Barriers and Enabling Factors for Safety Improvements on Farms in Finland

K. O. Kaustell, T. E. A. Mattila, R. H. Rautiainen

ABSTRACT. *Systematic reviews of agricultural safety and health interventions have shown little evidence of effectiveness. In this study, we used a self-documentation and collaborative interpretation method (cultural probes, n = 9) as well as farm interviews (n = 11) to identify factors affecting the adoption and implementation of safety information. The three main barrier groups found were (1) personal characteristics of the farmer, (2) limited resources to make safety improvements, and (3) the slow incremental evolution of the physical farm environment where old, hazardous environments remain along with new, safer improvements. The enabling factors included good examples or alarming (and thus activating) examples from peers, ease of implementation of the promoted safety measures, and enforcement of regulations. The findings suggest that a user-centered approach could facilitate the development of more effective safety and health interventions. A conceptual model of the safety intervention context created in this study can be used as a framework to examine specific barriers and enabling factors in planning and implementing safety and health interventions.*

Keywords. *Agriculture, Farm buildings, Farm machinery, Farm safety, Intervention.*

Agriculture is a hazardous industry worldwide. In the U.S., agriculture had the highest fatality rate in 2009 (26.0 fatalities per 100,000 workers in agriculture), while the rate was 3.3/100,000 in all industries (CFOI, 2010). In the European Union, the rate of agricultural fatalities was 8.8 per 100,000 workers in 2007, whereas the rate for all industries was 2.8/100,000 (Eurostat, 2011). Non-fatal agricultural injury rates vary widely, from 0.5 to 43 injuries per 100 person-years, based on population and data collection method (McCurdy and Carroll, 2000; Hard et al., 2002; Rautiainen et al., 2004). In Finland, all farmers have workers' compensation coverage. In 2009, the rate of compensated injuries was 6.1 per 100 workers and the rate of occupational diseases was 0.37/100 (Mela, 2010). Finnish workers' compensation costs in agriculture were estimated at 2.2% of net farm income in 1996 (Rautiainen et al., 2005).

Various intervention approaches, including the "three E's" (enforcement, engineering, and education), have been used to prevent injuries in agriculture (Murphy, 1992). However, the effectiveness of specific preventive measures, in terms of reducing injuries or illnesses, is very challenging to measure. A systematic review identified

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25 reported farm safety interventions but found little evidence of success. While some programs were able to report at least temporary changes in knowledge, attitudes, and behaviors, none showed a sustained decrease in injuries or illnesses. Multifaceted programs appeared most successful (DeRoo and Rautiainen, 2000). These comprised, for example, health screenings, farm visits, expert audits, targeted assistance, and even financial assistance. A more recent review found only eight rigorous evaluations of interventions (Rautiainen et al., 2008). None of the included educational interventions showed an injury-reducing effect. However, insurance premium discounts decreased injury claims in one study (Rautiainen et al., 2005), mandatory use of rollover protective structures (ROPS) on tractors was associated with a long-term reduction of overturn fatalities (Springfeldt, 1993), and legislation to ban endosulfan pesticides was associated with a reduction in fatal poisonings (Roberts et al., 2003).

In Finland, occupational safety in the workplace is mainly governed by the Occupational Safety and Health Act (Finlex, 2002), which applies to workplaces with hired workers. Thus, it does not apply to farms where only the farmer and family members work. While the proportion of work done by hired workers is growing, 80% of farm work is still done by self-employed farmers and family members (Matilda Agricultural Statistics, 2007). Occupational health and safety management systems, such as OHSAS 18001 (OHSAS, 2007), are too laborious or complex to be adopted by small-scale family farms (Jokipii et al., 2005). Parts of the safety management methods described in OHSAS 18002 (OHSAS, 2008) have been applied to quality and safety management systems that farmers can voluntarily adopt (Leppälä et al., 2011). Agricultural occupational health services, which include health screenings, farm safety evaluations, and education, have been widely utilized by farmers. In 2004, 41% of Finnish farmers were members of the voluntary occupational health service system (Taattola et al., 2006).

Given the high risk of occupational injury and illness in agriculture, and the limited evidence of effective interventions, there is a need to identify more effective approaches for intervention development. A better understanding of barriers and enabling factors to safety may provide a more advanced framework for developing interventions. Some recent studies have addressed this area, specifically related to retrofitting tractors with ROPS (Sorensen et al., 2006, 2008; Hallman, 2005). In this study, we aimed to identify barriers and enabling factors to agricultural health and safety and fire safety interventions, particularly from the farmer's point of view.

Materials and Methods

To identify barriers and enabling factors to health and safety interventions, we used two data collection methods: cultural probes and semi-structured theme interviews. Both methods promote deep reflection on the chosen topics. The core questions were how particular hazards had developed and why they continued to exist in the farm working environment. With both methods, we aimed to collect information in the farm setting, where the hazards and needs for intervention exist. In the cultural probes method, the farmers could choose which safety issues they wished to take into discussion. The theme for the semi-structured interviews was fire safety in animal confinements, an issue that has gained importance since the number of animal confinement fires has shown a rising trend in recent years (Finnish Rescue Services, 2011).

Cultural Probes

The cultural probes method, a self-documentation and collaborative interpretation method, has been described and used by Mattelmäki (2006), Crabtree et al. (2003), and Gaver et al. (1999). According to Gaver et al. (2004), the power of cultural probes comes from their ability to simultaneously activate the subjects and encourage them to express their attitudes and conceptions in many ways, thus creating engagement and possibilities for a deeper understanding of the target group. Cultural probes have been reported to produce “a rich and varied set of materials that ... let us ground [our designs] in the detailed textures of the local cultures” (Gaver et al., 1999).

The cultural probes method involves five steps (Mattelmäki, 2006): (1) tuning in, (2) probing, (3) first interpretations, (4) deepening, and (5) interpretation and ideation. In this study, these five steps involved the following activities:

Step 1: Tuning in

The first step involved a literature review, creation of a conceptual model of the intervention context (described later in this section), and creation of a probe kit. The modeling of the intervention context facilitated discussing and examining the intervention process cycle and its interfaces with the farmer and farm context during the research. The probe kit comprised mission instructions, a set of warning signs, a disposable or digital camera, and a notepad and pen (fig. 1). Maintenance and repair of farm machinery and buildings was emphasized because injuries related to these sources represent a large proportion of injuries on the farm. According to statistics of the Finnish Farmers Social Insurance Institution, machinery maintenance and repair caused 10.6% of all agricultural injuries on Finnish farms in 2002.

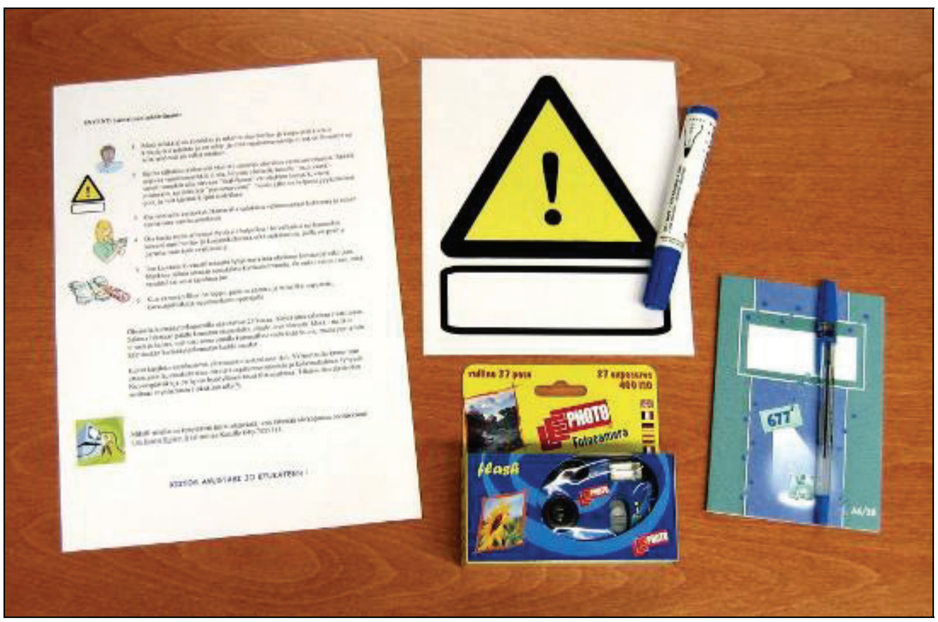

Figure 1. The cultural probe kit.

Step 2: Probing

Five students and four teachers who were actively involved in farming were recruited from the Department of Agriculture and Forestry at the Vocational Adult Education Center in Sedu, Finland. These subjects collected data on farms, and they convened for interpretation sessions. According to Beyer and Holzblatt (1998), such a group should not comprise more than 12 persons in order to make the session as efficient as possible. The main reason for choosing subjects from these populations was their expertise both as practical farmers and as trained professionals in agriculture. This expertise was expected to contribute to step 4. The probe mission was communicated in two identical briefing sessions, one for the teachers and one for the students. Both groups were asked to document hazards on their own farms or internship farms and to pay special attention to hazards related to the maintenance of machinery and buildings. A descriptive warning sign was to be placed in each scene before photographing it, and each photo was to be described using the notepad. We also asked subjects to identify, photograph, and document good safety solutions on their farms.

Step 3: First Interpretations

After the probe materials had been returned, the research team applied affinity analysis (as described by Beyer and Holzblatt, 1998) to categorize and refine the combined data of both groups into common themes. Photographs taken by the subjects, along with corresponding sticky notes extracted from the notepads, were used to create posters. The common themes that were formulated during the affinity analysis served as poster titles. The posters were used as stimulating background material for the group discussion in step 4.

Step 4: Deepening

The subject groups were convened again for a group interpretation session. During this session, we asked the participants to elaborate on individual pictures on the posters and on the identified common themes. Our intention was to guide the discussion to identify reasons behind the creation and accumulation of hazardous environments and working habits. The discussions were recorded and transcribed with a focus on barriers and enabling factors regarding occupational safety and health.

Step 5: Interpretation and Ideation

Subsequently, based on the new material from the group sessions, we refined our initial analysis from step 3. The new material comprised transliterations of the group discussion recordings, along with participants' and research team members' notes. This was combined with the original material to form a combined affinity analysis. Finally, the research group extracted barriers and enabling factors for safety improvements from the affinity analysis results.

Fire Safety Theme Interviews

Eleven animal production farms that had experienced a fire in their animal confinements were visited during January and March 2009 by a research group comprising an architect, an animal welfare specialist, and an agronomist. The farms were chosen by an insurance company that asked its customers to voluntarily participate in our research. Selection criteria were: (1) a fire in an animal confinement during the past five years, (2) representative geographical distribution, and (3) willingness to participate in a semi-structured theme interview on the farm. During each half-day visit, we completed an interview and reviewed building plans and prior use of the burned building. A walk-through on the premises was also conducted. Other material, such as photographs, construction plans, and newspaper reports on the fire were reviewed. In addition to the on-farm interviews, we interviewed one Emergency Services College teacher specializing in farm fires.

All discussions were recorded and transcribed with a focus on specific barriers and enabling factors regarding fire safety. The resulting material was organized according to the affinity method described above in the Cultural Probes section.

The Safety Intervention Context Model

A safety intervention context model was created during the research (fig. 2). It served as a conceptual framework for the research group's discussions concerning barriers and enabling factors for the effectiveness of agricultural health and safety interventions. The model is based on the general process model of information dissemination (Shannon and Weaver, 1949). We augmented this process model with the farmer and the farm context, which were the main focus of this study and formed the core of the model. We also included interfaces between the intervention process and the farmer/farm, adapting general user research principles (Nielsen, 1993; Beyer and Holzblatt, 1998).

The main components of our model are described below:

Impulses are driving forces that initiate the intervention process. Impulses can originate from external sources such as legislation, or from internal sources such as injuries, hazards, and observed occupational health and safety problems revealed by research.

Intention to intervene with the situation is the phase in which an individual or an organization, based on an external or internal impulse, becomes motivated to initiate an intervention.

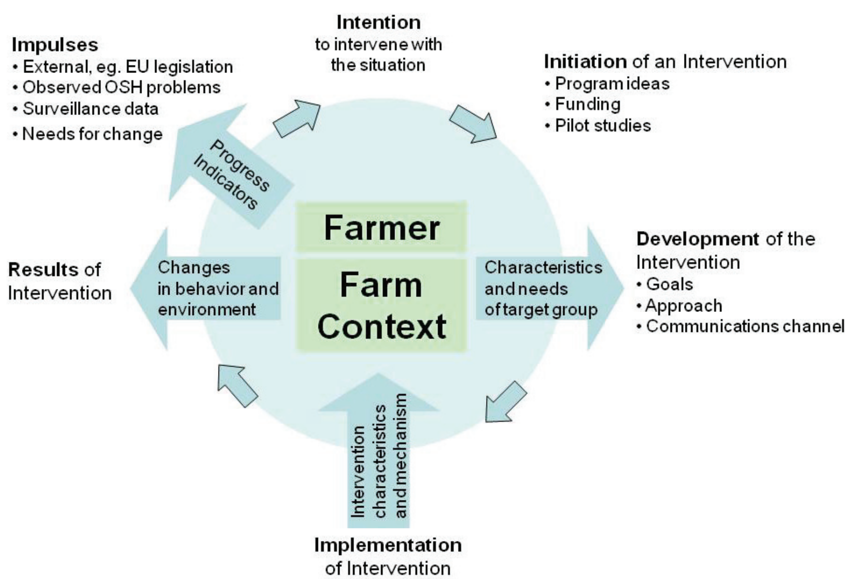

Figure 2. Conceptual model of the safety intervention context.

Initiation of an intervention (program ideas, funding, pilot studies) is the first step toward creating an intervention. It involves considerations of program models, partners, funding, and pilot-testing of chosen intervention approaches.

Development of an intervention comprises decisions on goals, approaches, target groups, and dissemination channels. Properties such as the novelty value of the approach, and the implied or expressed prerequisites and needs of the selected target group are crucial planning considerations. To assess the various aspects of interventions, the needs of the intervention target group and the context of implementing the intervention should be well established.

The approach may include new and existing methods to promote change (including engineering); education, training, participatory, and information dissemination methods; regulatory initiatives and enforcement; incentives including insurance premium ratings (Murphy, 1992; Rautiainen et al., 2008); and various combinations of these methods (e.g., the "multi-faceted approach"; DeRoo and Rautiainen, 2000; Tiemessen et al., 2007).

Goals include learning targets for competence building (knowledge, attitudes, and skills) and targets for safety practices, including increased use of personal protection, safer and healthier working habits and processes, and physical improvements in the working environment.

The dissemination channel involves the routes used for delivering the information to the farmers, including the media and various channels of communication:

Implementation of the intervention includes increasing awareness and adoption of intervention content among the farmers. The uptake of intervention depends on the delivery mechanism and the utility value of the intervention to the farmer. These factors are called the intervention mechanism in this model.

Results of the intervention involve (positive) changes in health status, safety and wellness, safety and health-related knowledge and skills, values and attitudes, and the image and attractiveness of the profession. Traditionally, the results are assessed using focus groups, interviews, surveys, health and injury statistics, and in some cases more rigorous research methods (e.g., randomized trials, interrupted time series studies).

The **farmer** has existing knowledge, skills, and attitudes; information-seeking habits and learning style; current health status and lifestyle characteristics; attitudes toward farm work; family history on the farm; future plans; values, habits, traditions, and internal behavioral models; risk-taking behavior; and safety-related experiences.

The **farm context** involves production cycles and seasons; phases and life cycles in machinery, buildings, and infrastructure; business ownership, social context, and family relations; existing safety culture and safety level; and availability and use of farm labor.

Results

When identifying barriers that hinder implementation of safety knowledge and thus the development of safe working conditions on farms, we found that the underlying causes are often interconnected. The analytical "why" questions often resulted in complex explanations for why knowledge had not resulted in safe working habits or why the available resources had not been in place to improve safety. To complement the analytical barrier analysis, it is also important to focus on understanding the underly-

Table 1. Summary of barrier and enabling factor constructs.

Context	Barriers and Enabling Factors	
	Barriers	Enabling Factors
Farmer	Personal inclinations	Power of examples
Both farmer and farm	Limited resources	Ease of application
Farm	Evolution of farm environment	Enforcement

ing enabling factors behind the actions of farmers. Accordingly, we identified enabling factors that had promoted or were thought to promote safe working environments and safe working habits on farms.

Table 1 summarizes the central barrier and enabling factor constructs based on our findings. These constructs were formulated using data originating from both the cultural probes and the theme interviews. The barriers and enabling factors are presented in relation to the farmer, the farm, or both, as in many cases they interact. Individual constructs are explained and discussed in detail in the following sections.

Personal Inclinations

The construct comprising such barriers as established unsafe habits, attitudes, and priorities, as well as ignoring known risks or regulations, was called "personal inclinations." It summarizes mostly conscious behaviors that can increase the risk of injury in daily work activities. These barriers are also likely to preserve existing hazards on the farm.

While machinery has become safer, this does not guarantee that the work has become safer. Established working habits can be transferred to new environments, undermining potential gains in safety. Being accustomed to old working methods, people are unwilling to change, although the hazard is known and alternative methods are available. The cultural probe subjects also felt that working is more efficient while accepting this risk, and therefore no change in working habits had occurred. Immediate benefits thus surpass the more remote gain in improved safety.

Persistence of old, hazardous working habits may also have other motivations. Hay bales are stacked as high as possible even if there is no need for it: "*We have always stacked them as high as we possibly can.*" It is not easy to determine if this is just a habit or if it is a "sport" or fun activity (Huizinga, 1955). The "manageable mess" was also mentioned. When an individual has created a messy environment, it is still possible to find things because the evolution of the mess is known: "*For sure, if we cleaned it [the storage room], we would not find anything [in there anymore].*"

Attitudes toward safety always play a role. These attitudes vary from person to person and from farm to farm. Having a lax attitude about safety, together with lacking skills, equipment, and planning, resulted in some hazardous situations on a farm building construction site with inadequate scaffolding: "*Construction workers will tell you, you won't fall from there; you just lean on to the wall and keep painting, and don't look down.*" Even aesthetic and status values may trump safety. On one farm there was a desire to maintain an older tractor in use as-is (i.e., without rollover protection), so it could be shown to visitors on the farm.

A behavioral pattern that could be described as ignorance or negligence of risk appears to exist. Examples of this were (1) use of an angle grinder in environments with flammable material, although this is a well known and frequent cause of fires; (2) keeping a peat litter pile against a wooden building wall, although it can selfignite; and (3) ignoring a chimney sweeper's report of cracks in the chimney. All these cases resulted in destructive fires.

Despite being mandatory, an emergency rescue plan was mostly "under construction" on the farms that had built new animal confinement facilities. Before their fires, none of the interviewed farms had a rescue plan. There were some expressions of doubt whether such a plan would be of any help in a real situation. However, fire rescue professionals have reported that firefighters have wasted precious time locating water sources or the main electrical breaker due to lack of a documented rescue plan.

Limited Resources

The next set of barriers was designated "limited resources," which refers to monetary limitations and the frequently mentioned lack of time, but also includes insufficient knowledge and skills, and lack of adequate tools and supplies. These factors can lead to hazardous "temporary" structures on the farm and an increase in unintended risks. Building and machine maintenance work is typically done with the available resources, i.e., knowledge, skills, time, materials, tools, and equipment. It is less common to search for optimal solutions and obtain the correct materials. Often, the solution is planned to be temporary: "*We'll make permanent stairs in there later*." However, temporary solutions tend to become permanent. People do not easily start reworking an already built solution, even if its safety level is poor.

Repair and maintenance of machinery and buildings require special expertise, including knowledge of structural design and electrical installations. Building safe walkways and working surfaces into existing spaces is not easy, and the work easily gets postponed. "*We've thought about fixing, but it's not easy ... We should use steel ... The space is cramped and there is not much space to build.*" Usually there are several options for a solution, but they are not always considered. It might require less time and resources to make a quick safety fix to the old system than to rethink the process and eliminate the hazard at its source.

Risks easily accumulate when farmers construct their own buildings. Safe working methods often require professional-quality equipment, such as work benches, safety equipment, and personal protective equipment. The construction manager, who is also officially in charge of building site safety, may be an absent relative. The farmer may not have the required knowledge. Cost-cutting is top priority, work is rushed, and the farmer works long days as the usual farm work also needs to be done.

Chemicals such as silage acids form poisonous nitrogen compound gases when they come into contact with nitrogen fertilizers. Greases and oils create an explosion hazard if they come into contact with the oxygen used in welding (fig. 3). Yet these chemicals are often stored and handled next to each other.

A technical deficiency in a machine or a building can lead to work patterns that involve unrecognized accident risks. On one farm, a skid-steer loader was used inside a cowshed to distribute hay. The loader did not have a fuel gauge, so the habit was to run it dry and then refuel it from a can wherever it stopped. Gasoline was spilled on the hot exhaust manifold, resulting in immediate vaporization and ignition, whereby the loader, the farmer's overalls, and the newly distributed hay caught fire.

The observed examples point out that certain "invisible" physical, chemical, and electrical hazards are not well known or seriously considered, or their presence is not recognized. Uncertainty of whether or not an electric installation is dangerous was documented in several cases.

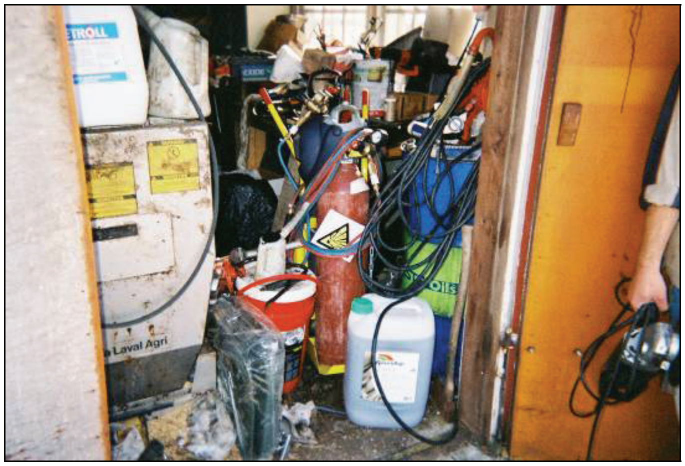

Figure 3. Congested storage room with several potential chemical hazards.

Evolution of the Farm Environment

Farms are challenging environments for safety improvements due to their way of growing and changing gradually over time. Buildings, machines, infrastructure, working processes, and the farm layout often reflect decades of building and expansion. This evolution also involves aging and deterioration of older structures and the physical environment. Production patterns and even the main commodities and types of production change over the years, which easily renders machines and structures obsolete. Buildings may have additions, installations, and machinery added over time, and their functional compatibility can be questionable. New, larger machines may not fit into old sheds. In many cases, the ROPS has been removed so that a tractor could fit into an old barn.

Repair and maintenance activity is likely to be influenced by many factors, including skills and interest in farming; available spaces, materials, and tools; availability of parts and supplies; and economic optimization: "*It pays to maintain equipment in working order*" as opposed to "*Repair takes time and money.*" Farms that are in the process of discontinuing production can argue that it is no longer necessary to invest in maintenance and repair.

Old structures often include flammable materials and structural features that promote the expansion of fire. However, it is common to store machinery with combustion engines in these old structures, or even perform hot work (welding, cutting, grinding, etc.) in these spaces, which have been taken out of their original use.

An often overlooked but important function in buildings is storing goods and equipment. Storage areas emerge without planning in different areas of the farm and may exist in the wrong places. We observed items accumulating on stairway steps, and a field roller awkwardly stored on a machine shop floor "*waiting to be moved to a better location.*" Inappropriate storage of chemicals in overflowing, disorderly, and unlocked storage rooms was common.

Other implications of weak planning are system components that are introduced with the assumption that the farmer will assemble a complete, safe system out of them. A grain drier shipment, for example, did not include appropriate safe walkways between levels, and the expectation was that the farmer would build them. Such a drier is then only a shipment of equipment, and not a complete functional solution from a safety perspective. It remains up to the skills, resources, and safety awareness of the farmer to determine how safe the walking surfaces become after installation: a pair of planks, or a safe walkway with guardrails?

Power of Examples

The power of examples, both good and bad, was evident in many cases. Characteristics of the farmers who had made safety and health improvements included being alert and open to safety. The impulse to making safety enhancements often came from other people, such as peer farmers and acknowledged authorities. Personal experiences and close calls were also mentioned as impulses.

Peer visits and discussions can help avoid "blindness" to hazards on an individual's own farm. The effect is greater when an influential person gives the impulse, such as the local fire marshal, building site supervisor, or a valued worker. Remarks made by a fire authority during an inspection often resulted in practical safety improvements, even if no re-check was ordered. The impulse may also be more effective if it comes from within the family. A good example is messages given in school that come home with the children. Education was seen as an important factor in the development of safe working habits. On the other hand, working habits were seen to interact with conditions, traditions, attitudes, and respect toward the views and contributions of others on the farm.

Experiences of actual accidents leading to injuries, occupational illness, or significant economical losses were mentioned to have positive influence on initiating practical measures to make the farm safer: "*A neighbor was working on a combine and he fell. He was in a hospital for two months and got some serious infection problems. So, we cleaned up, so we would not have slips and falls.*" Close calls were seen as valuable in indicating danger and providing specific information about what improvements should be made.

The farmer's aptitude for change was clearly connected with safety enhancements and preparations done on farms. Mental training was seen as one way to develop safety and to prepare for crisis situations. One farmer stated that the workers on his farm had envisioned certain accident scenarios and how to function in those situations. They had thus mentally prepared themselves for different crisis situations and for the measures to be taken if something happened. This mental preparation later helped them during a building fire.

The aptitude for changes and enhancement of safety may also result from a hobby or volunteer work. For instance volunteer firefighting develops skills to identify fire, carbon monoxide, and explosion hazards.

Ease of Application

To be feasible, the intervention should be easy to apply on the farm. Correct timing, regarding the yearly production cycle, evolution of the farm, as well as the farmer's phase of life, are important. Farms that are going out of business cannot be motivated to invest resources into upgrading working conditions. However, if the farm has a succession plan, that prospect appears to motivate the development of safety investments on the farm.

In some cases, convenience and effectiveness have been primary enabling factors in the introduction of solutions that also improve safety, such as when safety is not the central reason for the improvement, but comes as a by-product. For example, hand rails or proper standing platforms were introduced on one farm because they not only enabled the task but also actually made working more comfortable and effective.

No-cost, ready-to-apply solutions can overcome many safety barriers. A municipal safety organization hired a safety consultant to create safety instruction boards for all animal confinements in the municipality. This development was known and mentioned by many farmers as a good example of an effective safety intervention.

Enforcement

Safety enforcement involves mandatory actions on the farm. New animal confinements built using public financing are required to have a rescue plan and fire detection systems. Several examples and templates for rescue plans have been published. The existence of a rescue plan and fire detectors is checked during the acceptance inspection of new buildings. Based on results from the interviewed farms, most of them had either finished or at least started to prepare a rescue plan for their new building, and automatic fire detection was installed or planned.

During the discussions with the cultural probe groups, some farmers also suggested yearly inspections of electrical installations; currently, inspection of electrical installations is mandatory only at installation and once every 15 years thereafter. According to the Finnish Safety and Chemicals Agency, 15 years is far too long between inspections.

Discussion

The cultural probes and farmer interviews provided information on what impulses, from the farmer's point of view, have led to safety improvements on the farm. We also identified factors that create safety hazards, prohibit hazard mitigation, or in some way prevent intervention efforts from turning into action and thus a better safety and health status. The division of barriers and enabling factors between the farmer and the farm context is somewhat ambiguous because the farmer influences the farm environment, and vice versa. However, these two viewpoints can identify potential core targets for effective intervention planning.

The Farm Context

In our conceptual model (fig. 2), the farm context involves production cycles and seasons; phases and life cycles in machinery, buildings, and infrastructure; business ownership, social networks, and family relations; the existing safety culture and safety level; and the availability and use of farm labor. Based on the farmers' responses, there are many factors that create safety hazards and allow them to remain on the farm.

As the farm environment evolves over time, some changes can create new safety hazards if operations and working environments are not carefully planned. Fitting old and new technologies together and adapting corresponding working processes requires special attention and systematic planning. Coherent planning and design that includes safety and health checks does not appear to be very high on the farmers' priority list. This is an important omission, as, according to the well-accepted hierarchy of interventions, it is more effective to engineer out physical hazards than to train workers to work safely or use personal protective equipment (Murphy, 1992). Systematic reviews also suggest that interventions that reduce specific hazards in the farm environment reduce injuries in the long run (Rautiainen et al., 2008). Examples of such interventions are mandatory ROPS on tractors (Springfeldt, 1993) and legislation to ban endosulfan pesticides (Roberts et al., 2003). Hazard identification using walk-throughs and safety checklists address the existing situation and may succeed in eliminating hazards. However, the challenge remains to improve planning and construction so that new hazards are not created in the evolution of the farm environment.

One approach to address this “evolutionary hazard creation” problem is to develop systematic planning of the production processes, specifically at times when new investments are considered. A preliminary assessment of potential hazards could help eliminate risks cost-effectively during the planning process, rather than working around the newly created hazards, or making corrections afterward. Implementation of systematic occupational safety and health safety management systems, such as the system described in OHSAS 18001 (OHSAS, 2007), would be one way to tackle this barrier. Unfortunately, implementing such a system may seem overwhelming to many small-scale farms, which form the majority of Finnish farms (Jokipii et al., 2005). From the farmer’s point of view, the challenge of such voluntary systems is to make them as user-friendly and appealing as possible. Market demand for sustainable production or even enforcement may be other motivators for adopting systematic safety management practices.

Old systems are often not serviced and maintained as well as newer systems. It is not always easy to determine when it is time to repair a machine or a building. The repair is often initiated only when the condition of the machine or building makes it unusable. Investments in new technology, machinery, equipment, and buildings create opportunities to improve safety beyond their current standard built-in safety features. For example, machinery that has been designed in accordance with the EU machinery directive (EU, 2006) has passed a risk assessment that includes the hazards of typical use and misuse situations. It would be useful to assess how old existing technology, still partially in use on the farm, could benefit from this injection of safer new technology on the farm. Some of the safety features of the new technology could be adopted to upgrade older machinery as well.

The Farmer

In our conceptual model, we considered factors related to the farmer. These include existing knowledge, skills, and attitudes; information-seeking habits and learning style; current health status and lifestyle characteristics; attitudes toward farm work; family history on farm and future plans; values, habits, traditions, and internal behavioral models; risk-taking behavior; and safety-related experiences. The success of voluntary efforts to enhance safety on farms depends on the farmer’s motivation, skills, and other enabling factors. In most cases, farmers know the safety risks quite well (Mattila et al., 2008; Jørgensen, 2008). Nearly all interventions require the farmer to decide to implement the measure. Any voluntary intervention thus has to involve some attractive elements in order to motivate actions. However, factors affecting motivation vary from person to person and from situation to situation.

Subjective experiences and learning from others’ experiences were mentioned commonly as enabling factors for implementing safety enhancements. The alerting and educating effect of injuries as well as the opportunity to learn from peer farmers’ experiences, both good and bad, was often mentioned. In Denmark, Jørgensen (2008) reported that descriptions of tractor injury events of other farmers through farm media, seminars, etc., had a clear effect on injury rates. The rate of fatal accidents at work decreased during the campaigns.

Contrary to our findings, studies of private farms and small enterprises (Hasle et al., 2009) have shown very limited or no learning effect after injuries occurred. Hasle et al. (2009) suggest that for injuries and near-misses to have an educating effect, some means to decrease the defensive attribution associated with injuries and near-misses should be created. We asked our subjects to elaborate on factors that promoted the adoption of safety enhancements on their farms. The motivating effect of injuries or near-misses seemed to necessitate susceptibility and available resources (knowledge, skills, and materials).

According to our results, vocational education has a valued role in promoting safe working habits. On the other hand, educational interventions have not been found to be very effective in reducing injuries (Elkind, 1993; Rautiainen et al., 2008), and information about safety risks on a generic level has not been found beneficial (Stave et al., 2007; Jørgensen, 2008). However, Nevala-Puranen (1996) noticed that rehabilitation courses that offered specific training on ergonomically sound work techniques, physical activities, and theory of structure and strain responses of the musculoskeletal system, were successful in decreasing musculoskeletal pain and improving work postures and work ability of farmers.

Mental preparation for potential emergencies could be a strong model for prevention, and it should be promoted in education and communication. Use of positive experiential learning principles (Kolb and Kolb, 2005) could be another way to promote adoption of safety-enhancing measures, particularly if combined with practical solutions, guidance on how to make the necessary changes, and support from a network of peer farmers (Stave et al., 2007; Kawakami et al., 2008). Formation of peer groups should be encouraged, as well as visits by experts, such as fire and rescue personnel.

The Intervention Model

The conceptual model of the safety intervention context follows the principles of user research. The focus is on the user, in this case the farmer and the farm context. The four interfaces between the farm/farmer and the elements of the intervention form the basis for our discussion around the intervention model. Studies on the effectiveness of safety and health interventions, as well as new intervention development, should focus on these interfaces and address the following questions: (1) What characteristics and needs of the target group should be recognized and served? (2) How can knowledge of these factors be used to formulate an effective intervention approach? (3) What kind of accessibility, attractiveness, and utility value does the intervention represent to the farmer? and (4) What factors and background variables affect the data that are used to assess safety and health status and progress on farms (i.e., the "results of intervention" and "progress indicators" in the conceptual model)? These questions have to be answered in order to know the intervention target audience, seen as necessary by Anyaegbunam (2007). The answers to these questions not only enhance the potential of the intervention to be successful, they also identify criteria for the feasibility and sensibility of the intervention process.

Intervention Effectiveness

It is striking that so few intervention studies have been able to report positive results in systematic reviews (DeRoo and Rautiainen, 2000; Rautiainen et al., 2008). This is not unique to agriculture; similar reviews of construction industry interventions also found little evidence of success in injury prevention (Lehtola et al., 2008). This may be an indication that even well conducted studies have biases that are not well understood, and further research should be conducted to characterize such biases. For instance, it is plausible that the intervention subjects who receive training on injuries and injury prevention pay attention to their injuries and near-misses and report them more readily than the controls who are not sensitized to recognize their injuries and near-misses. Another issue is that many interventions take a long time to change outcomes, decades in some cases.

Study Strengths and Limitations

This study was conducted using two different data sources: cultural probes and theme interviews on fire safety. The number of cases in the primary material is limited (n = 9 and n = 11, respectively). A case series with larger sample size and more diversified subject group could yield more insight into the research question and make the results more representative. Yet when comparing the results with existing knowledge, they converge very well. The methods used for the farmer interviews and cultural probes are fairly labor intensive, thus limiting the number of cases. However, these methods were found very useful for elaborating on barriers and enabling factors to safety enhancements on farms. For context, one should consider that some features of the farm environment are specific to Finnish/Nordic/European agriculture.

Conclusions

We used the cultural probes method to stimulate thought and discussion among research subjects beyond simply documenting problems. Reviewing collected material from farms with participants in debriefing sessions, rearranging the material into themes, and conducting group discussions gave us insight into the way farmers experience hazards, occupational health and safety interventions, and actions that lead to a safer working environment.

A user-centered approach could facilitate the development of more effective safety and health interventions. This applies to all activities related to the development, implementation, and evaluation of interventions. It is not adequate to have a “good message” or science-based knowledge of the hazards and the potentially effective preventive measures. It is also important to know the context in which the intervention impulse is given and to recognize the barriers and enabling factors for each particular change that is intended to occur. The conceptual model of the safety intervention context created in this study can be used as a framework to identify specific barriers and enabling factors in planning and executing safety and health interventions.

As a unique finding in our study, it is important to focus occupational safety and health interventions on reducing the evolutionary creation of new hazards on the farm.

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