Guest Editorial

Emerging Technologies and the Safety and Health of Farming People

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Technology has contributed significantly to improving the safety and health of agricultural workers through reduced exposure to recognized risks. The best example is the development of rollover protective structure technology to guard against injury in the event of a tractor overturn. Even though these structures along with seatbelts are standard equipment on newer tractors, many fatalities still occur when unguarded older tractors overturn. These fatalities in the hundreds bear witness to our failure to guard against this known hazard on most older tractors. So, how can we avoid such uncontrolled hazards in the future?

In 2003, the USDA's NCR–197 Committee on Agricultural Safety and Health Research and Extension identified several emerging technology–based research topics in their "National Agenda for Action" (USDA 2003). That agenda focused on the potential attributes of emerging technologies for reducing or eliminating farming hazards as well as on potential harmful effects. The topics included:

- Automatic steering, autopilot, and computer–operated processing equipment
- Biosensors
- Exposure to high–pressure hydraulic systems
- Exposure to genetically modified organisms
- Using genetically modified organisms to develop safer production methods
- High–speed equipment
- Irradiation of food
- Land application of sludge
- Managing safety in on–farm, value–added processing operations
- Operatorless/remote–control tractors and machinery
- Power transmission lines and communication towers
- Using global positioning systems to monitor worker activities.

A method has been lacking for anticipating both the potential hazards and benefits of such emerging technologies prior to their deployment in the marketplace. However, the National Institute for Occupational Safety and Health has developed a "prospective analysis" method for evaluating emerging technologies for hazards and benefits (NIOSH, 2005). This prospective analysis adds benefits to the risk–assessment approach, is scientific knowledge–driven rather than regulation–driven, and is an iterative rather

than a linear process. This analysis starts with an identification step, like the one conducted by the NCR−197 Committee (Myers, 2005), which is followed by four more steps:

- Exposure or contact assessment gauges the potential of a technology to expose a worker to or protect a worker from a physical, chemical, or biological agent or from contact with equipment−related energy (e.g., kinetic, thermal).
- Dose (contact)−response assessment is used to understand the relationship of this exposure to its possible response.
- Risk and benefit characterization describes the risk or benefit characteristics in a way that separates the significant risks or benefits from those that are trivial.
- Prospective assessment extrapolates beyond what is known about a new technology and attempts to forecast future risks and benefits with the questions, "What if ... ?" and "How could ... ?" This step is integral to the previous steps as well as a capstone for the overall prospective analysis.

This final step must also consider options for *inherently safer designs* so as to eliminate risks, not just control them. Toward this end, the chemical manufacturing industry has developed several principles that can be expanded to agriculture. An example of these principles is *substitution*, in which safer materials or processes are substituted for more hazardous substances or processes. Another example is *alternative reaction routes or production logistics*, in which the sequencing in the process may reduce or eliminate a hazardous exposure, such as the change in the sequence of steps in the production of the insecticide carbaryl that eliminated methyl isocyanate as an intermediate product. Methyl isocyanate was the chemical released in Bhopal, India, that killed hundreds of people. Redesigning production logistics can also reduce risks. For instance, separating pedestrians from motorized work reduces the risk of runovers of pedestrians by the equipment. A third example is *energy reduction*, which refers to the reduction of potential energy in its various forms, whether chemical, thermal, or kinetic. An illustration of energy reduction is the application of a titanium−dioxide nano−particle film to the window glass of greenhouses. This film makes the windows self−washing and thus avoids the potential for falls during window washing. In addition, it saves the expense of window−washing work.

Analyzing emerging technologies prospectively is an approach for escaping our legacy of deploying hazardous technologies into agricultural production. We must design the hazard out of technologies before the hazard becomes embedded in the investment made by farmers. The ideal result for an emerging technology is that it be inherently safer for, or better yet, benefit the safety and health of farmers, farm workers, and their families. The challenge is to apply prospective analysis to designs of agricultural equipment, buildings, materials, and logistics. Another challenge is to apply, or create if need be, principles of inherently safer designs for agricultural production.

References

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