European Agency for Safety and Health at Work

POLICY BRIEF

IMPACT OF NEW TECHNOLOGIES ON OCCUPATIONAL SAFETY AND HEALTH IN AGRICULTURE AND FORESTRY

Background

This policy brief summarises the impact of new technologies on occupational safety and health (OSH) in agriculture, and is based on the European Agency for Safety and Health at Work (EU-OSHA) report on the future of agriculture and OSH, which provides a comprehensive analysis of new and emerging risks and their impact on OSH in the sector (EU-OSHA, 2020a).

Introduction

The digitalisation of agriculture or smart farming are broad concepts used to cover the area of digital technological developments in the sector. These concepts include the use of drones, sensors, global positioning or satellite systems, automation and robotisation, big data, the internet of things, artificial intelligence (AI) and augmented reality. Another term commonly used is 'Agriculture 4.0', which covers precision or smart agriculture using a combination of information and communications technology (ICT) and sensing devices to permit precise use of inputs to optimise food production and prevent environmental degradation, and also streamline data availability to assist farm management (Klerkx and Rose, 2020).

Smart farming has been the subject of much attention in the sector, being identified as one of the few innovations that could potentially bring about a paradigm shift in productivity and increased food production. While robotic milking parlours have been in use for some time, more recent developments such as robotic harvesters, mechanical fruit pickers and weeding machines are just some examples of the technological revolution taking place in agriculture.

However, the take-up of smart technologies in the sector has tended to lag behind that in other sectors, and their roll-out is uneven, with them being taken up most often by larger agricultural holdings, in certain specific farming practices or crop sectors, and in certain European regions.

Impact of smart farming and digitalisation on OSH

The agriculture and forestry sector is already one of the most dangerous work sectors. However, new technologies offer the potential to improve OSH in the sector. There is great potential to enhance workplace safety and health by building **safety, health and ergonomic features into the development and design** of smart farming technologies, as well as into the design of farm and crop layouts and animal handling processes and facilities. In the following sections, we look at the potential of smart farming to improve OSH in the sector, but we also look at new risks that could emerge if the introduction of new digital technologies is not managed effectively.

Smart farming and OSH improvements

Smart farming developments have the potential to reduce OSH risk factors and improve the working environment.

Technological solutions through smart agriculture have the potential to reduce workload by **substituting labour for capital** and minimising risk exposure. Examples include Noguchi (2013), related to crop production, and Jago et al. (2013), related to dairy farming. By replacing labour, the risk of workplace injury is removed, thus improving OSH; examples include mechanical harvesting of crops (e.g. potatoes and fruit), automated milking of dairy cattle and forestry harvester technology.

Adopting technologies such as telecommunications, automation and precision agriculture[1] will foster **more efficient management systems** (including time management systems), increase farm profitability, minimise adverse environmental impacts and improve sustainability of agricultural production, while improving OSH standards.

[1] A farming management concept using digital techniques for monitoring and optimising agricultural production processes, also known as precision farming.

Smart farming solutions have the potential to simplify work systems and **improve process control and safety systems management**. This will improve work organisation and lead to OSH improvements as a result. However, challenges remain in many areas of agriculture owing to the irregularity and unpredictability of the work environment (soil, topography, crops and livestock, weather, etc.), making 'sensing' particularly challenging (Wang, C., 2013). An intermediate step will most probably be the use of 'co-robotics' — designing robots to work alongside human workers, with the robots handling simple tasks while people continue to perform the more complex and delicate actions (Downing, 2018).

As we have seen with the adoption of technologies such as automated milking systems, farmers' **work-life balance will improve** because they will be able to manage and monitor machines and systems virtually, that is, at a distance and at different times. Examples include monitoring pig or poultry building environments via mobile phone, using a remote camera to monitor livestock around calving time, or employing automated irrigation systems to determine when and where to irrigate and how much water to apply (Wang, D. et al., 2013).

The **prevention of musculoskeletal disorders (MSDs)** through ergonomic improvements will be one of the most important benefits of the introduction of smart technologies in farming and forestry. MSDs are one of the most common health conditions suffered by farmers (Osborne et al., 2012).

Figure 1: Agricultural drone

Smart precision spraying equipment (such as drones for remote spraying or field-based robotic equipment) can spray at distance and reduce the quantity of chemicals used, providing the opportunity to **reduce occupational exposure to hazardous substances** such as pesticides, as well as reducing the impact of such substances on the environment. Precision spraying equipment can reduce pesticide use by up to 80-90 % in some instances (Wipro, 2019). Some smart technologies under development, such as weed pulling or 'zapping' technology (using lasers), remove the use of pesticides completely.

New technology will also provide the opportunity to **improve machine and vehicle safety**, for example through force torque sensors, tactile and pressure sensors, safe maximum speed and proximity sensors, area detectors and cameras, and emergency stop buttons (Vasconez et al., 2019).

Technology used in precision livestock farming (PLF) offers great potential to **improve livestock safety**. Innovative approaches, such as the use of biosensors for animal health management, have been gaining recognition (Steeneveld et al., 2015). PLF can facilitate herd monitoring and reduce repetitive physical tasks such as milking and feeding while simplifying the monitoring of animals (e.g. heat and health problems).

New smart monitoring technologies could improve safety and health on the farm and in the forest, particularly through the use of smart devices that can be worn, such as smart watches and smart personal protective equipment (PPE) (EU-OSHA, 2020b).

In addition to safety improvements in forestry through smarter, more digitalised machinery such as harvesters, **remote-controlled felling wedges** can reduce risk in felling operations. Although their use is not yet widespread, they will likely be employed more frequently in the future, as the effects of climate change result in a need to remove more damaged or dying trees.

New and improved digital technologies and apps are also being developed to **record and manage (farm) safety risks and support OSH training**; examples include specific hazard identification tools, tools for risk assessments and OSH audits, and a number of tractor simulator training devices[2].

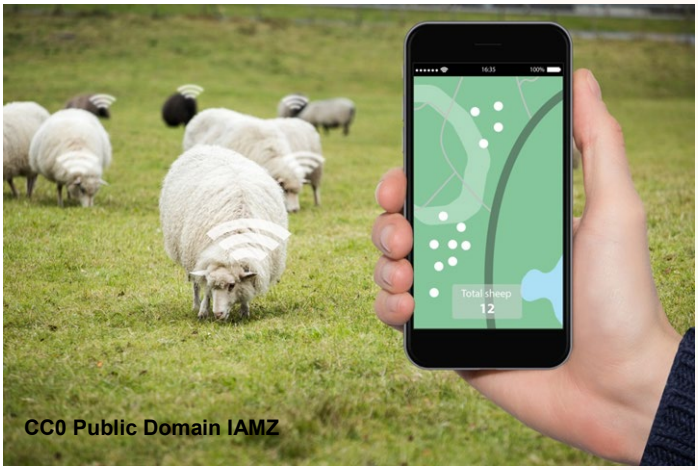
[2] Examples include the tractor overturn simulator from the Spanish National Institute for Safety and Health at Work (INSST) and the University of Cartagena: https://www.insst.es/-/tu-vida-sin-vuelcos; and the tractor driving simulator of the Department of Agriculture, Environment and Rural Affairs in Northern Ireland: https://www.daera-ni.gov.uk/news/minister-poots-launches-nis-first-tractor-driving-simulators.

OSH risks from smart farming technologies

New technologies will need to be evaluated to establish whether they bring any **new or additional risks to the workplace**.

According to the UK Robotics and Autonomous Systems Network (UK-RAS Network, 2018), human supervision of farm robots will be required to ensure safety for the foreseeable future, at least until the technology becomes more autonomous.

Figure 2: Smart farming app



Smart agriculture applications and technology include autonomous vehicles, decropping and cutting devices, automatic spraying, laser-cutting technologies and drones. If not effectively managed together, several of these systems operating at the same time, in the same field area and among workers could create risks from crushing, collision, cuts and burns, as well as possible stress-related issues resulting from fear of accidents caused by autonomous technologies. So-called 'cobots' will most likely be the first intermediary step in robotic developments in farming (Huelke, 2016).

Although new technologies provide opportunities for improving safety, they will also reduce the workload and the number of workers needed to carry out certain agricultural tasks. This may **increase the number of lone workers** in forestry and agriculture who, without direct supervision, will be at greater risk. Farms may also be tempted to rely solely on cheaper technological solutions for oversight and emergency support, rather than providing accompanying workers.

Psychosocial challenges such as **monotony and stress** are associated with the introduction of new automated technologies in farming and forestry. Farmers experience stress and frustration over malfunctioning automated systems during their initial implementation periods, such as false alarms, and older workers experience stress related to the introduction of new technology (Holte et al., 2018; Karttunen et al., 2016; Lunner-Kolstrup et al., 2018). Monotonous work can present additional psychosocial risks. Task diversity is important in both farming and forestry work, so that operators are not compelled to stay in fixed positions operating machinery for long periods of time, increasing the risk of MSDs and cardiovascular illness.

'Hacking' and interference could become a real safety and security threat in the future. According to a US study (DHS, 2018), a number of risks need to be managed in smart farming, such as the potential theft of confidential data, systems being subjected to ransomware, agricultural production being disrupted and the integrity of livestock being threatened. In addition, a robot tractor could be hacked and could run amok, and people may deliberately interfere with robots, either for 'fun' or with malicious intent.

Monitoring of workforce performance and pace through new wearable technologies could give rise to ethical concerns and contribute to worker stress if not implemented properly. This risk would be most relevant where farm workers are monitored depending on their pro-rata performance, such as in the horticultural sector. If managed effectively through collective bargaining, however, and given that seasonal crop workers are already monitored based on the amount of fruit they pick, the impact here could potentially be positive. These technologies could add value in safety and health terms, with monitoring systems able to check and evaluate aspects such as heat stress and repetitive movements.

Recommendations

Training needs to keep pace with technological progress, and **safety and health training** will also need to be adapted to incorporate the use of digital technologies, robots and AI.

Risk assessment techniques will also need to be adapted to new technologies, such as robots and cobots, particularly in relation to AI and transparency in decision-making, to avoid risks of harm caused by misunderstandings/misinterpretations between AI and human workers (EU-OSHA, 2018).

From an early stage, **OSH considerations need to be integrated into the development and design** of new precision and smart farming equipment and technologies, as well as into farm and crop layouts, to eliminate

or reduce risk. A strong 'prevention through design' approach that integrates a user-/worker-centred design approach was also identified in an EU-OSHA report on OSH digitalisation (EU-OSHA, 2018).

However, the positive impact of new technologies and machinery on OSH will be limited unless accompanied by the development of a **genuine prevention culture** in the sector. Farm management will be at the centre of this prevention culture, along with training, education, advisory and extension services and awareness-raising activities.

OSH research on the agriculture and forestry sector should be included in the Horizon Europe research programme. Areas for research could be linked to the common agricultural policy (CAP) priority of digitalisation in agriculture, and could include research on agricultural cobots and the integration of safety, ergonomic and psychosocial considerations or smart wearable PPE for worker protection in agriculture.

Conclusions

In summary, enormous potential exists for using technological solutions (including smart agriculture) to reduce OSH risk factors in agriculture and forestry. However, **smart farming will not offer immediate solutions for safety and health** in the sector. The key challenge that remains is the effective adoption of such technology, which is associated with variables such as farm income and scale, farmer age and education, usability of specific technology, and industry and extension support for farmers. With the uptake of technology, workers' skill levels (and training) will also need to be improved to keep pace with change.

Many of the OSH improvements resulting from new technologies tend to be 'spin-offs' of developments aimed at increasing productivity and profit margins in the sector, rather than OSH goals per se. Nevertheless, such developments still offer real potential to improve the work environment, particularly when integrating effective risk assessment techniques and 'prevention by design' principles from the beginning, and thus avoiding any unintended impacts.

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