

Determination of occupational risks in Cherry tomatoes cultivation under greenhouse conditions

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ABSTRACT: *Currently, climatic conditions have modified field production scenarios. This situation has led to the search for new production alternatives, where greenhouse growing conditions occupy an important place. In this work, a procedure is applied for risk analysis in the cultivation of Tomatoes in a greenhouse. A methodology is proposed for determining risks and other factors that affect occupational safety in these facilities. A set of actions was established with the purpose of preventing, eradicating or controlling occupational risks, as well as a process to manage them in an integrated manner.*

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I. INTRODUCTION

In Mexico, agricultural production is limited by a series of natural, economic, social and political factors that participate together. Approximately 80% of the total crop area has erratic and scarce weather, which causes low yields per unit area and poor quality of the products obtained from the field [1]. Authors such as [2] suggest that vegetative development and climatic factors sometimes make it difficult to grow certain species in the open air; the solution to these difficulties is to grow vegetables under a greenhouse. According to [3], tomatoes grown in greenhouses have higher yields compared to those grown outdoors, in addition their fruiting is distributed in a shorter time and they gain precocity.

The tomato (*Solanum lycopersicum* L.) is the most popular and accepted vegetable in the gastronomic culture of the world, since its fruits are consumed fresh or industrialized [4]. Tomatoes are grown in more than one hundred countries; Of them, China, the USA, India and Turkey produce 57% of the total, and Mexico occupies tenth place in its production [5]. In [6] state that greenhouses are closed structures made of wood or metal, provided with a transparent cover - polyethylene -, which allows the passage of sunlight and prevents the escape of heat. These artificial microclimate conditions allow cultivation in optimal conditions inside without being subject to seasonal climatic changes.

The dangers constituted by facilities in poor condition or by the physical environment, poor working conditions, long working hours or poorly organized work days, excessive work rhythms and remuneration dependent on performance are risk factors for the occurrence of accidents and illnesses. from work. These conditions have a direct impact on people's quality of work and family life. From the point of view of occupational risks, agriculture has been a "forgotten" sector, as García López et al point out [7].

The work under greenhouses is not far from what the vast majority of farmers do in the open air. The activities are carried out in conditions that reflect the need to build solid action schemes that allow influencing the prevention of accidents and diseases typical of agricultural work. The purpose of carrying out an occupational risk assessment is to identify the dangers or risk factors in order to eliminate or minimize them, prioritizing the preventive measures to be taken and establishing the appropriate means of control. In this work, a risk analysis was carried out in the cultivation of cherry tomatoes under greenhouse conditions, proposing a methodology for determining risks and other factors that affect occupational safety in these facilities.

II. MATERIALS AND METHODS

The To collect the necessary information, surveys, direct observations and in-depth interviews with workers and owners of the small business were used, in order to generate a diagnosis of the safety and hygiene conditions in the facility. In carrying out the study, the methodologies proposed by the Ministry of Labor and Social Affairs of Spain, and the National Institute of Safety and Hygiene at Work of the country itself, for the Evaluation of Occupational Risks in Small and Medium Enterprises, were taken as a reference

basis. Company (SME) As well as those related to the official regulatory context of agricultural work in Mexico, the Official Mexican Standards (NOMs) the NOM-003-STPS-1999 – and its modification in 2003- and the NOM-007-STPS-2000 that They are identified with special interest for agricultural activity.

The proposed methodology consists of four fundamental stages, stage 1 is based on risk identification taking into account the (non-exhaustive) list that appears in figure 1, and which was prepared in accordance with the provisions of NOM-003-STPS- 1999 and NOM-007-STPS-2000.

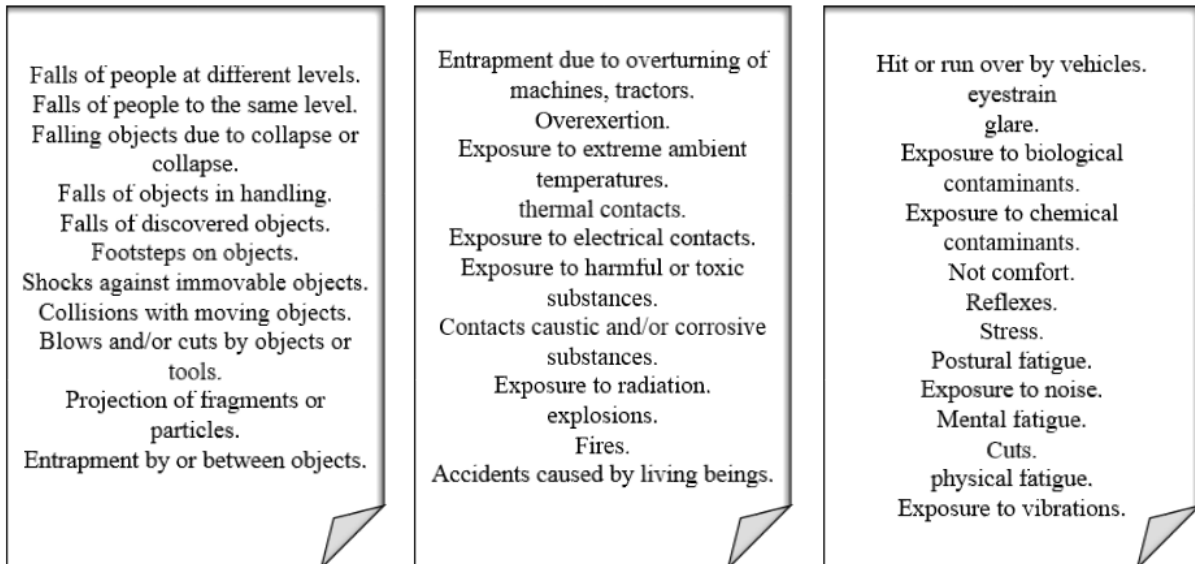


Fig. 1 List of possible risks that may occur in greenhouses. (Proposed original design).

In stage 2, the risk assessment or estimation is carried out. For each risk detected, the severity of the damage (consequences) and the probability of the event occurring must be determined, as can be seen in Figure 2. To determine the potential severity of damage, the following should be considered: a) Parts of the body that will be affected; b) Nature of the damage, grading it between slightly harmful, harmful and extremely harmful. As can be seen in figure 2.

The probability of damage occurring is graded from low to high, for this the following criteria will be taken into account: a) High probability: damage will always or almost always occur; b) Medium probability: damage will occur on some occasions; c) Low probability: damage will occur rarely.

		Consequences		
		Slightly Harmful	Harmful	Extremely Harmful
Probability	Low	Trivial Risk	Risk Tolerant	Moderate risk
	Half	Risk Tolerant	Moderate risk	Significant risk
	High	Moderate risk	Significant risk	Intolerable risk

Fig. 2 Severity of the damage and the probability of the event occurring (Proposed redesign).

In stage 3, the planning and execution of preventive measures to eliminate, control and reduce risks is worked on. This is the essential instrument for the management and application of the Occupational Risk Prevention Plan, which is materialized in a document that establishes “what preventive measures must be carried out to eliminate or reduce and control occupational risks, “who should do them”, “when they will be done” and “how it will be controlled that they have been done”.

Risk	Action and Timing
Trivial	It is not required a specific action.
Tolerable	There is no need to improve preventive action. It is advisable to consider solutions or improvements that do not entail a significant financial burden.
Moderate	Efforts should be made to reduce risk by determining the precise investments.
Important	Work should not begin until the risk has been reduced.
Intolerable	Work should not be started or continued until the risk is reduced. If it is not possible to reduce the risk, even with unlimited resources, the work should be prohibited.

Fig. 3 Actions to be taken depending on the severity of the risk. (Proposed redesign).

The fourth stage refers to the control and compliance with the proposed preventive measures. Contributing effectively to controlling or eradicating occupational risks, carrying out the development of a plan for compliance with the methodology.

III. RESULTS

The tasks usually carried out in the greenhouse are land preparation, soil disinfection, removal of crop remains, destruction of weeds, transplanting/planting work, pruning, leaf removal, handling of pollinating insects, preparation and application of pesticides and fertilizers. , staking, thinning of defective or excessive fruits and harvesting. These activities, which Pérez Alonso (2011) also identified, together with those carried out during the maintenance of the greenhouses, present a series of risks that affect the safety and health of the workers of these facilities. To carry out this study, the methodology described above was taken as a guide and can be clearly seen in Figure 4.

Through the study carried out, the deficiencies found were recorded, as well as dangerous elements and the factors that may cause the risk to materialize or not with the purpose of subsequently evaluating the risk and the most probable consequences that may occur. The risks in the workplace were identified and assessed considering that the worker who currently occupies it is not included in any specific protection case. For this, the existing protection or prevention measures were analyzed and whether these measures are correct or not, or if they are maintained over time or depend on their application by each worker. The risks detected were the following:

The Falls to the same level (1): This type of risk occurs in greenhouses due to the existence of slippery or wet floors and obstacles in the steps or accesses inside the buildings.

Falls at different levels (2): They appear during ship maintenance. In the cultivation phase, it originates from carrying out different work tasks, either for placing the raffia, tying and rearranging the plant or due to the height that it can reach.

Falling objects during handling (3): Handling of the collection drawers may result in them falling at the worker's feet, as well as the use of tools during greenhouse repair or maintenance tasks.

Entrapment due to overturning (4): One of the safety problems is the overturning of the mobile platforms for harvesting the fruit.

Entrapments, knocks and cuts in machinery (5): Among the elements of the equipment used in greenhouses that can cause this risk are the conveyor belts of production boxes.

Cuts and punctures (6): When handling hand tools such as knives, scissors, wires, tips, etc. cuts or punctures may occur.

Bumps and entrapments (7): These occur when the structure, cables, tensioners, and construction elements of the greenhouse cover present defects due to deterioration. Bumps and trapping can also occur due to uncontrolled movements of tools, machine elements or other objects.

Fire or explosion (8): The accumulation of combustible or flammable materials next to ignition sources is another of the risk factors that tend to occur most frequently. The risk caused by short circuits in the greenhouse's electrical system can be taken into account.

Poisoning by chemical products (9): The facility handles phytosanitary products, fertilizers and other preparations for use in agriculture, fuels and fuels, calcium carbonate, solvents, etc. Likewise, exposure to dust, particles and aerosols generated in work such as cleaning and disinfecting the greenhouse for cultivation must be taken into account.

Exposure to physical agents (10): In the greenhouse, the combination of temperature, environmental humidity, physical effort, inadequate work clothing and poor ventilation, creates a risk of significant thermal stress that is generated especially in the months of May to August.

Exposure to biological agents (11): Organic waste from compost use may contain biological agents harmful to workers. The bites of the pollinating insects used for this activity can be considered in this section, as well as the possible exposure to other biological agents such as bacteria, given the temperature and humidity conditions.

Exposure to environmental agents (12): Due to the proximity to the Colima volcano, facilities and workers may be at risk of eruption or expulsion of ash. Tropical storms that occur in the region can also have a severe impact.

Physical load (13): In harvesting tasks, loads are handled, which can lead to overexertion, with the risk of musculoskeletal injuries. Forced positions are frequently adopted during different cultivation tasks (planting, harvesting, pruning, etc.), performing repetitive work that favors the appearance of this type of injuries.

Work stress (14): Excessive working hours, and tasks that require a qualification other than the one possessed, inadequate distribution of tasks, lack of coordination, conflicts between colleagues, etc. They make up a work environment that sometimes leads to stress.

Derived from the lack of gender perspective (15): Poor adaptation of protective materials and equipment for women who form the majority of greenhouse workers. Likewise, the influence of high temperatures or the lack of knowledge about the effects of chemical products become specific risks for female workers.

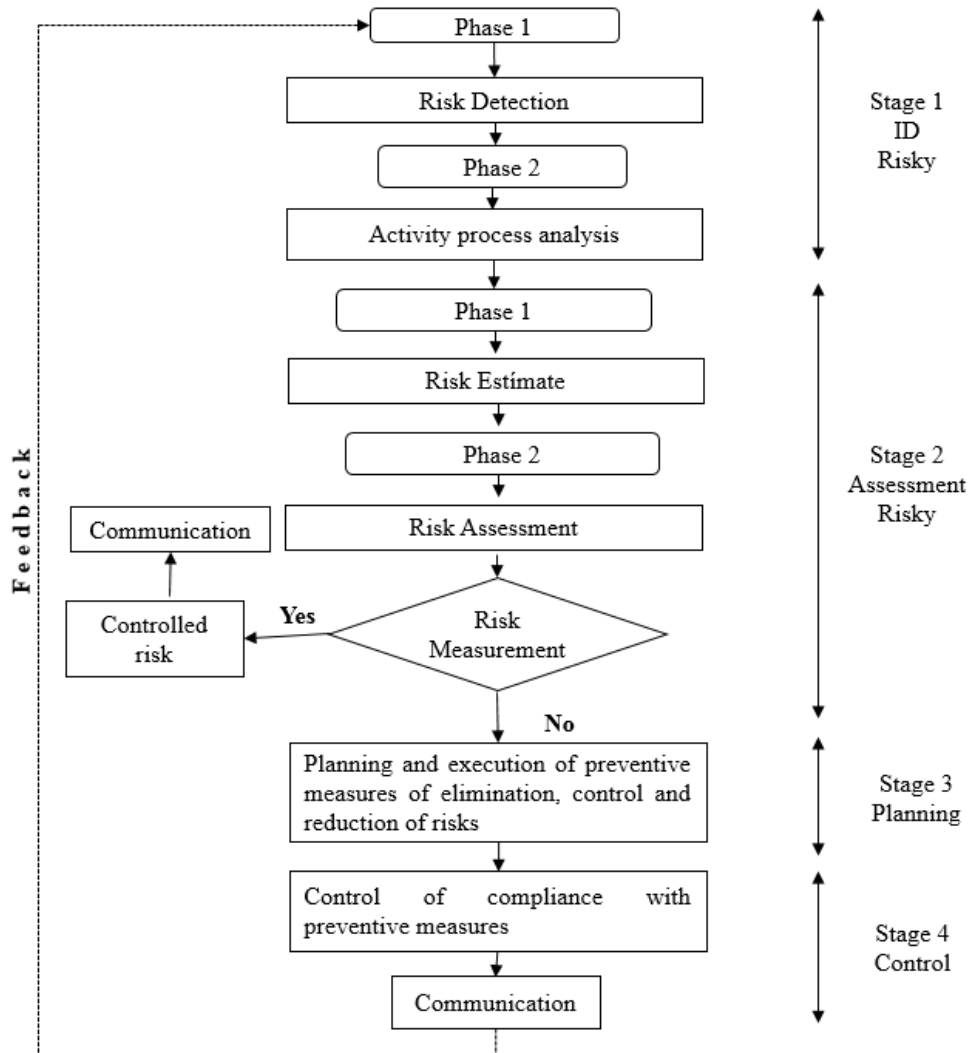


Fig. 4 Methodology to manage occupational risks in an integrated way and with a process approach. (Proposed redesign).

After identifying the risks that affect the safety and health of workers in the facility, they were evaluated taking into account the criteria established in table 1. These are as follows (see figure 5).

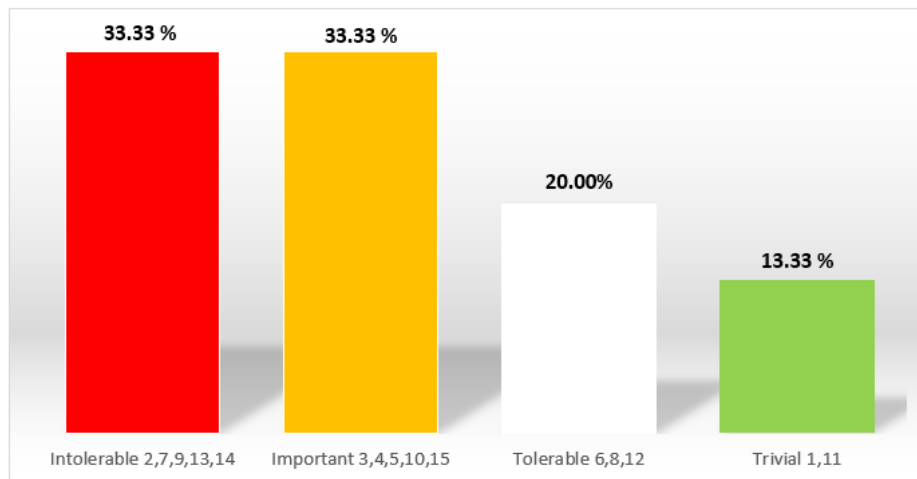


Fig. 5 Classification of risks detected after their survey. (Proposed redesign).

The classification of risks made it possible to establish a compendium of actions to prevent, eradicate or control them and thus focus efforts on those classified as important and intolerable, which must be addressed before starting work. These guidelines can be seen in figure 6.

	Riesgo	Actions to prevent, eradicate or control risks
Important	Falling objects during handling (3)	Use of personal protective equipment: safety boots and industrial gloves.
	Rollover entrapment (4)	Training in the use of agricultural machinery, preventive maintenance of tractors and proper use of protective clothing, safety footwear, industrial gloves and visual protection.
	Entrapments, blows and cuts in machinery (5)	That the greenhouse staff use the protective equipment provided to them such as gloves and observe the protective measures and appropriately calibrate the operating parameters of the conveyor belt.
	Exposure to physical agents (10)	Carrying out awareness campaigns about the mandatory nature of monitoring the health of workers.
	Derived from the lack of gender perspective (15)	Adaptation of materials, preventive measures and prevention equipment to the characteristics of working women.
Intolerable	Falls at different levels (2)	Stability in the design of equipment and use of personal protective equipment (observance of the parameters when designing and building equipment), as well as safety measures: helmet and safety boots.
	Hits and entrapments (7)	Prepare a maintenance plan for the greenhouse.
	Chemical poisoning (9)	Training in the use and application of chemical products (use of masks, appropriate clothing, work glasses and necessary equipment).
	Physical load (13)	Requirement of compliance with the regulations on machines and work equipment (NOM-003-STPS-1999 - and its modification in 2003- and NOM-007-STPS-2000).
	Work stress (14)	Installation of hygienic services and rest areas, strategically distributed in the greenhouse.

Fig. 6 Actions to prevent, eradicate or control them. (Proposed redesign).

IV. CONCLUSION

The identification and assessment of risks in the workplace was carried out considering that the worker who currently occupies it is not included in any specific protection case.

The occupational risks to which the workers in the Jitomate greenhouse are exposed were determined.

A methodology was established and applied for the evaluation of occupational risks that yielded a

total of 10 situations that must be addressed before starting work.

A proposal of actions was made that allows the execution of preventive measures to eliminate, control and reduce risks.

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