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Ensuring Safe Labor For Workers In Agriculture Through The Use Of Smart Technologies

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ABSTRACT: *This article provides recommendations on the safe operation of smart agricultural machinery and ways to enhance their efficiency. The article discusses the correct selection of smart machinery, necessary training programs to ensure workers' safety, safety systems of the machinery, and the certification processes. It also emphasizes the importance of creating ergonomic conditions to improve safe operation, implementing automatic safety systems, providing protective equipment, and the significance of technical service and maintenance. The analysis explores how the integration of innovative technologies, such as intelligent systems and artificial intelligence, can enhance safety and efficiency in smart machinery. The article includes practical recommendations for ensuring safe and efficient operations in agriculture through smart technologies.*

KEYWORDS: *Agriculture, Smartex machinery, Safe operation, Efficiency, Training programs, Safety systems, Certification, Ergonomic conditions, Automated safety systems, Protective equipment, Maintenance and repair, Innovative technologies, Smart systems, Artificial intelligence, Safe work, Efficient work.*

ANNATASIYA*: Ushbu maqolada qishloq xo'jaligida smart texnikalarining xavfsiz ishlashi va ularning samaradorligini oshirishga doir tavsiyalar taqdim etiladi. Maqolada smartex texnikalarining to'g'ri tanlovi, ishchilarning xavfsizligini ta'minlash uchun kerakli o'quv dasturlari, texnikaning xavfsizlik tizimlari va sertifikatlash jarayonlari ko'rib chiqilgan. Shuningdek, texnikaning xavfsiz ishlashini oshirish uchun ergonomik sharoitlar yaratish, avtomatik xavfsizlik tizimlarini joriy etish, himoya vositalarini taqdim etish, texnik xizmat va ta'mirlashning muhimligi ta'kidlangan. Innovatsion texnologiyalar, jumladan, aqlli tizimlar va sun'iy intellektning smartex texnikalariga integratsiyasi orqali xavfsizlik va samaradorlikni oshirish imkoniyatlari tahlil qilingan. Maqola, smartex texnikalari orqali qishloq xo'jaligida xavfsiz va samarali ishlashni ta'minlashga qaratilgan amaliy tavsiyalarni o'z ichiga oladi.*

TAYANCH SO'ZLAR*: Qishloq xo'jaligi, Smart texnikalari, Xavfsiz ishlash, Samaradorlik, O'quv dasturlari, Xavfsizlik tizimlari, Sertifikatlash, Ergonomik sharoitlar, Avtomatik xavfsizlik tizimlari, Himoya vositalari, Texnik xizmat va ta'mirlash, Innovatsion texnologiyalar, Aqlli tizimlar, Sun'iy intellekt, Xavfsiz ish,*

АННОТАЦИЯ: *В этой статье представлены рекомендации по безопасной эксплуатации умной сельскохозяйственной техники и способам повышения ее эффективности. В статье рассматриваются правильный выбор умной техники, необходимые учебные программы для обеспечения безопасности работников, системы безопасности техники и процессы сертификации. Также подчеркивается важность создания эргономичных условий для повышения безопасности работы, внедрения автоматических систем безопасности, предоставления средств защиты и значимость технического обслуживания и ремонта. В анализе рассматривается, как интеграция инновационных технологий, таких как интеллектуальные системы и искусственный интеллект, может повысить безопасность и эффективность умной техники. Статья включает практические рекомендации для обеспечения безопасной и эффективной работы в сельском хозяйстве с использованием умных технологий.*

КЛЮЧЕВЫЕ СЛОВА*: « Сельское хозяйство, Смартехники, Безопасная работа, Эффективность, Образовательные программы, Системы безопасности, Сертификация, Эргономические условия, Автоматические системы безопасности, Защитные средства, Техническое обслуживание и ремонт, Инновационные технологии, Умные системы, Искусственный интеллект, Безопасная работа, Эффективная работа.»*

INTRODUCTION

Agriculture occupies a critically important role in human life, and increasing its efficiency while ensuring the safety of workers is one of the most pressing issues today. With the development of modern technologies, the use of smart machinery in agriculture has become possible. Smart machines are innovative technical tools that integrate artificial intelligence, sensors, and automation technologies, enabling complex processes such as soil cultivation, harvesting, and pest control to be performed with high precision and efficiency.

These technologies play a particularly important role in labor protection in agriculture. By reducing the human factor, smart machines eliminate hazardous working conditions and significantly lower the risk of injuries. Moreover, these technologies

contribute to ecological sustainability, efficient resource utilization, and increased labor productivity. As an integral part of modern agricultural innovations, smart machines not only simplify production processes but also create new opportunities for ensuring the health and safety of workers.

The application of smart machinery elevates agriculture to a higher technological level, contributing to the resolution of global challenges in the field, particularly in safeguarding worker health and restoring ecological balance. Therefore, the introduction of smart technologies in agriculture as an advanced solution for labor protection is becoming increasingly relevant.

RESEARCH METHODS

The study employed a range of methods including analysis of scientific and methodological literature, pedagogical observation, comparative analysis, generalization, programming, and digital modeling.

LITERATURE REVIEW

Several studies have investigated the application of smart machinery in agriculture to ensure labor safety. Notably, specialists such as S.V. Aleksandrov, N.V. Kosyakov, and G.P. Timofeev have examined the role of technological innovations in enhancing occupational safety. Their work provides recommendations on ensuring the safety of machinery and creating ergonomic conditions for workers, emphasizing the importance of certification and the implementation of safety systems.

In the context of integrating digital technologies into agricultural machinery, the studies by M.A. Shneps-Shneppe and D.Ye. Namiot explore the main components of the digital economy and its characteristics. Their research highlights the significance of digital technologies and smart systems in improving machinery efficiency.

Furthermore, according to GOST 12.0.003-74 and studies on ergonomic conditions and automated safety systems by researchers such as Sh. Mustafakulov and Z.M. Qurbonov, practical recommendations are provided for creating the necessary conditions for the safe operation of smart machinery. They emphasize the importance of developing control systems based on artificial intelligence and automation to enhance operational safety.

Maintenance and repair processes also play a critical role in labor safety. Researchers such as M.Yu. Jumaniyozova and Z.M. Otakuzieva have studied the effective organization of technical service and the impact of regular maintenance on machinery safety. Their findings underscore the importance of consistent maintenance and repair to ensure the safe operation of agricultural machinery.

In summary, the existing scientific literature on ensuring the safe operation of smart machinery in agriculture provides important insights into the use of new technologies and the creation of ergonomic conditions. These studies form a solid foundation for developing practical recommendations and implementing the approaches presented in this article.

RESEARCH RESULTS AND DISCUSSION

With the development of modern technologies, smart machines have become increasingly important in various sectors of human activity. Smart machines are devices or technical tools that operate using artificial intelligence, the Internet of Things (IoT), sensors, and automation technologies, designed to perform diverse tasks autonomously. These machines are capable of collecting, analyzing, and making decisions based on real-time data, which fundamentally distinguishes them from traditional technologies and enhances operational efficiency.

One of the main features of smart machines is their autonomous operation capability. For instance, autonomous vehicles, including driverless cars, can independently determine their routes and navigate around obstacles. They rely on GPS systems for movement and use high-precision cameras and sensors to detect the surrounding environment. Such smart machines are widely applied in logistics, urban transport, and tourism sectors.

In addition, smart machines in manufacturing and agriculture play a crucial role. Automated production robots in industrial enterprises perform assembly, processing, and packaging operations. These robots reduce human physical labor, increase production speed, and lower the risk of injuries. In agriculture, smart tractors, combines, and drones efficiently handle soil cultivation, harvesting, and pest detection tasks.

Household appliances also represent a distinct category of smart machines. Intelligent vacuum cleaners, refrigerators, and washing machines simplify users' daily lives. Using IoT technology, these devices can connect with other devices and be controlled remotely. For example, a smart refrigerator monitors product inventory and notifies the user when essential food items are running low.

Another important category of smart machines is drones. Equipped with high-precision cameras and artificial intelligence systems, drones are applied in diverse fields ranging from logistics to search and rescue operations. In agriculture, drones assist in monitoring field conditions and in the precise distribution of fertilizers and pesticides, improving efficiency and reducing human exposure to hazardous chemicals.

Depending on needs and technological possibilities, there are many other types of smart machines. Surgical robots in medicine perform complex operations, while smart meters in the energy sector optimize electricity consumption. The overarching goal of all smart machines is to simplify human labor, ensure safety, and improve resource efficiency.

Smart machines clearly play a critical role in the technological development of the future. Their implementation across various sectors increases productivity, optimizes production with minimal environmental impact, and improves quality of life. Therefore, studying and applying these technologies is a pressing issue today.

In modern agriculture, the adoption of smart technologies is becoming increasingly relevant. Smart machines, including drones, autonomous tractors, and intelligent irrigation systems, play an essential role in addressing numerous agricultural challenges. These technologies provide high efficiency, conserve resources, and significantly contribute to labor protection.

One of the main benefits of smart machines in agriculture is the mitigation of inefficient resource use. For example, intelligent irrigation systems monitor soil moisture and supply only the necessary amount of water. This conserves water resources and ensures optimal plant growth conditions. Similarly, smart combines and tractors reduce fertilizer and fuel consumption, making production more environmentally sustainable.

Smart technologies also play a key role in pest and disease control. Drones can monitor field conditions and detect pests or diseased plants at an early stage. Based on this data, pesticides are applied only to targeted areas, minimizing environmental impact and limiting direct contact with humans. This is particularly important for labor protection, safeguarding workers' health.

Automated machinery, such as autonomous tractors and combines, significantly reduces physical workload. Automation of heavy manual labor decreases worker fatigue and the risk of injury. Moreover, remote-controlled technologies enable workers to operate in hazardous conditions, such as extreme heat or cold, without direct exposure.

The use of chemicals is another area where smart machines ensure safety. Traditionally, workers handling pesticides were at risk of chemical exposure, negatively affecting their health. Now, drones and other automated devices can safely apply pesticides and fertilizers to precisely defined areas. This approach protects workers and improves product quality.

Smart machines also allow real-time monitoring and optimization of work processes. Sensors and artificial intelligence systems track soil conditions, productivity, and other parameters, providing reliable information for decision-making. These technologies facilitate effective field management, improve labor culture, and enhance workers' skills.

The adoption of smart machines in agriculture addresses numerous challenges while elevating labor protection to a new level. They help save resources, ensure worker safety, and promote ecological sustainability. Proper implementation of these technologies not only enhances productivity but also simplifies labor and guarantees safety.

Despite their advantages, some challenges and risks exist in using smart machines. Firstly, these technologies require significant financial investment. Purchasing and maintaining smart machinery can impose substantial costs on agricultural enterprises. Additionally, the shortage of skilled personnel for operation and technical maintenance is a significant issue.

Over-reliance on technology can also have negative consequences. For example, malfunctions in sensors or software may result in decisions based on inaccurate data, potentially affecting crop yields and causing economic losses.

To mitigate these risks, several measures should be implemented. Regular technical inspections of smart machines are necessary to ensure continuous operation. Furthermore, training workers to operate new technologies and providing specialized courses is crucial. This approach ensures both effective management of machinery and enhanced safety.

Overall, smart machines have a significant positive impact on productivity, improve operational efficiency, and facilitate rational resource use. Automated systems reduce physical labor, thereby enhancing worker efficiency. Real-time monitoring enables farmers to track every field operation accurately and allocate resources effectively.

The use of smart machines in agriculture plays a vital role in increasing sector productivity and ensuring labor safety. Correct planning and management are essential to address potential challenges and risks associated with implementing these technologies. When applied appropriately, smart technologies can contribute to the sustainable development of agriculture.

Agricultural work involves hazardous and potentially harmful tasks, including heavy physical labor, handling chemical substances, and operating dangerous machinery. The implementation of smart technologies provides effective solutions to these problems, elevating labor protection to a new level. Autonomous smart machinery reduces human exposure to risks, prevents injuries, and safeguards workers' health, particularly when dealing with pesticides, fertilizers, and heavy equipment.

Figure 1. Application of Smart Technologies in Agriculture

In agriculture, tasks that require heavy physical labor, such as soil cultivation and harvesting, often pose risks to workers' health. Smart machinery, including automated equipment, reduces the physical workload by automating these processes. This not only increases labor productivity but also ensures healthier and safer working conditions.

Additionally, smart technologies allow real-time monitoring of hazardous work conditions. For example, sensors can detect temperature, humidity, and other potentially dangerous conditions in the field and alert workers accordingly. This helps ensure worker safety and prevents injury incidents.

Figure 2. Smart Machines and Human Labor Activities in Agriculture

The implementation of smart technologies in labor protection not only ensures worker safety but also contributes to the efficiency of agricultural processes. By applying innovative technologies, the negative consequences of hazardous and harmful work in agriculture can be significantly reduced. Therefore, the widespread adoption of smart technologies is not only economically beneficial but also strategically important for protecting human life and health.

CONCLUSION

The use of smart technologies in agriculture plays a crucial role in ensuring worker safety, preventing occupational diseases, and increasing production efficiency. Autonomous technologies and robotics, such as autonomous tractors, drones, and smart irrigation systems, help automate agricultural processes, improve working conditions, and ensure the safety of labor. These technologies minimize hazardous situations, protect workers from dangerous conditions, and reduce the risk of injuries. Additionally, in processes involving chemical substances, smart technologies prevent direct human contact, which is critical for preventing occupational diseases.

Furthermore, smart technologies allow for efficient management of production processes. Through autonomous systems and sensors, operations are carried out precisely and quickly, saving time, optimizing resource use, and improving production efficiency. Smart systems also ensure effective use of energy and water resources, enhancing the environmental sustainability of agriculture.

However, the introduction of smart technologies also has some drawbacks. Firstly, they require significant initial investments, which may create financial challenges for small and medium-sized farms. Secondly, the lack of qualified personnel and technical malfunctions can pose additional problems. Successful implementation requires proper training of skilled personnel and robust technical maintenance.

In summary, smart technologies serve to enhance labor safety and production efficiency in agriculture. Yet, challenges such as high investment costs, technical malfunctions, and insufficient qualified personnel must be addressed. Effective implementation of these technologies is a key factor in improving labor safety and ensuring sustainable agricultural productivity.

Recommendations:

1. Proper Selection and Implementation of Smart Equipment: Smart machines should be compatible with all types of agricultural equipment. Machine size, power, and capabilities must match operational conditions. Technical parameters should be considered to ensure safe and efficient integration with new technologies.
2. Training Workers on Smart Equipment: Workers should undergo specialized training on operating smart machines. Training programs should cover device capabilities, operating principles, and safety procedures. Practical demonstrations and safety guidelines should be provided.

3. Monitoring Safety and Equipment Certification: Smart equipment should undergo regular safety inspections. All safety systems, sensors, and automatic alerts must comply with established standards. Regular certification of machines is essential.
4. Creating Safe Working Conditions: Ergonomic and safe conditions should be ensured at the operation site. Areas should be secured to prevent fire, electrical hazards, or mechanical failures.
5. Personal Protective Equipment: Workers should be provided with protective gear, such as gloves, footwear, and goggles, especially for high-speed or heavy machinery. Training on correct use of protective equipment is necessary.
6. Equipping Machines with Automatic Safety Systems: Smart machines should have sensors and automatic shutdown systems to protect operators and prevent malfunctions. These systems should detect hazardous conditions and alert workers.
7. Improving Maintenance and Repair Procedures: Machines should undergo regular maintenance to ensure safe operation. Components must be checked, potential malfunctions repaired, and service schedules established to maintain optimal performance.
8. Incorporating Innovative Technologies: Integration of AI and smart systems can automate monitoring, detect errors, and minimize risks, ensuring efficient and safe machine operation.
9. Developing New Safety Standards: New safety standards should be established for smart machines. Potential risks associated with innovative technologies must be identified, and technical requirements and safety regulations developed to improve labor conditions.

Implementing these recommendations ensures the safe operation of smart technologies in agriculture, safeguarding workers while enhancing production efficiency.

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