TECHNOSPHERE SAFETY

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Improvement of Employees' Working Conditions When Processing Vegetables in Open Ground by the Designing Device for Lifting and Lowering Containers in the Storage

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Introduction. Vegetable production is one of the branches of plant cultivation that is distinguished by the specifics of conducting technological processes, characterized by the structural variety of cultivation facilities and special working conditions. Injuries of employees are the serious problem in the workplace now. The body of a worker is exposed to a complex of unfavorable production factors: mineral fertilizers, pesticides and products of their metabolism: heating microclimate, high humidity, significant physical exertion. If agrotechnical techniques are followed, they cannot be a source of deterioration of health. Violation of sanitary and hygienic regulations and technological schemes for growing crops increases the risk of health problems and affects the ability to work.
Problem Statement. The task for the study is to develop a simplified design to lower vegetables into storage, improve working conditions and safety of workers.
Theoretical Part. Occupational safety improvement in agriculture is necessary, first of all, from the point of the preservation and purpose of the system as a mechanism for protecting the interests of workers, guaranteeing the preservation of their life, health, working capacity in the process of professional activity, as well as for the purpose of agricultural production efficiency. There is an urgent problem of safety when laying vegetables in containers. The main type of injury to workers is occurred during work for eliminating technical and technological failures.
Conclusions. As a result of the research, market analysis and evaluation of the competitiveness of the development under consideration, the main distinguishing features of the proposed device from the existing ones are determined. This design can be recommended for further integration into the existing enterprise system, as well as for use in any agricultural enterprises.

Keywords: working conditions, labor safety, technology, vegetable storehouse, containers, lift, trolley, ramp, overturning.

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Introduction. The development strategy of the Russian Federation is aimed at the development of the agro-industrial complex, which provides for a steady increase in agricultural production and entails an increase in labor productivity, acceleration of scientific and technological progress. As a result, the role of the human factor increases under certain working conditions associated with the production and sale of agricultural products [1, 2].

During the years of reforms, about half of the fixed assets of the agro-industrial complex were lost; a large amount of machinery and equipment became obsolete and became unusable [3]. It is no coincidence that every third injury with temporary disability and every fourth with a fatal outcome that occurred in the national economy of the country fall on the agro-industrial complex (AIC) of Russia [4]. It is also important that, with a general decline in production volumes, injuries and morbidity in the industry have not significantly decreased. Over the past ten years, the number of fatalities in rural construction has amounted to about 9% of the number of victims in all branches of agriculture, crop production — 23.2%, repair and maintenance of machinery — 18.1%, animal husbandry — 16.2% and food production — 9.9% [5–8].

Improving labor protection in agriculture is one of the priority areas. First of all, it is necessary to improve labor safety at the level of the agricultural industry development system, move away from outdated equipment, modernize human labor, replacing manual labor with mechanical labor, introduce the principles of digitalization, and calculate risks and possible negative developments.

The problem of ensuring the safety of workers when using agricultural machinery remains relevant today, as the sources of injury in 74% of cases with a fatal outcome are machines and mechanisms.

As a result of experimental studies during potato harvesting in various farms from 2010 to 2020, the most dangerous and harmful production factors affecting workers were identified.

The main type of injury to workers is work to eliminate technical and technological failures, which accounts for about 27% of the total operating time. According to source [8], a diagram was compiled reflecting the troubleshooting time (Fig. 1):

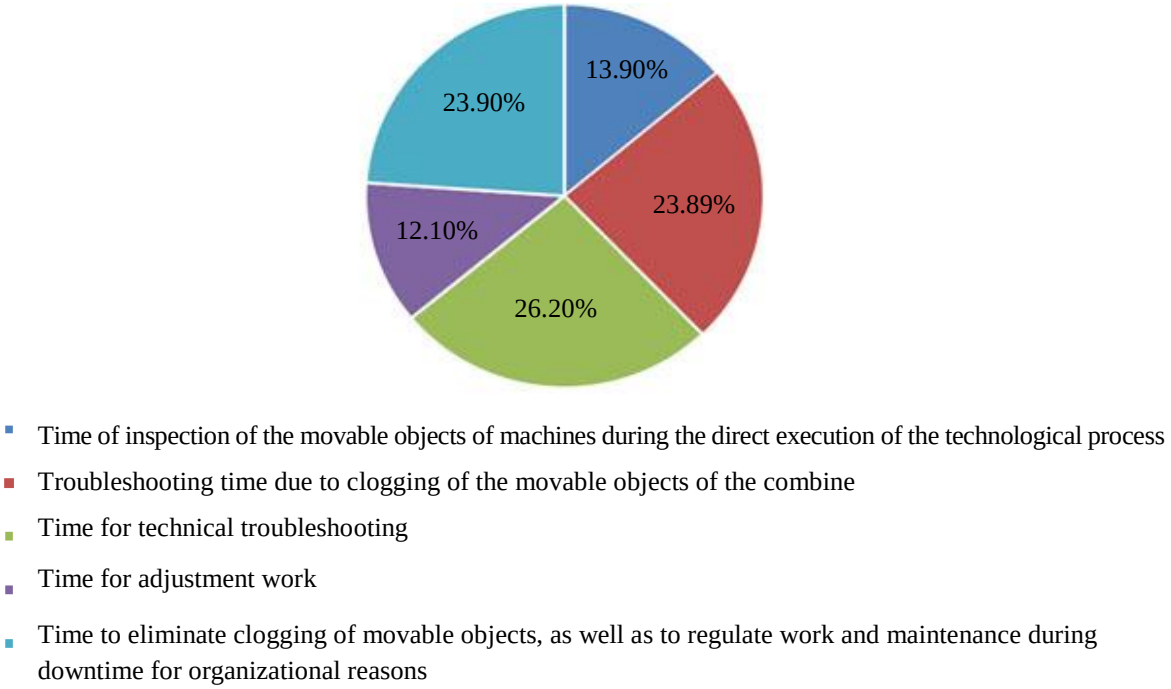

Fig. 1. Main causes of injuries to workers

The process of laying vegetables in storage remains dangerous from the point of view of safety and labor protection (Fig. 2). The technology has remained unchanged since the 90s. First, the potatoes are poured into a hopper, from where they are transported and moved, then at the end of the work they are put into containers.

Fig. 2. The process of laying potatoes in storage

After that, with the help of loaders, containers with potatoes are delivered to the storage and put up in columns. The disadvantage of this technology is that not all storages have the possibility of access of loaders. Part of the storages of large agricultural concerns is buried in the ground by 1–1.5 meters and ramps are specially equipped for arrival. However, it is impossible to move along the ramps due to the danger of car overturning together with the container [9, 10].

Problem Statement. The objective of the study is to propose a developed, simplified design for lowering vegetables into storage, which will improve the working conditions and safety of workers.

Theoretical Part. The rationale for the development of a device for lifting and lowering containers into storage during the processing of open-ground vegetables was the study of regulatory requirements for the organization of this type of work on the territories of agricultural complexes. After conducting a critical analysis of the existing solutions to this problem, a number of shortcomings were identified.

Lifts can be installed both outside the building and inside in a temporal and permanent way. A variety of options for lifting cargo, different high-altitude tasks, working conditions gave rise to differences in the design features of lifts: various cargo open and closed platforms, swing doors or roller shutters, only one control panel or one on each floor, various types of safety and locks, the type of lift drive, etc. The design of the lift depends on the load rate, installation location and application. This type of lifts is capable of lifting cargo to a height of up to 50 m. The cargo lift is installed outside or inside the building.

For the installation of the lift, it is possible to use the existing lift shafts of the building. Each lift model has an upper and lower drive arrangement. The main technical characteristics of the cargo lift are its load capacity from 50 to 6300 kg, lifting height from 7500 mm to 36 meters.

The SC 100 construction lift with a single cab is characterized by ease of maintenance and operation. The cabin is equipped with a speed limiter to stop the equipment when the lowering speed reaches 12 m/sec. The lift is equipped with an overload protection system that turns off the power when the permissible load capacity is exceeded. This equipment is able to significantly increase the level of production safety due to the stability and evenness of work [11].

The main components of the construction lift with two cabins SC 200/200 are cabins, operator's cabin, transmission mechanism, speed limiter, roller guide frame, connectors, lower cabin, mast, electrical system, safety system.

The container lift with manual mechanical (winch) drive "BAMBULA 252-16-4" with a steel frame is designed for lifting and moving baskets/containers. The considered devices do not allow to be used when lowering and lifting loads on the territory of the vegetable storage. The most suitable in this case are inclined lifts.

The advantages of inclined lifting platforms:

– available in three different options;

– the installation of the lift does not require any construction work and does not spoil the design of the premises;

– has remote control, active and passive safety devices, retractable safety barriers, which reduce the occupied space when the equipment is not in use.

The developed inclined lift consists of a rectangular cross-section mast located at a certain angle to the ground (Fig. 3). A cargo platform (cab) moves along one of the sides of the mast under the action of an electric drive, which can be installed at the top, bottom or side of the mast (Fig. 4). The lift is mounted on a load-bearing base, which is flat or in the form of a pit. The control is carried out using push-button control posts from any stop. On request, it is possible to supply a lift with fences for each floor.

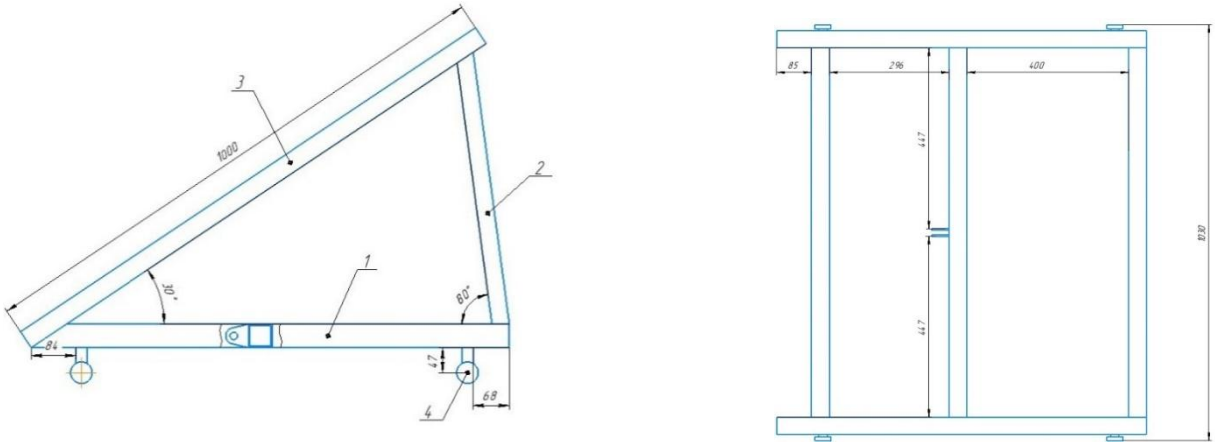

Fig. 3. General view of the inclined lift under development

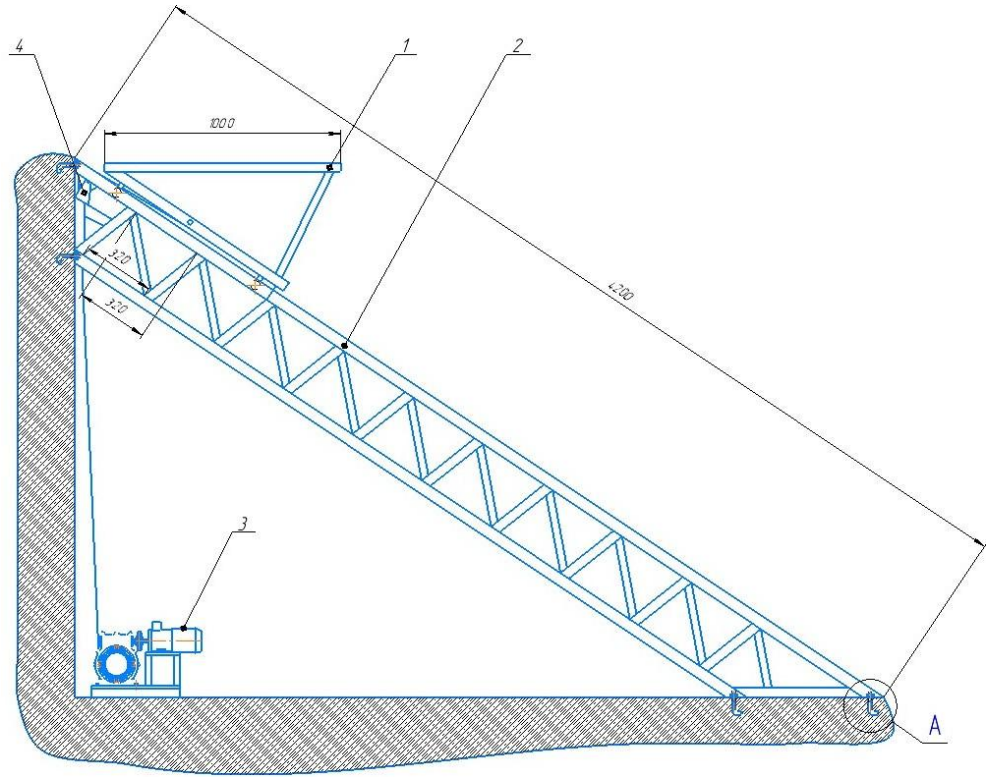

Fig. 4. General view of the inclined lift under development:

1 — trolley, 2 — lift, 3 — engine

The control is carried out using a push-button station (PBS), which is located on or near the mast. Sending and calling of the cargo cage is carried out with the help of the PBS from any floor to any floor. The control units are equipped with a light indication that allows you to determine the location of the cage (Fig. 5).

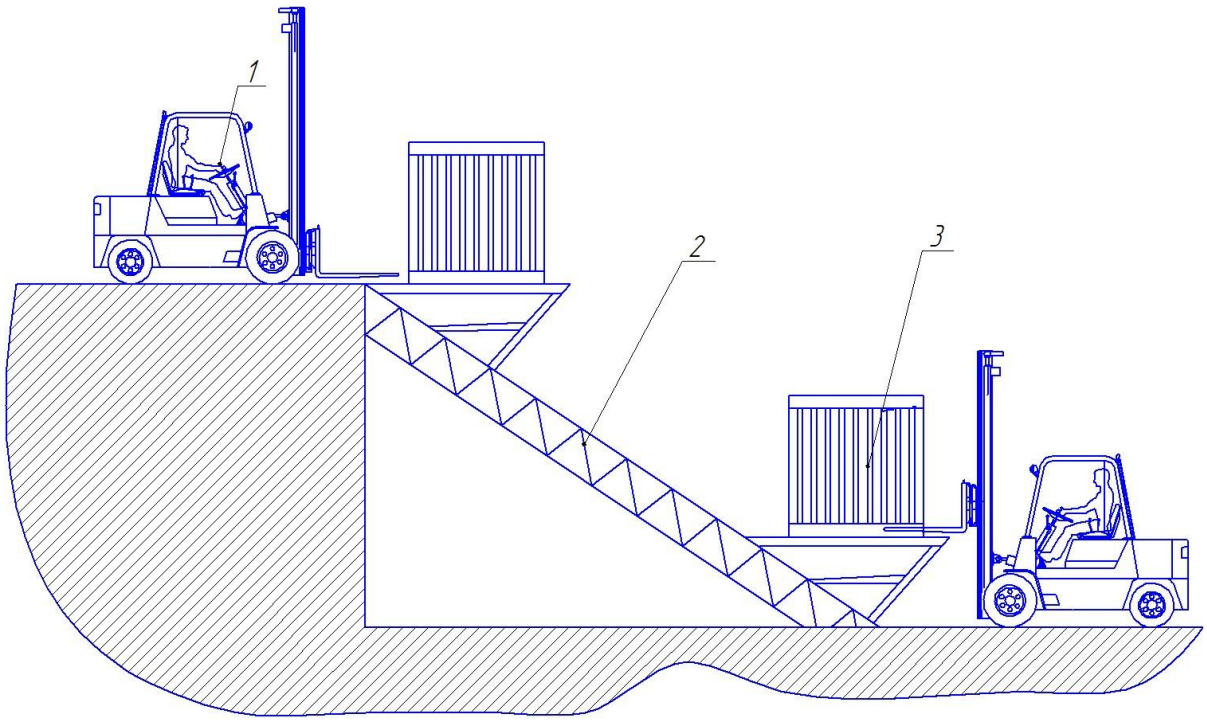

Fig. 5. General view of work using an inclined lift for containers:
1 — loader, 2 — lift, 3 — container

When designing an inclined lift, constructive calculations were carried out, the method of calculating inclined lifts was used; its performance, load capacity, required power, speed of movement of the lifting platform and permissible angles of inclination of the mast were determined. The introduction of the design will solve the problem of improving working conditions; reduce the number of injuries and accidents.

Conclusions. An inclined lift for containers has been developed and recommended for implementation, which makes it possible to perform these works more safely and efficiently, taking into account the specifics of the industry and work. This development can be recommended for use in any agricultural enterprise with similar types of work.

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N. V. Matyusheva — formulation of the basic concept, goals and objectives of the study, calculations; V. M. Khudyakova — preparation of the text, analysis of the research results, formulation of the conclusions.