Another strategy that has been shown to be effective is to develop safety innovations that are effective in agriculture *and* in other industries where the demand will be stronger. For example, the AutoROPS project¹⁸ was initially developed for farm tractors, but found an application in the lawn/landscaping industry. The collaboration led to the development of a new American Society of Agricultural and Biological Engineers (ASABE) standard that will make AutoROPS available for future manufacturing. When other sectors increase potential demand, industry has responded by actively participating in advancing the design. This should stimulate agricultural safety and health researchers to think more broadly and actively seek collaboration with other industry sectors. Off-the-shelf components that already exist for one industry can be applied to others. One such project that has reached the marketplace is the fishing winch e-stop developed by NIOSH. This product utilized an actuator for pedestrian crosswalk signals.¹⁹ Research with existing components could advance Research to Practice in multiple industries.

3. *Develop innovations that have other benefits that offset the cost.* Another avenue for developing demand more effectively for agricultural safety innovations is to develop them in such a way that they have other benefits as well. The most obvious example of this is to develop innovations that increase productivity, but dual benefits don't have to end there. Comfort, convenience, and attractiveness can increase demand, even when safety potential alone does not. An ergonomic blueberry harvesting rake was found to be popular among workers, because it increases productivity, and the inexpensive modification could be conveniently done for the worker right in the field.²⁰

4. *Focus on low-investment innovations.* Creating simple health and safety designs easily fabricated on farms is an alternative to expensive manufacturing efforts. Farmers and farm workers have a long tradition of repair and fabrication of farm tools and machinery. In the New York ROPS program, 67% of participating farmers chose to self-install ROPS on their own tractors.²¹ Creating simple health and safety designs easily fabricated on farms is an

alternative to expensive manufacturing efforts. Another example is NIOSH's Simple Solutions for Farm Workers manual, which described a series of ergonomic designs which farmers could create themselves.²²

5. *Create an intermediary government supported role where prototypes are created, evaluated, and then marketed and sold (below cost if needed).* Thus far, all the possible ideas have related to how the innovations are designed. However, there are also ways to change the structure of the research-to-market process that would enhance the viability of agricultural innovations. One way of doing this would be to create an intermediary step where newly created innovations could be assessed and promoted for a time before they are placed in the market. For example, if a product were promoted for a period of 5 years, it could then be determined whether demand for the item could be grown. Such an "agricultural r2p center" could be financed through a cooperative agreement with NIOSH to support agricultural r2p activities just as the National Children's Center supports agricultural safety activities targeting youth all across the United States. Under such a model, small-quantity manufacturing runs could be performed on a contract basis with private firms, and over time, consumer feedback could be gathered to fine tune the design and establish pricing. Government agencies have been doing similar economic development grants for a range of commercial products for decades. The manufacture of new products is supported through a variety of ways, such as grants, low interest loans, incubators, and tax incentives. Unfortunately, the commercial development of safety innovations does not generally qualify for such support because they cannot promise high financial return or large numbers of jobs created within a short period of time. Adapting the current business development program model for safety innovation commercial development appears quite promising.

6. *Work with insurers to develop incentive systems that incorporate proven safety innovations.* Although the concept of insurers requiring property and personal safety steps is not new, agricultural health and safety leaders have not fully taken advantage of the role that insurers

can play in making proven safety innovations a key part of the insurance equation. For example, if insurance companies fully appreciated the cost savings that could be enjoyed if farms had tractor rollover protection, power-take-off (PTO) and other machinery shielding, and a few other protections against the most common, deadly, and expensive farm injuries, they could well do more to encourage their clients to adopt them.

This does occur on a limited basis. State Departments of Labor offer reductions in workers' compensation premiums for businesses that create and follow comprehensive safety plans. A similar OSHA plan, the Safety and Health Achievement Recognition (SHARPS) Program,²³ offers a 2-year exemption from OSHA inspections for farms with 10 or more employees for implementing a safety plan. Perhaps a simpler approach would be to work with insurers to base rates on the presence of a list of proven safety innovations, such as tractor rollover protection structures, PTO shields, animal barriers, and respiratory protection.

. *Explore the potential of international markets, manufacturers, and funding agencies.* One final area that has not been fully explored by agricultural safety innovators is the international market. Production of commodities crosses national boundaries and the need for an innovation may be identified in multiple national markets. This will expand potential sales to interest manufacturers and retailers. For example, the ergonomic belt developed for American orchards²⁴ could also have application in citrus groves or coffee plantations. Similarly, nursery pot lifting tools²⁵ would have application anywhere that plants are grown commercially or in reforestation projects. Global marketing is now commonplace and agricultural safety products should seek out these opportunities. Buyers in industrialized nations are likely to be large farms and trade associations, whereas in developing nations third parties such as nongovernmental organizations may be the customer. International manufacturing companies themselves could also be partners. Companies with lower production costs and stronger local demand may present a more affordable production option for new innovation.

It is clear that the current r2p model needs further development if it is going to be successfully implemented within agriculture. So much of the US agricultural industry is small and economically stressed that it does not make a ready customer for new safety innovations coming on the commercial market. However, this is not a reason to give up the r2p concept entirely. Part of the American tradition has always been to work with the market to successfully adapt. New safety innovation ideas should be evaluated for their translation potential early in the development process. This means analyzing potential sales numbers, production cost per unit, safety regulations that apply to potential purchasers, the presence of other adoption incentives (from government or insurance companies), and whether the new technology has sales potential in other industries. Successful r2p projects may need long-term subsidized manufacturing and marketing support that can accommodate slow adoption rates. However, using one or more of the approaches described here, the r2p process can bring safety to the farm. Once on the market, more work would remain in terms of effectively marketing the innovations; however, in this second phase, research is already underway exploring a range of approaches.^{26–32}

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