Addis Ababa University

Addis Ababa Institute of Technology

School of Mechanical & Industrial Engineering

Investigating Workplace Risks & Ergonomic Interventions for Agricultural Harvest Workers: A Case of Agri-flower Strawberry Harvesting Workers of Holeta

A Thesis Submitted to the School of Graduate Studies of Addis Ababa Institute of Technology, Addis Ababa University in partial fulfillment for the Degree of Master of Science in Industrial Engineering

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Declaration

I hereby declare that the work which is being presented in this thesis entitled "Investigating Workplace Risks & Ergonomic Interventions for Agricultural Harvest Workers: A Case of Agri-flower Strawberry Harvesting Workers in Holeta" is original work of my own, has not been presented for a degree of any other university and all the resource of materials used for this thesis have been duly acknowledged.

Hana Girma

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This is to certify that the above declaration made by the candidate is correct to the best of my Knowledge.

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Abstract

The main aim of this research study is to investigate the workplace risks faced by agricultural harvest workers and proposes ergonomic interventions to mitigate these risks and improve worker safety and well-being of Agri-Flower strawberry harvesting workers in Holeta.

A mixed method approach is used to meet the research objective and answer research question. Systematic way of literature review is conducted to approach the study. Comprehensive risk assessment is conducted to evaluate the likelihood and severity of each identified risk. Stata 15 version and excel used for data analysis.

This assessment identified MSDs as a decisive from the whole prioritized and identified risks. Therefore, based on that, the study proposed several ergonomic interventions to address the identified risks and improve worker safety. After a detailed assessment of MSDs related safety issues, training and education programs were suggested.

The finding has a practical implication for the companies of same sector to explore their drawbacks related to ergonomic. Likewise, enhance works satisfaction and increase their competitiveness in the current harvesting place.

So far studies under ergonomic interventions of strawberry harvesters were not comprehensive and practicality of interventions was not verified. Therefore, the originality and uniqueness of this research work lay in its focus on Agri-Flower

strawberry harvesting workers in Holeta, as there is limited research conducted on this specific domain.

In conclusion, this research contributes to the existing body of knowledge by providing a detailed investigation of workplace risks and proposing practical ergonomic interventions for Agri-Flower strawberry harvesting workers. The study's findings and proposed interventions improve worker safety, reduce musculoskeletal disorders, and enhance productivity in the agricultural sector.

Keywords: MSDs, Fatigue, Stooping, Risk Assessment, Workers Safety, Engineering intervention, PPE

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List of Acronyms

No	Acronyms	Description
1.	MSDs	Musculoskeletal Disorders
2.	WMSDs	Work-related musculoskeletal disorders
3.	ILO	International Labor Organization
4.	QEC	Quick Exposure Check
5.	OCRA	Occupational repetitive Assessment
6.	PATH	Posture, Activity, Tools and Handling
7.	NMQ	Nordic musculoskeletal questionnaire
8.	RULA	Rapid upper limb assessment
9.	PPE	Personal Protective Equipment
10.	LBP	Lower Back Pain
11.	BPDS	Body Part Discomfort Score
12.	SI	Strain Index
13.	RPE	Rating of Perceived Exertion

Chapter One
1. Introduction and Problem Justification

1.1 Introduction

Each section of agriculture has particular types of ergonomic hazards(Zerssa et al., 2021). Because they brings about certain stress and strain on bones and muscles leading to WMSDs (Kaewdok et al., 2021). The purpose of analyzing musculoskeletal problems among workers engaged in agriculture was to know about the risk factors dangerous to health so that interventions can be planned for mitigating them thereby increasing the efficiency of work(Jirapongsuwan et al., 2023).

Kirkhorn et al., (2010) state that nowadays in agricultural production, the ergonomic hazards associated with MSDs due to repetitive motion are a highly recognized issue. The agricultural hazards and MSDs that caused by the agricultural production process is the result of the uncomfortable position of workers due to the natural position of crops, due to the type of tools used for the cultivation purpose, the weather and temperature during harvesting and collection and so on(Barneo-Alcántara et al., 2021).

The climate conditions in Ethiopia makes Ethiopia the only country in the world that can produce strawberry crops 12 months a year nonstop. Strawberries are also grown on raised beds to control weed and promote water drainage. Gardeners do mulching around the plants to help the soil retain. The most prevalent agriculture practice used to improve soil fertility is the use of compost manure. It is an integral and mandatory exercise since malnourished soils affect yields (Hoehne et al., 2020).

In our case the major type of work in the harvesting of strawberry fruits and the associated risk factors are forceful repetitive cutting prolonged and repetitive stooping (bending), lifting and carrying a heavy load so the body region affected or the potential for MSDs and other problems are hand /wrist lower back and shoulder. So as the result of observing the frequent number of MSDs due to above-mentioned tasks they need for an ergonomic risk factor analysis and intervention is arise and the main focus of this

research paper is also Investigation of work place risk and ergonomic intervention for agricultural harvest workers of Agri-flower strawberry harvesting workers in Holeta.

1.2 Problem Statement

Agricultural workers play a critical role in the food supply chain, yet they often work long hours in harsh environmental conditions and lack access to essential health care. These workers are vulnerable to developing physical health issues. The common physical health issues that happened to agricultural workers are fatigue and musculoskeletal disorder (Jakob et al., 2021). This type of disorder has also appeared to the strawberry harvesting workers. This happens due to the steps that the workers follow to plant the strawberry seed. For strawberry seed planting inland management the steps followed are first to keep the soil moisture and prevent the weed growth the workers are expected to cover the soil with mulch plastic. Then as a place to plant the strawberry seed, the holes are made on this mulch plastic. To make the hole the workers used a simple tool that looks like a can filled with burning coals so in this activity to make the hole the workers were exposed to repetitive bending work posture. Furthermore when the products are ready to collect the workers bend for a long time to collect the strawberry and they carry the load on their shoulders to transport to the store. Many of the activities performed by the workers demand a high degree of physical effort because of repetitiveness and assuming static awkward posture, leading to early fatigue and work-related musculoskeletal problems. This makes the worker subjective for MSD and easily get tired. Since the aim of ergonomics is about designing for people and also it can be defined as fitting a workplace to the user's needs to increase efficiency and productivity by reducing discomfort, (Komarnicki & Kuta, 2021) in order to minimize the worker's subjective disorder and speed up the work the problem has to be identified, defined, investigated, analyzed and directed to the possible solution. So to do that there must be Investigation of workplace risk and ergonomic intervention for the solution.

A lot of research papers have been conducted on ergonomic intervention with a different method and different approach. However, there is no research conducted on the Investigation of workplace risk and ergonomic intervention for agricultural strawberry harvest workers in Holeta. Therefore, the purpose of the research is to investigate the existing workplace risks related to the working conditions of the strawberry crop harvesting process, identify the ergonomic problems and finally come up with a possible

solution which is an ergonomic intervention for agricultural harvest workers for an intended sector.

1.3 Research Questions

To achieve the research objectives, the study will address the following research questions:

- What are the occupational risks and hazards faced by strawberry harvesting workers in Holeta?
- What are the ergonomic challenges related to workstations, manual handling tasks, and tools/equipment in strawberry harvesting?
- What are the suitable ergonomic interventions to mitigate these risks and improve working conditions?
- How effective are the proposed ergonomic interventions in enhancing the safety, health, and productivity of strawberry harvesting workers?

1.4 Objectives

1.4.1 General Objective

The general objective of this research is to investigating the workplace risks and ergonomic intervention for Agri-Flower strawberry harvesting workers in Holeta.

1.4.2 Specific Objective

This research sought to fulfill the following specific objectives:

- To identify the specific occupational risks and hazards associated with strawberry harvesting.
- To assess the ergonomic challenges related to workstations, manual handling tasks, and tools/equipment.
- To propose and evaluate ergonomic interventions to mitigate these risks and improve working conditions.

1.5 Significance of the Study

This study holds significant importance for various stakeholders involved in the agricultural sector, including workers, employers, policymakers, and researchers. The findings of this research will contribute to: Enhancing the understanding of workplace risks and ergonomic challenges faced by strawberry harvesting workers in Holeta. Providing insights into the specific areas that require ergonomic interventions to improve working conditions and reduce occupational risks. Guiding employers and policymakers in implementing effective measures to ensure the safety, health, and well-being of agricultural harvest workers. Adding to the existing body of knowledge on occupational health and ergonomics in the agricultural sector, particularly in the context of strawberry harvesting.

1.6 Scope and Limitations

1.6.1 Scope

This research focuses specifically on Agri-Flower strawberry harvesting workers in Holeta. The scope includes the identification of workplace risks, ergonomic challenges, and the proposal of interventions within this specific context. However, the findings may have broader applicability to the agricultural sector and strawberry harvesting practices in other regions.

1.6.2 Limitations

It is important to acknowledge potential limitations such as sample size constraints, access to organized data, time limitations, the blocking of roads due to political situation on the country, COVID-19 pandemic. Nonetheless, to overcome the issue efforts is made by going to the place at the moment the road is open to collect the required data as well as using different privation methods for the pandemic. All other effort such as walking long miles also made to ensure the research findings provide valuable insights and recommendations for improving the occupational health and ergonomics of strawberry harvesting workers in Holeta.

1.7 Organization of the Thesis

The research comprises six-chapters and appendixes, the research is organized so that the entropy layout to the proofreader is staged in sequential order.

Chapter 1 – Introduction: This section provides a porta to the proofreader about the background of the research, statement of the problem, research question, and research objective, significance of the research, scope & limitation of the research.

Chapter 2 – Literature review: Presents a related literature review of the terms and concept definitions, agricultural ergonomics and workplace safety, process of strawberry harvesting and picking, challenges of manual strawberry harvesting, occupational risk in agricultural harvesting, ergonomic challenge in that working are and the gap analysis.

Chapter 3 – Research Methodology: Describes the methodologies employed in the research, i.e., the overall research plan which incorporates of what task should be through & the sequential order of the task, a method to execute the task, what major data required, what data collecting technique is taken, determine the research sample size, selecting a data source, what data analysis approach/tools/technique/method executed, and finally how research conclusion & recommendation is drawn.

Chapter 4 – Data Collection & Analysis or Result & Discussion: Demonstrate the sample data collected from the respondents using the survey questioner, Likert method by using Borges 10-scale body ergonomic questioner, yes or no questions and the data analysis is done on stata 15 version and the correlation of the variables is done on Microsoft excel.

Chapter 5 – Proposed Intervention for the Case Company: depending on the result and discussion on the previous chapter there four proposed interventions for the case company. Which are engineering intervention, administrative intervention, personal protective equipment intervention and training and education program interventions.

Chapter 6 – Conclusion, Recommendation & Future work: shows a conclusion drawn from the research, forward a method of how the company can overcome issues related MSDs and queuing to and at the end suggestions for future research in the area.

Chapter Two
2. Literature Review

2.1 Introduction

This part of the study potentially intended to cover the prior works that so far have been done on the subject area of this thesis work. Strawberry harvesting process and the challenge that imposed to human being due to the repetitive work, the musculoskeletal disorder that happens to workers in the strawberry farming process, the possible intervention areas to mitigate the problem and the methodological approach that prior works in this area used to solve the problem analyzed.

To do so different data bases have been analyzed like Google scholar, Scopus, springer. Peer reviewed articles have been given high focus for the quality of the work. The following search string have been used to capture the relevant articles: work place risk, ergonomic intervention, mitigation of work place risk, strawberry harvest, agricultural ergonomics, musculoskeletal disorder, work related musculoskeletal disorders, physical fatigue, work place risk intervention, work place risk investigation. Agricultural occupational risk factor and others as well. The study approached a systemic way of review and the following point's shows the overall scheme of the review process and filtration approach.

2.2 Terms and concepts definitions

According to Pinzke & Lavesson, (2018) Musculoskeletal Disorders or MSDs are disorders and injuries that affect musculoskeletal system or the movement of human body such as muscles, tendons, ligaments, nerves, discs, blood vessels, etc. In addition to that according to Młotek et al., (2015) Fatigue is the state of feeling very tired, weary or sleepy resulting from insufficient sleep, prolonged mental or physical work, or extended periods of stress or anxiety. Boring or repetitive tasks can intensify feelings of fatigue. Fatigue can be described as either acute or chronic.

Meyers et al., (2000) stated that Work-related musculoskeletal disorders or WMSDs are a group of painful disorders of muscles, tendons, and nerves. Carpal tunnel

syndrome, tendonitis, thoracic outlet syndrome, and tension neck syndrome are some examples of Work-related musculoskeletal disorder. According to ILO International Labor Organization Vyas, (2012) state Stoop is also another example that cause Work-related musculoskeletal disorders that happened due to Repetitive bending work position in the work activity (Ulrey and Fathallah, 2012).

The Quick Exposure Check (QEC) is one of the method used for assessments of the exposure of workers to musculoskeletal risk factors. It focuses on exposure assessment and change in exposure, thus allowing the benefits of workplace interventions exposure, thus allowing the benefits of workplace interventions to be assessed rapidly (Kotowski et al., 2009).

Occupational repetitive actions OCRA is a commonly applied method of evaluating the musculoskeletal load of the upper limbs caused by repetitive tasks and the risk of developing MSDs (Kotowski et al., 2009). PATH or Posture, Activity, Tools and Handling is a work sampling approach to ergonomic job analysis for non-repetitive work (Lee and Park, 2011).

According to Yusuf et al., (2016) NMQ Nordic musculoskeletal questionnaire and RULA Rapid upper limb assessment can be used as a questionnaire or as a structured interview to develop and test a standardized questionnaire methodology allowing comparison of low back, neck, shoulder and general complaints for use in epidemiological studies Malchaire et al., (2001) and used for evaluating the exposure of individual workers to ergonomic risk factors associated with upper extremity musculoskeletal disorder upper extremity musculoskeletal disorder Rahul et al., (2018) respectively.

2.3 Agricultural Ergonomics and Workplace Safety

Agriculture in any country in the world weather it is developed country or not is a main policy focus area. In the developed countries machinery and equipment on a farm are indispensable; they make work easier and more efficient. More importantly these days no one can hardly imagine farming without a tractor or a combine harvester. Mechanization of agricultural production, however, involves a large number of threats to

the life and health of people who use the equipment, and thus, numerous accidents, diseases and ailments associated with it. When we come to the developing countries where the agricultural mechanization is at the infant stage the workers exposure to the occupational safety issues is higher than the developed countries. Workers in the agricultural sector of the least developed countries are exposed to various risk factors such as manual lifting and handling loads, milking or tractor driving (Kuta et al., 2015).

The productivity of agricultural production is directly related with the convenient work environment in which the workers exposed to. Today robotics and artificial intelligence have revolutionized this in the technologically advanced countries. Technology reduces the burdens of the physically fatigue work environment to less risky and convenient work atmosphere. Even in some areas of this sector automation has reached its maximum potential in a way to totally replace human being. Such approach is capital intensive and needs high technological advancement due to these developing countries like Ethiopia cannot afford. Therefore, within the developing countries framework that study intended to analyze the potential workplace risks and remedial actions that needs policy intervention for strawberry harvesting workers in Holeta.

2.4 Process of strawberry harvesting and picking

Strawberry Harvesting and Packing: This type of employment requires the worker to be able to stroll down the field row while pulling a harvesting cart that is equipped with a harvesting box, bend over, and search for ripe strawberries. The following table illustrates task breakdown in strawberry harvesting:

Table 2. 1 Table Task breakdown in strawberry harvesting

No	Task breakdown in harvesting of strawberry
1.	Walk down the field row
2.	Push a harvesting cart that holds a harvesting box
3.	Bend down and look for the ripe strawberries
4.	Pick the ripe strawberries off the bush
5.	Lightly pulling and twisting at the same time
6.	Letting the berry roll into the palm of their hand

7.	Place the fruit in a container that sit in the harvesting box
8.	The full harvesting box is taken to a loading truck
9.	An empty box is given back to the worker and the process is started again.

By gripping the stem between their forefinger and thumbnail, the worker will pluck the ripe strawberries from the bush. They will then gently pull and twist at the same time, allowing the fruit to roll into the palm of their hand while being careful not to bruise it. After that, the worker will carefully pack the berries into the container until it is full, taking care not to overfill it or pack the fruit too tightly. A loading truck is brought the harvesting box once it is full. The process is restarted once the employee receives an empty box. Each picker enters a furrow and begins collecting fruit from the plants on the raised beds on either side of that furrow during the manual strawberry harvesting process in a raised-bed agriculture method. After being separated, the strawberries are put into two little (0.5 kg to 2 kg) individual containers, which are laid in a larger container known as a "tray" or "flat". The removed fruit is thrown to the ground. The picker moves forward and keeps gathering all of the fruit from each plant until the flat's containers are full. After the container's capacity is achieved, the picker moves towards the field's edge collecting point, waits in line to deliver the full flat, and then moves back carrying an empty flat to continue picking. The progress of the worker may halt at any point during the picking process owing to exhaustion, the need for personal time, etc. when a whole row has been harvested; the picker quits it, moves down the field's headland and enters a new un-harvested row.

2.5 Challenges of manual strawberry harvesting

Not only robotic harvesting of strawberry is financially infeasible but also in some instances manual harvesting. Nonetheless of its physical work fatigue has some advantage of quality strawberry being harvested. Machines can cause damage and malfunctioning in some instances. As per Kumudini & Hasegawa (2009) work in Japan, small-scale strawberry famers conduct hand harvest, as mechanized harvest is not economically and technically feasible. Those strawberry harvesters in Japan highest risks, especially in the field of hand harvest, with stooped postures, long hours of bending and

lifting and carrying of heavy materials. Furthermore, due to seasonal working environment for strawberry farmers and since work cannot be delayed; working hours are generally uneven and often very long.

Furthermore, Momose et al., (2007) revealed that there are three main types of physical fatigue in strawberry harvesters, this physical fatigue are lower back pain, shoulder pain and eye pain. As per their analysis they come it to conclusion that showed similar prevalence among males and female's risk of exposure, the related formwork differed between them. Furthermore, their work unearthed that lower-back pain proved the strongest association with the application of gibberellins at bloom among males and with the harvesting of strawberries among females. In addition, "Shoulder-pain had the strongest association with the removal of older leaves among males, and with the harvesting of strawberries among females". Likewise, "Eye-pain had the strongest association with the clipping of needless runners among males and with the application of gibberellins at bloom among females".

From the Momose et al., (2007) work we can conceptualize that workload fatigue in strawberry harvesting is directly related with that task of different work and also it can be taken there is some gender based different risks associated with the work performed.

Komarnicki & Kuta (2021) tried to present the association between the assumptions of ergonomics in the work of a strawberry picker and quality of picked strawberry. After analyzing and identifying three characteristics of picker positions during strawberry harvesting; they came up with a substantial conclusion of "The body posture that a person adopts while working has a significant impact on their health, working comfort, and productivity, but also on the quality of the fruit that is harvested". Their analysis also unearthed that "the influence of working position on changes in the load of the picker's musculoskeletal system and the surface pressure exerted on the fruit during manual strawberry picking, which are decisive factors for maintaining fruit quality." From their experimentation, we inferred to conclude that "the most comfortable position of the worker's body was determined along with the harvesting technique or position during work that has the least negative effect on the quality of the harvested fruit."

Therefore, it is clear now from the synthesis of the above work that quality is directly related with workers workload and safety. If the burden and ergonomically uncomfortable work environment solved or at least reduced; there is a tremendous gain in terms of quality of work as well as productivity of workers. Once having this in mind strawberry growers and those stallholders in the sector need to understand this and pay attention to consider the workers working condition in order to exploit more from theses blooming sector.

Developing countries like Ethiopia are at the infant stage of the sector but need to consider a head of such challenges facing its agricultural workforce. The export market for such agricultural products has a bargaining power that not only the quality of the products but also the workers safety issue in a high and sensitive manner.

2.6 Occupational Risks in Agricultural Harvesting

Agricultural harvesting work is known to involve various occupational risks. Previous studies have highlighted hazards such as slips, trips, and falls, exposure to extreme weather conditions, contact with sharp tools or machinery, and exposure to chemicals and pesticides. These risks can lead to injuries, respiratory problems, dermatological issues, and long-term health consequences for agricultural workers.

Kogi, K. (2005) provides an overview of occupational health and safety issues in agriculture, including harvesting activities. It discusses common hazards, such as slips, falls, machinery-related accidents, exposure to pesticides, and physical strain, and highlights the importance of preventive measures. NIOSH (2012) this comprehensive report by the National Institute for Occupational Safety and Health (NIOSH) provides an in-depth analysis of occupational risks in agriculture, including harvesting. It covers hazards associated with machinery, manual labor, exposure to chemicals, and environmental factors, and offers recommendations for risk reduction. Stål, M., & Hansson, G. Å. (2017) examines official reports on occupational health and safety in Swedish agriculture over several decades. It identifies different types of accidents and injuries in agricultural work, including harvesting, and discusses the underlying causes and preventive measures.

Mekonnen, Y., & Aga, F. (2020) focuses on occupational hazards in Ethiopian agriculture, including harvesting. It identifies various risks faced by farmworkers, such as musculoskeletal disorders, pesticide exposure, and accidents, and explores the factors contributing to these hazards. Singh, A., & Singh, S. K. (2019) examines occupational health and safety issues among agricultural workers in India, with a specific focus on hazards related to harvesting activities. It discusses physical and chemical risks, ergonomic challenges, and the impact on workers' health and well-being. Mitchell, et.al (2019) evaluates the effectiveness of occupational health and safety interventions in agriculture, including those targeting harvesting activities. It assesses various intervention strategies, such as engineering controls, training programs, and policy interventions, and their impact on reducing occupational risks.

From the point of Literature discussed above related to Occupational Risks in Agricultural Harvesting, it can be summarized as below. Agricultural harvesting work poses various occupational risks that can have detrimental effects on the health and safety of workers. The literature survey reveals several key findings:

1. Hazards: Occupational risks in agricultural harvesting include slips, trips, and falls; machinery-related accidents; exposure to pesticides and chemicals; physical strain from repetitive tasks, heavy lifting, and prolonged standing; and environmental factors such as extreme weather conditions.

2. Injuries and Health Issues: These risks can lead to a range of injuries and health issues among agricultural harvest workers, including musculoskeletal disorders (MSDs), respiratory problems, dermatological issues, and long-term health consequences.

3. Specific Risks: The specific risks faced by agricultural harvest workers vary depending on factors such as the type of crop being harvested, the work environment, and the machinery and tools used. For example, workers in strawberry harvesting may face risks associated with working in awkward postures, repetitive motions, and exposure to pesticides.

4. Preventive Measures: Preventive measures are crucial to reducing occupational risks in agricultural harvesting. These measures may include the use of engineering

controls to improve machinery and equipment safety, the implementation of training programs to raise awareness and promote safe work practices, and the development of policies and regulations to ensure compliance with safety standards.

5. Intervention Effectiveness: Studies have evaluated the effectiveness of various interventions in mitigating occupational risks. These interventions include ergonomic redesign of workstations and tools, mechanization of repetitive tasks, use of personal protective equipment (PPE), and training programs. The effectiveness of these interventions is dependent on factors such as their proper implementation, worker compliance, and ongoing evaluation.

6. Global Perspectives: The literature survey included studies from different countries, highlighting that occupational risks in agricultural harvesting are a global concern. However, the specific risks and challenges may vary depending on the agricultural practices, crops, and regulatory frameworks in different regions.

Overall, the literature emphasizes the importance of understanding and addressing occupational risks in agricultural harvesting to ensure the health, safety, and well-being of workers. It highlights the need for comprehensive risk assessments, targeted interventions, and ongoing monitoring and evaluation to create safer working environments for agricultural harvest workers.

The literature review on occupational risks in agricultural harvesting identifies a few gaps that warrant further research and investigation. These gaps include:

1. Contextual Specificity: While there is existing research on occupational risks in agriculture, including harvesting, there is a need for more studies that focus specifically on the context of agricultural harvesting in different regions and crops. Each agricultural sector may have unique risks and challenges that require tailored interventions. Further research is needed to explore the specific occupational risks faced by different types of agricultural harvest workers and the effectiveness of interventions in mitigating those risks.

2. Long-Term Health Effects: While the literature acknowledges the potential long-term health consequences of occupational risks in agricultural harvesting, there is a lack of comprehensive studies examining the long-term health effects on workers. Further research is needed to investigate the cumulative impact of occupational hazards on the health and well-being of agricultural harvest workers, especially in terms of chronic conditions and the development of musculoskeletal disorders.

3. Worker Perspectives: The literature predominantly focuses on identifying and assessing occupational risks from an external standpoint. However, there is a need for more research that incorporates the perspectives and experiences of agricultural harvest workers themselves. Understanding their perceptions of risks, challenges, and potential solutions can provide valuable insights for developing targeted interventions and improving worker engagement in safety practices.

4. Comparative Analysis: While there are studies that examine occupational risks in agricultural harvesting in specific regions or countries, there is a lack of comparative analyses across different regions or crops. Comparative studies can help identify similarities and differences in risks, interventions, and outcomes, enabling the development of best practices and evidence-based recommendations for improving occupational health and safety in agricultural harvesting.

5. Intervention Evaluation: While there are studies that evaluate the effectiveness of interventions in mitigating occupational risks in agriculture, including harvesting, there is a need for more rigorous evaluation and long-term follow-up. Further research is needed to assess the sustainability and long-term impact of interventions, including their effectiveness in reducing injuries, improving health outcomes, and enhancing the overall well-being and productivity of agricultural harvest workers.

Addressing these gaps in the literature will contribute to a more comprehensive understanding of occupational risks in agricultural harvesting and support the development of evidence-based interventions and policies to improve the occupational health and safety of workers in this sector.

2.7 Ergonomic Challenges in Agricultural Work

Ergonomic challenges are prevalent in agricultural work, including strawberry harvesting. Studies have identified issues such as awkward postures, repetitive motions, heavy lifting, and prolonged standing, which can contribute to musculoskeletal disorders (MSDs) among workers. Poorly designed workstations, inadequate tools and equipment, and lack of breaks or rest periods further exacerbate ergonomic challenges in the agricultural sector.

Alcântara, A. C., & Rocha, F. L. R. (2018) explores ergonomic risk factors in various agricultural activities. It identifies and examines factors such as awkward postures, repetitive motions, heavy lifting, and prolonged standing, and discusses their impact on musculoskeletal disorders (MSDs) among agricultural workers. Hildebrandt, et.al (2000) investigates the influence of climatic factors on the development of non-specific back and neck-shoulder diseases in agricultural workers. It highlights the importance of considering environmental factors, such as temperature and humidity, in understanding ergonomic challenges in agricultural work.

Kogi, K. (2005) provides an overview of occupational health and safety issues in agriculture, including ergonomic challenges. It discusses the impact of physical strain, repetitive tasks, and awkward postures on the health and well-being of agricultural workers, and emphasizes the need for preventive measures. Pinzke, S., & Cole, H. P. (2015) provides practical guidance on ergonomics in agriculture, including specific interventions and strategies to address ergonomic challenges. It covers topics such as manual handling, tool design, work organization, and work posture, and offers recommendations for improving ergonomics in agricultural work. Rautiainen, et.al (2017) presents a practical toolkit for improving safety and health through ergonomics in agriculture. It provides guidance on identifying ergonomic risks, implementing solutions, and evaluating their effectiveness. The toolkit covers various agricultural tasks, including harvesting, and offers practical recommendations for reducing ergonomic challenges.

Rempel, et al (2007) explores the perspectives of young farmers on ergonomic hazards and safety controls in agriculture. It examines their knowledge, attitudes, and behaviors

related to ergonomic challenges and provides insights for developing targeted interventions and improving safety practices among agricultural workers.

Ergonomic challenges in agricultural work pose significant risks to the health and well-being of workers. The above literature that related to Ergonomic Challenges in Agricultural Work can be summarized as below. The literature survey reveals several key findings:

1. Risk Factors: Ergonomic risk factors in agricultural work include awkward postures, repetitive motions, heavy lifting, prolonged standing, and exposure to environmental factors such as temperature and humidity. These risk factors can contribute to the development of musculoskeletal disorders (MSDs) among agricultural workers.

2. Impact on Health: Ergonomic challenges in agricultural work have a detrimental impact on the health and well-being of workers. The literature highlights the association between ergonomic risk factors and the development of non-specific back and neck-shoulder diseases, as well as other MSDs. Workers in agriculture are particularly vulnerable due to the physically demanding nature of their tasks.

3. Importance of Prevention: The literature emphasizes the importance of preventive measures in addressing ergonomic challenges in agricultural work. Practical interventions and strategies, such as manual handling techniques, tool design, work organization, and work posture improvements, are recommended to reduce the risk of injuries and MSDs.

4. Practical Guidance: Practical resources, such as handbooks and toolkits, are available to assist in improving ergonomics in agriculture. These resources provide guidance on identifying ergonomic risks, implementing solutions, and evaluating their effectiveness. They offer specific recommendations for addressing ergonomic challenges in various agricultural tasks, including harvesting.

5. Worker Perspectives: The literature acknowledges the importance of considering the perspectives and experiences of agricultural workers themselves when addressing ergonomic challenges. Understanding their knowledge, attitudes, and behaviors related to

ergonomic risks can help inform the development of targeted interventions and improve safety practices.

6. Need for Further Research: While the literature provides valuable insights into ergonomic challenges in agricultural work, there is a need for further research. Specific gaps include more context-specific studies focusing on different regions and crops, long-term health effects of ergonomic challenges, and comparative analyses across different agricultural practices. Additionally, research that incorporates the perspectives and experiences of agricultural workers can provide valuable insights for developing effective interventions.

Addressing ergonomic challenges in agricultural work is crucial for promoting the health, safety, and well-being of workers. The literature highlights the importance of preventive measures, practical guidance, and further research to develop evidence-based interventions and policies that improve ergonomics in agricultural work settings.

The literature review on ergonomic challenges in agricultural work identifies several gaps that warrant further research and exploration. These gaps include:

1. Specific Agricultural Tasks: While there is existing research on ergonomic challenges in agriculture, there is a need for more studies that focus on specific agricultural tasks and practices. Different tasks, such as harvesting, planting, and livestock handling, may have unique ergonomic challenges that require tailored interventions. Further research is needed to explore the specific ergonomic challenges faced in different agricultural tasks and develop targeted solutions.

2. Long-Term Health Effects: While the literature acknowledges the impact of ergonomic challenges on the development of musculoskeletal disorders (MSDs) among agricultural workers, there is a lack of comprehensive studies examining the long-term health effects on workers. Further research is needed to investigate the long-term impact of ergonomic challenges on the health and well-being of agricultural workers, including the prevalence of chronic conditions and the effectiveness of interventions in preventing long-term health consequences.

3. Impact of New Technologies: With the advancement of technology in agriculture, there is a need to understand the ergonomic challenges associated with the adoption of new tools, machinery, and automation systems. Research is needed to evaluate the ergonomic implications of these technologies and develop guidelines for their safe and efficient use in agricultural work.

4. Cultural and Socioeconomic Factors: Ergonomic challenges in agricultural work can be influenced by cultural and socioeconomic factors. However, the literature currently lacks comprehensive research on how cultural and socioeconomic factors impact the perception and management of ergonomic challenges in different agricultural settings. Further research is needed to explore these factors and their influence on the implementation and effectiveness of ergonomic interventions.

5. Intervention Evaluation: While there are studies that examine the effectiveness of ergonomic interventions in agriculture, there is a need for more rigorous evaluation and long-term follow-up. Further research is needed to assess the sustainability and long-term impact of ergonomic interventions, including their effectiveness in reducing injuries, improving work efficiency, and enhancing the overall well-being and productivity of agricultural workers.

Addressing these gaps in the literature will contribute to a more comprehensive understanding of ergonomic challenges in agricultural work and support the development of evidence-based interventions and policies to improve ergonomics and reduce occupational risks in this sector.

2.8 Ergonomic Interventions in Agricultural Harvesting

Several studies have explored ergonomic interventions to address the challenges faced by agricultural harvest workers. These interventions include the design and modification of workstations and tools to reduce physical strain, implementation of mechanized systems for repetitive tasks, and the use of personal protective equipment (PPE) to mitigate exposure to hazardous substances. Some studies have also focused on training programs to raise awareness and promote proper ergonomic practices among workers(Ng et al., 2013; Salian, 2018).

Kee D, (2019) examined the effectiveness of interventions in reducing musculoskeletal disorders and injuries in agriculture, including harvesting activities. The study identified various interventions, such as mechanization, equipment modifications, and ergonomic training programs that showed positive effects in reducing musculoskeletal disorders and injuries. Kim et al.,(2018) evaluated the effectiveness of a new harvester handle designed to reduce the muscular workload of workers during harvesting. The handle was found to significantly reduce muscle activity in the forearm and shoulder, leading to a decrease in perceived exertion and fatigue. The researchers developed and implemented an intervention program that included training workers on proper work techniques and providing ergonomic tools and equipment. The intervention reduced the prevalence of musculoskeletal symptoms and improved worker satisfaction.

Ajayeoba, (2019) evaluated the effects of ergonomics interventions in the Nigerian sawmill industry, which included harvesting activities. The interventions focused on improving work techniques, providing training, and modifying equipment. The study found significant reductions in physical workload and musculoskeletal disorders among workers. Punnett et al., (2004) investigated ergonomic stressors and upper extremity musculoskeletal disorders in automobile manufacturing. The findings highlighted the importance of ergonomic interventions, including job rotation, workstation adjustments, and training, in reducing musculoskeletal disorders.

Boriboonsuksri et al., (2022) explored ergonomic risk factors in various agricultural activities, including harvesting. The study identified factors such as awkward postures, repetitive motions, heavy lifting, and prolonged standing as significant contributors to musculoskeletal disorders among agricultural workers. Stock et al., (2018) reviewed and focused on the effectiveness of an ergonomic intervention in reducing work-related musculoskeletal disorders. The intervention included training in ergonomics principles and providing ergonomic tools and equipment. The study demonstrated significant improvements in musculoskeletal symptoms among carpet weavers. Gangopadhyay & Dev, (2014) examined ergonomic interventions to reduce musculoskeletal disorders in the Indian agricultural sector, including harvesting activities. The study identified various interventions, such as training, equipment modifications, and work practice changes, that

showed positive effects in reducing musculoskeletal disorders among agricultural workers. Boriboonsuksri et al., (2022) focused on ergonomic interventions in the prevention of musculoskeletal disorders in the agricultural sector. The study identified interventions such as equipment modifications, work practice changes, and training programs that demonstrated positive effects in reducing musculoskeletal disorders among agricultural worker

2.9 Literature Summary

Numerous research papers are done in the area of this thesis title and some of them are summarized in the following subtopics accordingly based on their topic of study, methodology, finding and conclusion.

Table 2. 2 Literature summary

Author	Topic of study	Methodology	Findings	Conclusion
(Costa & Camarotto, 2012)	An ergonomic approach to citrus harvest Mechanization	-By using the stopwatch technique time study and -Comparison between manual and semi-mechanized harvesting work was done.	This study also showed that the semi-mechanized harvesting Speeded up the activity compared to a manual one. - This occurred through reducing the walking frequency and distance to the bin carrying weight, and eliminating harvesting on top of the ladder, bringing with it less physical stress during working hours and greater harvesting safety, Consequently reducing accident rates.	-The implementation of this harvesting device in orchards managed to join increased productivity and improved working conditions, by providing more comfort to orange pickers.
(Vyas, 2012)	Mitigation of musculoskeletal problems and body discomfort	-In order to conduct this study 120 workers were selected by simple random sampling method.	-This study presented that agricultural works cause musculoskeletal disorders especially in the trunk.	- Musculoskeletal problems are known as one of the main work related diseases among manual and physical work activities of farm

	of agricultural workers through educational intervention	-Among 120 workers both man and women participant were selected. - For the data gathering the assessment method used was the Body Part Discomfort Score (BPDS) and Body map.		workers -According to the data gathered in this study the main risk factors of musculoskeletal disorder were weeding, handling of heavy loads and prolonged work activities. And also some safety problems might be occurring as well due to chemical used in some parts of agricultural works.
(Bhattacharyya & Chakrabarti, 2012)	Ergonomic basket design to reduce cumulative trauma disorders in tea leaf plucking operation	-In order to conduct this study a purposive sampling method were used. -All the participant were 180 women workers with age between 35 and 50. -Jorhat district, Assam and India are were the samples are chosen. They used	-This study showed that body postures had some problems in terms of ergonomics and also the QEC scores were 110 (out of 138) for plucking job. -Besides, the new design confirmed a better condition for back new basket, too. -There was a promoted condition in terms of WMSDs,	-Ergonomics intervention provides the better condition for working activities. - The plucking of tea leaves involved some kinds of awkward postures, so any promotion in productivity and decreasing of MSDs need some effective intervention in terms of ergonomics. -By changing the working

		ergonomics methods were also Strain Index (SI), OCRA (Occupational Repetitive Assessment), and Quick Exposure Check (QEC), Rating of Perceived Exertion (RPE) *and* Nordic Musculoskeletal Questionnaire (*NMQ).* -Heart rate and energy consumption were also measured.	as well. -	conditions and tasks methods and related technology. -The productivity will be improved by the proper improved technology, skill labor and efficient managements.
(Cha et al., 2009)	Prevalence and changes in chronic diseases among South Korean farmers	-This case series study was conducted among south Korean farmers. -The three cross-sectional national survey data was gathered and assessed in	- According to this study the chronic disease occurrence among female farmers is more than other workers who are working on another kind of jobs.	This study shows that chronic diseases (especially for musculoskeletal disorders) among the target group, have a occurrence higher than other population.

		1998, 2001 and 2005. -Moreover, the stated surveys covered more than 110,000 samples		
(Fulmer, S., Punnett, L., Tucker Slingerland, D., & Earle-Richardson, 2002)	Ergonomic Exposures in Apple Harvesting: Preliminary Observations	It's a descriptive type of case study that done among 81 male workers in 8 apple orchards (8 orchards in New York, and 2 in Pennsylvania) -In order to relate the gathered data PATH (Posture- Activities-Tools-Handling) ergonomics task analysis method was used - while the study is done the size of the apple trees and the distance between the ladder and the tree	-Awkward postures during apples' picking according to arm reaching and working at above shoulder were detected. -Static activities do some stress on the back according to bending during the apple bags reloading	There are several risk factors in terms of musculoskeletal disorders among workers in an apple orchard. -For working style improvement some other research considering with force measurements are Recommended as future studies. -Some sorts of ergonomic interventions are feasible in apples farms activities for decreasing the muscle disorders, especially for neck and back. - More ergonomic assessment should be done to these workers. -For effective and practical

		were estimated. -Time study were done by stopwatch -Gathered data were evaluated by EpiInfo database. -The dimension of the tools and the weight of an apple bags is measured using tape measure and bathroom scale respectively.		intervention, making a proper Communication between researchers and related human power in the apple orchard is necessary. -Increasing the workers' knowledge about work related disorders are so important.
(Kotowski et al., 2009)	Investigation of Select Ergonomic Interventions for farm youth Part 2 Wheelbarrows	-This intervention study is conducted on people who had some experiences in farm related activities. -The target group was 20 youth among this 20 youth 10 are girls and 10 are boys.	- Using a 3-wheels wheelbarrow equipped with a push bar shows the decreasing in trunk flexion but on back disorders risk it does not have significant impact. -In terms of twist velocity by gender a significant difference was found among 3-wheel wheelbarrow	The reduction in motion and awkward postures on trunk is observed by the alternative designs of wheelbarrow. Nevertheless long term usage should be done for the mentioned positive effect confirmation. - Effect of reduction of

		-For the designed 4 wheelbarrows the related measurement was done. - The rate of exertion during pushing, pulling and dumping was Determined - To assess the trunk motion lumbar motion monitor was used.		LBP risks -One of the important thing should be considered is the cost of the new wheelbarrow design.
(Bezerra et al., 2012)	Manual bamboo cutting tool	-In order to prevent or reduce the environmental impacts Eco-design method were used for designing.	In this study, a hand tool was designed and developed for workers who are involved in cutting Bamboo.	-Spread the use of bamboo as a building material, crafts, among others, from a handy tool, easy to assemble and available material.

Costa & Camarotto, (2012) stated that the semi-mechanized harvesting technic speeded up the activity by reducing the time taken by different activities such as the walking frequency and laddering. In order to investigate this the researcher uses stopwatch technique time study on the orange pickers. The conclusion show increased productivity and improved working conditions. According to Vyas, (2012) by using Body Part Discomfort Score (BPDS) and Body map assessment method Among 120 workers the main risk factors of musculoskeletal disorder were weeding, handling of heavy loads and prolonged work activities.

Bhattacharyya & Chakrabarti, (2012) study showed that body postures had some problems in terms of ergonomics. To investigate this the researcher uses a purposive sampling method for the participant 180 were also Strain Index (SI), OCRA (Occupational Repetitive Assessment), and Quick Exposure Check (QEC), Rating of Perceived Exertion (RPE) and Nordic Musculoskeletal Questionnaire (NMQ) are used for assessment method. On the other hand according to Cha et al., (2009) the chronic disease occurrence among female farmers is more than other workers as the result of cross-sectional survey covered more than 110,000 samples.

A descriptive type of case study that done among 81 male workers in 8 apple orchards by Fulmer, S. et al., (2002) shows awkward postures during apples' picking and reloading bags. This result is obtained by assessing gathered data by using PATH (Posture- Activities-Tools- Handling) ergonomics task analysis method. This intervention study is conducted on people who had some experiences in farm related activities by (Kotowski et al., 2009).The target group was 20 youths. Using a 3-wheels wheelbarrow equipped with a push bar shows the decreasing in trunk flexion but on back disorders risk it does not have significant impact. Bezerra et al., (2012) study, a hand tool designed and developed for workers who are involved in cutting Bamboo In order to prevent the environmental impacts Eco-design method were used for designing.

2.10 Gap Analysis

The existing literature on occupational risks and ergonomic interventions in agriculture provides valuable insights into the broader field. Studies have highlighted the physical demands, repetitive movements, and awkward postures associated with various agricultural tasks Benos et al., (2020); Lim et al., (2021). However, the focus of these studies has primarily been on other crops or regions, with limited research specifically addressing the risks and challenges faced by strawberry harvesting workers in Holeta.

This research aims to address this gap by synthesizing the available literature and conducting a comprehensive review of the specific risks and challenges faced by strawberry harvesting workers. By focusing on this specific context, the study will provide a deeper understanding of the unique ergonomic challenges associated with strawberry harvesting in Holeta.

The investigation will consider the physical hazards, including exposure to pesticides and other agrochemicals, which pose health risks to workers. Additionally, the study will examine the musculoskeletal risks associated with repetitive movements, lifting heavy loads, and prolonged standing, which can lead to the development of MSDs.

In conclusion, the existing literature on occupational risks and ergonomic interventions in agriculture provides a foundation for understanding the broader challenges faced by agricultural workers. However, there is a significant gap in knowledge specific to strawberry harvesting workers in Holeta. This study aims to address this gap by synthesizing the available literature and conducting a comprehensive review to identify the specific risks and challenges faced by this workforce. The findings will contribute to the development of tailored ergonomic interventions to improve the safety, health, and productivity of strawberry harvesting workers in the Holeta region.

While there is existing research on occupational risks and ergonomic interventions in agricultural work, there is a limited body of literature specific to strawberry harvesting industry in Holeta. The unique context of strawberry harvesting, including the nature of tasks, work environment, and worker demographics, necessitates a focused investigation to identify the specific risks and challenges faced by strawberry

harvesting workers. Additionally, there is a need for tailored ergonomic interventions that consider the specific needs and constraints of this workforce.

By conducting a comprehensive review of the literature, this study aims to bridge the existing knowledge gap and contribute to the understanding of workplace risks and ergonomic interventions for strawberry harvesting workers in Holeta. The findings will provide insights into the specific ergonomic challenges faced by this workforce and propose effective interventions to mitigate those challenges, thereby improving the safety, health, productivity of agricultural harvest workers in the strawberry industry and sustainable economy.

Chapter Three

3. Methodology

In this research methodology the entire research plan and how it's executed is outlined. This consists what is done, how it is done, what type of data is collected, what data-gathering devices is employed, how sources of data is selected, how the data is analyzed, and a conclusion is drawn. Likewise, Research methodology is the path through which researchers need to conduct their research.

3.1 Introduction

To address the research objectives and answer the research questions, a mixed-methods approach is employed. This include: Literature review to gather existing knowledge on agricultural workplace risks, ergonomic challenges, and interventions. Occupational risk assessment is also done to identify and evaluate specific hazards and risks faced by strawberry harvesting workers. Ergonomic evaluation to assess workstations, manual handling tasks, and tools/equipment for ergonomic deficiencies. Development and implementation of ergonomic interventions to mitigate identified risks and challenges. Evaluation of the effectiveness of the proposed interventions through data collection and analysis.

3.2 Research Design

Research Design for Investigating Workplace Risk and Ergonomic Intervention for Agricultural Harvest Workers: A case of Agri-Flower strawberry harvesting workers in Holeta.

A cross-sectional study design is employed to assess the current ergonomic risk factors and workplace hazards among Agri-Flower strawberry harvesting workers. This involves collecting data at a single point at a time to provide a snapshot of the current situation.

On the other hand an intervention study is also used to assess the effectiveness of ergonomic interventions in reducing workplace risks and improving worker health and safety.

3.3 Sampling Technique:

A purposive sampling technique is used to select the respondent for the proposed questioner from Agri-Flower strawberry harvesting workers in Holeta. The sample size is depend on the number of workers in the company which is 96. A 55 workers selected to ensure representative data since the sampling technique is purposive sampling technique. From the 55 selected respondent only 49 respondent was fully respond the question in questioner.

This 49 respondent was selected only to identify the potential ergonomic risk factors that happened to the workers are their working environment. After the potential ergonomic risk factors are identified based on the result obtained by using borges 10-scale we go for further identification of the MSD area by providing another questioner for 20 respondent to perform more advanced analysis since it gives the scale interval data properties.

Finally after the potential ergonomics risk factor are identified and an intervention is implemented to assess the effectiveness of the intervention another 25 respondent is involved.

3.4 Data Sources:

While doing this paper different data source such as literatures, company report and Workplace observations conducted to identify ergonomic risk factors, work practices, and hazards. This will involve direct observation of workers during the harvesting process and noting any potential risks.

In-depth interviews conducted with key stakeholders, such as farm managers and supervisors, to gather insights into the organizational factors influencing workplace risks and the feasibility of implementing ergonomic interventions.

3.5 Structured Questioners

Structured questionnaires administered to workers to collect data on their demographics, work-related factors, ergonomic risk perceptions, and health outcomes. The surveys is designed based on established ergonomic assessment tools and adapted to the specific context of Agri-Flower strawberry harvesting. Since the sampling technique used to select Agri-Flower strawberry farms is purposive sampling technique 55 participant was expected but due to the work schedule and the ability to understand the question the data has been collected only from 49 respondent. In addition to those 49 respondent anther 20 and 25 respondent also included for further investigation and intervention evaluation.

3.5.1 Pre-Test

After the questioner is prepared before it distributed to directly to the 49 respondent 10 key personnel including the production manager in the company test the content of the questioner and 5 people comment on the questioner to use simpler ergonomic words in the questioner to make it more understandable by workers since the workers are collected from different educational background.

This section aims to assess the participants' baseline knowledge and awareness of workplace risks and ergonomic practices. The objective is to gather information about the participants' understanding of the potential hazards and challenges they may encounter in their work environment and their familiarity with ergonomic practices that can help mitigate these risks. In this section, a series of questions is designed to gauge the participants' existing knowledge and awareness. The questions cover various aspects related to workplace risks and ergonomic practices, including.

3.5.2 Pilot Test

After the research work is completed and an intervention is implemented by proposing different interventions and training, to validate what training and education intervention contribute to the workers in the working environment of Agri-Flower

strawberry harvesting company by availing there at the field with production manager different benefit is discussed and appreciated.

The pilot test section of the questionnaire aimed to gather feedback on the clarity, relevance, and comprehensibility of the questionnaire itself. This section allows participants to provide input on the questionnaire structure, wording, and any missing or redundant questions. The feedback obtained from the pilot test helps ensure that the questionnaire is well-designed and can effectively capture the desired information from the participants. During the pilot test, a small group of participants, representative of the target population, be selected to complete the questionnaire. These participants ideally have similar characteristics and backgrounds as the intended respondents. The pilot test participants have been asked to carefully review and provide feedback on the questionnaire.

3.6 Data validation and verification

Data validation is a critical process that ensures the accuracy, reliability, and integrity of data entered or stored in a system. While there are various methods available for data validation and verification, seeking expert opinions stands out as a valuable approach. Consulting subject matter experts or individuals with expertise in the relevant domain can provide unique insights and perspectives that help validate the data and identify potential errors or inaccuracies. Therefore, in this study expert opinions applied for data validation. Experts bring specialized knowledge, critical thinking, and deep domain expertise, enabling them to identify errors, address assumptions, and enhance data quality. Their insights contribute to accurate data validation and improve the overall reliability of the data.

3.7 Data Analysis Methods

Data Analysis Methods for Investigating Workplace Risk and Ergonomic Intervention for Agricultural Harvest Workers: A case of Agri-Flower strawberry harvesting workers in Holeta

1. Descriptive Analysis:

Descriptive analysis is conducted to summarize the demographic characteristics of the workers, workplace risk factors, and health outcomes. This analysis involve calculating frequencies, means, percentages, and standard deviations for relevant variables. Descriptive statistics provide a comprehensive overview of the data collected.

2. Ergonomic Risk Assessment:

Ergonomic risk factors identified through observation, surveys, and ergonomic assessment tools is analyzed to quantify the level of risk. Depending on the specific assessment tool used which is Likert scale, risk levels is categorized into (1. Very low, 2. Low, 3. Moderate, 4. High, 5. Very high) and to evaluate each part of the body pain they feel Borges 10 scale is used which is every value indicate the amount of pain the workers feel Rest(0), Extremely Easy(1), Very Easy(2), Easy(3), Moderate(4), Somewhat Hard(5), Moderately Hard(6), Hard(7), Very Hard (8) Very Very Hard(9), Extremely Hard(10). This analysis will help prioritize interventions by focusing on high-risk areas.

3. Correlation Analysis:

A Pearson correlation analysis has been performed to examine the relationships between different variables such as Body part Ergonomic rating, Productivity rating, and Injury rating. For example, correlations is explored between ergonomic risk factors and musculoskeletal symptoms or between worker perceptions and intervention effectiveness. Correlation coefficients, such as Pearson's correlation is calculated to determine the strength and direction of the relationships.

4. Qualitative Analysis:

Qualitative data from interviews and open-ended survey questions is analyzed using thematic analysis or content analysis. Themes and patterns is identified in the responses to gain deeper insights into worker experiences, perceptions, and suggestions for ergonomic interventions. This analysis provides qualitative evidence to complement the quantitative findings.

5. Intervention Evaluation:

The effectiveness of ergonomic interventions evaluated by analyzing the changes in ergonomic risk factors, worker perceptions, and health outcomes.

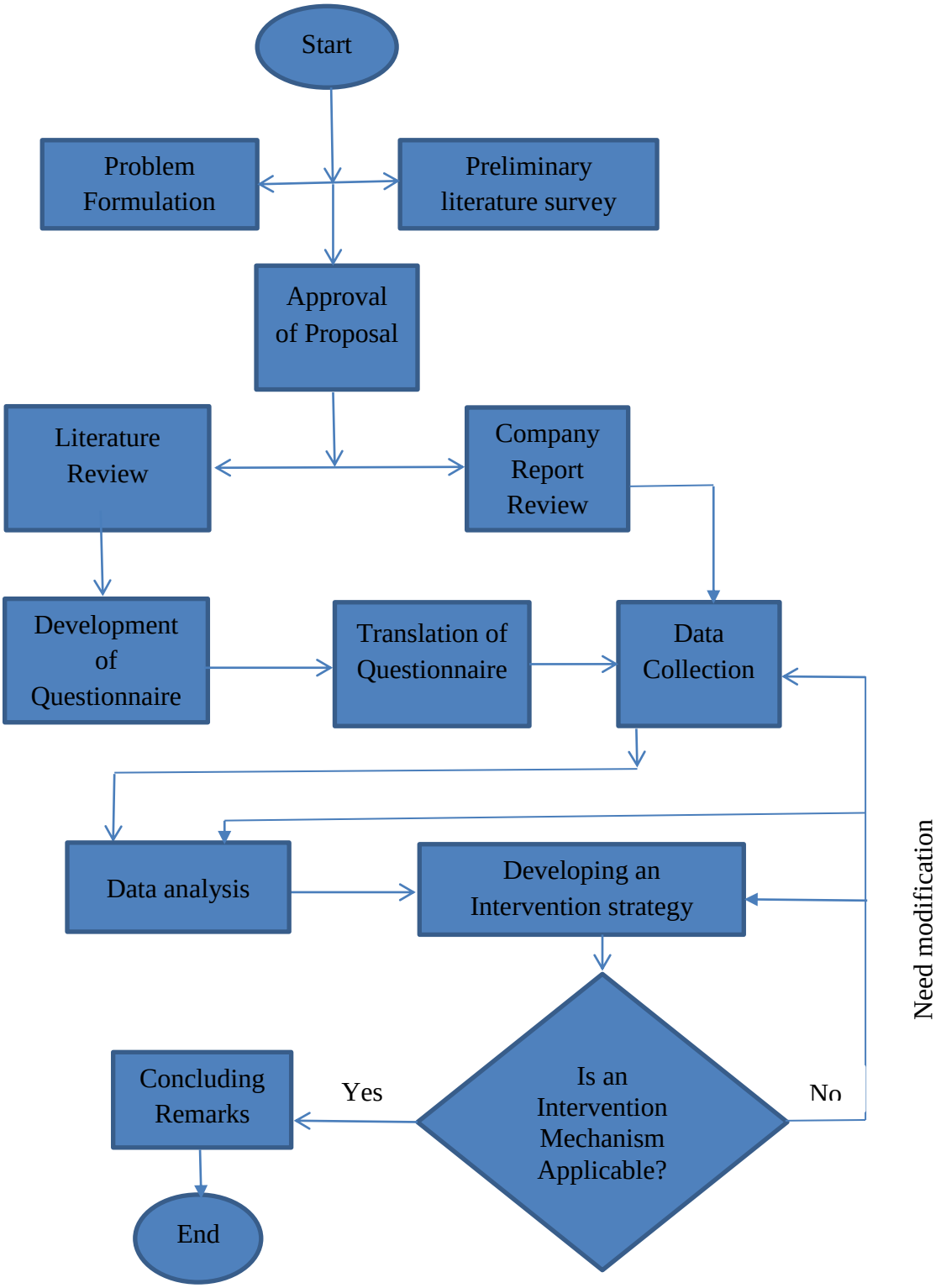

Figure 3. 1 Research Framework

Chapter Four

4. Result and Discussion

4.1 Identification of Workplace Risks in Agri-Flower Strawberry Harvesting

In this identification of workplace risk in agri-flower strawberry harvesting there are the detail description of each risks happening to the worker in the coming sub-sections.

4.1.1 Description of Workplace Risks in Agri-Flower Strawberry Harvesting

Here are detail descriptions of each of the commonly occurring risks in the strawberry harvesting occupations. Slips, trips, and falls: This risk involves the possibility of workers experiencing slips, trips, and falls while performing strawberry harvesting tasks. These accidents can occur due to uneven terrain, wet surfaces, or obstacles in the work area, and can result in injuries ranging from minor bruises to more serious fractures. Pesticides: This risk refers to the potential exposure of workers to pesticides during strawberry harvesting. Workers may come into contact with pesticides through direct handling or inhalation, which can pose health risks if not properly managed. Musculoskeletal disorders: This risk pertains to the development of musculoskeletal disorders among workers engaged in strawberry harvesting. The repetitive nature of the work, prolonged bending or stooping, and heavy lifting can contribute to conditions such as back pain, strains, and sprains.

Machinery-related accidents: This risk focuses on accidents that may occur while using machinery or equipment during strawberry harvesting. Workers may be at risk of entanglement, crushing, or being struck by moving parts of machinery, which can lead to severe injuries such as amputations or fractures. Heat stress: This risk involves the potential for workers to experience heat-related illnesses due to prolonged exposure to high temperatures and physical exertion during strawberry harvesting. Heat stress can range from heat exhaustion to heat stroke and can be life-threatening if not managed properly.

Allergic reactions: This risk refers to the possibility of workers experiencing allergic reactions while working in strawberry fields. Allergies can be triggered by

exposure to pollen, dust, or other allergens present in the environment, leading to symptoms such as skin rashes, respiratory difficulties, or even anaphylaxis in severe cases. Injuries from sharp tools: This risk pertains to the potential for workers to sustain injuries from handling sharp tools such as knives or pruners during strawberry harvesting. Accidental cuts or punctures can occur if proper safety measures are not followed.

Bee stings: This risk involves the possibility of workers being stung by bees or other stinging insects while working in strawberry fields. Bee stings can cause localized pain, swelling, and allergic reactions in some individuals, which may require medical attention. Chemical exposure: This risk refers to the potential exposure of workers to hazardous chemicals, such as fertilizers or cleaning agents, during strawberry harvesting. Improper handling or inadequate protective measures can lead to adverse health effects, including skin irritation, respiratory issues, or long-term health complications.

Dust and respiratory hazards: This risk pertains to the presence of dust and other respiratory hazards in the work environment during strawberry harvesting. Dust particles, mold spores, or other airborne contaminants can lead to respiratory issues, allergies, or occupational lung diseases if workers are not provided with appropriate respiratory protection.

4.1.1.1 Slips and falls

Slips and falls are accidents that occur when a person loses their footing or balance, resulting in them falling to the ground. These accidents can happen in various settings, including homes, workplaces, public spaces, and outdoor environments. Slips typically occur when there is a lack of traction between the person's footwear and the walking surface, while falls can happen due to factors such as tripping over an object, uneven surfaces, or loss of balance.

Slips and falls can lead to a range of injuries, from minor bruises and sprains to more severe fractures or head trauma. Certain individuals, such as the elderly or those with mobility issues, may be more susceptible to slips and falls.

The frequency of slips and falls during a strawberry harvesting season can vary depending on various factors such as weather conditions, terrain, worker experience, and safety measures in place. However, slips and falls are relatively common in agricultural settings due to uneven ground, wet conditions, and the physical nature of the work. It is important for strawberry farmers to prioritize safety and implement measures such as providing proper footwear, maintaining clear pathways, and training workers on safe harvesting techniques to minimize the occurrence of slips and falls.

4.1.1.2 Harmful chemicals

Harmful chemicals refer to substances that can pose risks to human health, the environment, or both. These chemicals can be found in various products, industries, and everyday environments.

The occurrence of harmful chemicals during a strawberry harvesting season can vary depending on the specific circumstances and practices employed by the strawberry farm. However, it is important to note that harmful chemicals may be used in agricultural settings, including the application of pesticides or fertilizers. The frequency of harmful chemical use and potential exposure can depend on factors such as the farm's pest management strategy, local regulations, and the farmer's approach to chemical usage. Some farms may prioritize organic or sustainable farming practices that minimize the use of harmful chemicals, while others may rely more heavily on conventional methods. To ensure the safe handling and use of chemicals, farmers should follow recommended guidelines and regulations provided by local authorities and agricultural organizations. This includes using appropriate protective equipment, adhering to recommended application rates, and properly storing and disposing of chemicals. It is worth noting that many strawberry farms have implemented integrated pest management (IPM) practices, which aim to minimize the use of harmful chemicals by integrating various pest control strategies. These strategies may include biological controls, crop rotation, and cultural practices to reduce the need for chemical interventions. Ultimately, the frequency of harmful chemical use and potential exposure during a strawberry harvesting season can vary, but it is crucial for farmers to prioritize safe and responsible practices to minimize risks to human health and the environment.

4.1.1.3 Musculoskeletal injuries

Musculoskeletal injuries refer to injuries that affect the muscles, bones, tendons, ligaments, or other components of the musculoskeletal system. These injuries can occur due to various causes, including accidents, repetitive motions, overexertion, poor ergonomics, or trauma.

Musculoskeletal injuries can occur during the process of harvesting strawberries, especially if proper precautions and safety measures are not followed. Some potential musculoskeletal injuries that can occur during strawberry harvesting include: Back strains: Bending over or crouching for extended periods while picking strawberries can put strain on the lower back muscles, leading to pain and discomfort. Shoulder and arm injuries: Reaching and stretching to pick strawberries repetitively can cause strains or overuse injuries in the shoulders, arms, and wrists. Knee injuries: Constant kneeling or squatting on hard or uneven surfaces can lead to knee strain or joint pain. Hand and finger injuries: Repetitive gripping and twisting motions while picking strawberries can cause hand and finger strains, sprains, or even conditions like carpal tunnel syndrome.

4.1.1.4 Heat stress or Dehydration

Heat stress and dehydration are significant concerns during strawberry harvesting, as this activity often takes place during hot weather conditions. Here are some tips to prevent heat stress and dehydration: Stay hydrated: Drink plenty of water before, during, and after work. Aim for at least 8 cups (64 ounces) of water per day. Avoid sugary drinks and alcohol, as they can contribute to dehydration. Take regular breaks: Schedule frequent breaks in shaded or cool areas to rest and hydrate. Avoid working continuously in the sun for extended periods. Wear appropriate clothing: Choose lightweight, loose-fitting, and breathable clothing that allows sweat to evaporate and helps in cooling the body. Consider wearing a wide-brimmed hat and sunglasses for added sun protection. Use sunscreen: Apply sunscreen with at least SPF 30 or higher to protect your skin from harmful UV rays. Reapply as directed by the product instructions. Seek shade: Whenever possible, work in shaded areas or use umbrellas or canopies to create shade. This helps reduce direct sun exposure and lowers the risk of heat-related illnesses. Monitor weather conditions: Stay informed about weather forecasts and heat advisories in your area. If extreme heat warnings are issued, consider rescheduling work to cooler times of the day or opting for alternative tasks indoors. Train workers on heat stress prevention: Employers should provide training on

recognizing the signs and symptoms of heat stress and dehydration. Workers should be educated on the importance of hydration, rest breaks, and seeking medical attention if necessary. Encourage proper nutrition: Consume a balanced diet that includes fruits, vegetables, and foods rich in electrolytes (e.g., bananas, oranges, and sports drinks) to replenish lost nutrients and maintain electrolyte balance. Monitor for signs of heat-related illnesses: Be aware of symptoms such as dizziness, headache, nausea, rapid heartbeat, confusion, or excessive sweating. If any of these symptoms occur, immediately move to a shaded area, rest, and seek medical assistance if needed.

4.1.1.5 Allergies or respiratory issues

Allergies or respiratory issues during strawberry harvesting can occur due to a variety of factors. Here are some possible reasons: Pollen: Strawberries are flowering plants, and their pollen can trigger allergies in susceptible individuals. When harvesting strawberries, you may come into contact with pollen, which can lead to allergic reactions such as sneezing, itching, watery eyes, or respiratory symptoms. Mold or fungal spores: Strawberries are susceptible to mold growth, especially in humid environments. Handling moldy strawberries or being in close proximity to them during harvesting can release mold spores into the air. Inhaling these spores can cause respiratory issues or exacerbate existing allergies. Pesticides or chemicals: To protect strawberry crops from pests and diseases, farmers may use pesticides or other chemicals. Direct exposure to these substances during harvesting can irritate the respiratory system or trigger allergic reactions in sensitive individuals. Dust or soil particles: Working in the fields, especially during dry and windy conditions, can stir up dust or soil particles. Inhaling these particles can irritate the respiratory system and potentially cause respiratory issues or allergies. Pre-existing conditions: Individuals with pre-existing respiratory conditions such as asthma or allergies may be more susceptible to experiencing symptoms during strawberry harvesting due to their heightened sensitivity to allergens or irritants.

4.1.1.6 Insect bites or stings

Insect bites or stings during strawberry harvesting can be an unfortunate occurrence. Preventing insect bites or stings while harvesting strawberries can be challenging, but one can reduce the risk by wearing long sleeves, pants, and closed-toe shoes, and applying

insect repellent to exposed skin. Additionally, avoid wearing bright colors or using scented products that may attract insects.

4.1.1.7 Machinery or equipment-related hazards during

Machinery or equipment-related hazards can pose risks during strawberry harvesting. Here are some potential hazards to be aware of and safety measures to consider: Hand tools such as pruning shears or knives are commonly used in strawberry harvesting. Handle them with care, keeping blades covered or locked when not in use. Use appropriate personal protective equipment, like gloves, to protect against cuts or punctures. To mitigate these hazards, it is crucial to provide training and education on proper safety practices to all individuals involved in strawberry harvesting. Implement safety protocols, conduct regular equipment inspections, and establish clear communication channels for reporting and addressing any safety concerns. Always prioritize the well-being and safety of all workers involved in the strawberry harvesting process.

In general the list of risks that found at the work area of agri-flower strawberry farmers are Slips, trips, and falls, Pesticides related risk, musculoskeletal disorders, Machinery-related accidents, Heat stress, Allergic reactions, Injuries from sharp tools, Bee stings, Chemical exposure, Dust and respiratory hazards.

4.1.2 Data presentation and variable coding

The questionnaires which have 39 questions have got 49 full respondents from the selected 55 selected sample workers. From the 55 selected sample workers only 49 workers fully responded the questioner and finally in this work only 49 entries used for the analysis. The authors of this work used research assistant to administer the questionnaire.

The questionnaire translated to Amharic for those in needs and for those who prefer to respond as it is, it provided as it is with the English version. The questionnaire is with easy likert scale and yes or no for easy communications and understanding.

Furthermore, each question is previously checked on pilot test with the workers, experts and managers for its clarity and appropriateness.

For easy data management and analysis on Stata 15 version; coding was done and the following Table 4.1 listed all the questionnaire in the English versions and its coding for Stata usage.

Table 4. 1 Variable Coding

	Questionnaires	Variable code
1.	Do workers come into contact with pesticides during strawberry harvesting? (Yes/No)	contact_pesticides
2.	How severe are the potential health effects of pesticide exposure? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	health_effects_pesticides
3.	How frequently are workers exposed to pesticides? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	frequency_pesticides
4.	Are there measures in place to minimize pesticide exposure? (Yes/No)	minimize_exposure
5.	Are slips, trips, and falls common during strawberry harvesting? (Yes/No)	slips_trips_falls
6.	How severe are the potential injuries from slips, trips, and falls? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	severity_injuries_falls
7.	How frequently do slips, trips, and falls occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	frequency_falls
8.	Are safety measures in place to prevent slips, trips, and falls? (Yes/No)	safety_measures_falls
9.	Are musculoskeletal disorders a concern among workers? (Yes/No)	musculoskeletal_disorders
10.	How severe are the potential musculoskeletal disorders? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	severity_musculoskeletal
11.	How frequently do musculoskeletal disorders occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	frequency_musculoskeletal
12.	Are ergonomic measures in place to prevent musculoskeletal disorders? (Yes/No)	ergonomic_measures

13.	Are machinery-related accidents a concern during strawberry harvesting? (Yes/No)	machinery_accidents
14.	How severe are the potential injuries from machinery-related accidents? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	severity_injuries_machinery
15.	How frequently do machinery-related accidents occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	frequency_machinery
16.	Are safety protocols and training provided for machinery operation? (Yes/No)	safety_protocols_heat
17.	Is heat stress a concern in the work environment? (Yes/No)	heat_stress
18.	How severe are the potential health effects of heat stress? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	severity_heat
19.	How frequently does heat stress occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	frequency_heat
20.	Are measures in place to prevent and manage heat stress? (Yes/No)	prevent_heat
21.	Are allergic reactions a concern among workers? (Yes/No)	allergic_reactions
22.	How severe are the potential allergic reactions? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	severity_allergic
23.	How frequently do allergic reactions occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	frequency_allergic
24.	Are workers provided with protective equipment to prevent injuries from sharp tools? (Yes/No)	protective_equipment_injuries_sharp
25.	How severe are the potential injuries from sharp tools? (1. Very Low, 2. Low, 3. Moderate, 4.	severity_injuries_sharp

	High, 5. Very High)	
26.	How frequently do injuries from sharp tools occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	frequency_injuries_sharp
27.	Are workers trained in proper handling and use of sharp tools? (Yes/No)	training_sharp
28.	Are bee stings a concern among workers? (Yes/No)	bee_stings
29.	How severe are the potential health effects of bee stings? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	severity_bee_stings
30.	How frequently do bee stings occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	frequency_bee_stings
31.	Are measures in place to prevent and manage bee stings? (Yes/No)	prevent_bee
32.	Is chemical exposure a concern in the work environment? (Yes/No)	chemical_exposure
33.	How severe are the potential health effects of chemical exposure? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	severity_chemical
34.	How frequently does chemical exposure occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	frequency_chemical
35.	Are workers provided with appropriate personal protective equipment for chemical handling? (Yes/No)	ppe_chemical
36.	Are dust and respiratory hazards a concern during strawberry harvesting? (Yes/No)	dust_respiratory_hazards
37.	How severe are the potential health effects of dust and respiratory hazards? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	severity_dust_respiratory

38.	How frequently do dust and respiratory hazards occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)	frequency_dust_respiratory
39.	Are workers provided with respiratory protection and training? (Yes/No)	respiratory_protection_training

After the questioner is distributed and relevant data is collected directly from the works with easy Likert scale and yes or no for easy communications and understanding the collected data is directly feed to Stata 15 versions according to the coded variable in order to get the mean, standard deviation, minimum and maximum value of the data. Using Stata 15 versions the following summary is generated.

Table 4. 2 Descriptive Stata result

Variable	Obs	Mean	Std. Dev.	Min	Max
contact_pe~s	49	.6326531	.4870779	0	1
health_eff~s	49	3.693878	1.004243	1	5
frequency~es	49	2.836735	.8501701	1	5
minimize_e~e	49	.2244898	.4215698	0	1
slips_trip~s	49	.9183673	.2766417	0	1
severity_i~s	49	3.204082	.7632057	2	5
frequency~ls	49	2.612245	.5329293	2	4
safety_mea~s	49	.1428571	.3535534	0	1
musculoske~s	49	.9591837	.1999149	0	1
severity_m~l	49	4.653061	.5609152	3	5
frequenc~tal	49	4.44898	.5025445	4	5
ergonomic_~s	49	.1428571	.3535534	0	1
machinery_~s	49	.1020408	.3058389	0	1
severity_i~y	49	1.612245	.4922875	1	2
frequenc~ery	49	1.489796	.5050763	1	2
safety_pro~t	49	.0612245	.2422261	0	1
heat_stress	49	.8163265	.3912304	0	1
severity_h~t	49	3.877551	.6961996	3	5
frequency_~t	49	2.387755	.7857143	1	4
prevent_heat	49	.0816327	.2766417	0	1
allergic_r~s	49	.8571429	.3535534	0	1
severity_a~c	49	3.244898	.7508499	2	5
frequency_~c	49	3.387755	.9961661	2	5
protective~p	49	0	0	0	0
severity_i~p	49	3.428571	.5773503	2	4
frequency_~p	49	2.530612	.8921426	1	4
training_s~p	49	.2653061	.4460713	0	1
bee_stings	49	.3673469	.4870779	0	1
severity_b~s	49	1.734694	.6700594	1	3
frequency~gs	49	2.469388	.6487822	1	4
prevent_bee	49	.0408163	.1999149	0	1
chemical_e~e	49	.8367347	.3734378	0	1
severity_c~l	49	3.469388	.9596449	2	5
frequenc~cal	49	2.142857	.6123724	1	3
ppe_chemical	49	.6938776	.4656573	0	1
dust_respi~s	49	.9387755	.2422261	0	1
severity_d~y	49	2.571429	.7071068	1	4
frequenc~ory	49	3.795918	.6763749	3	5
respirator~g	49	.122449	.3312007	0	1

The variables listed under Table 4.2 are the abrivated codes of the question given under Table 4.1. The variable code contact__ pe~s which is contact pesticides is stands for the question number one that says Do workers come into contact with pesticides during strawberry harvesting? And the question is simple Yes or No question that the workers can answer easily.

When we come to the 2nd variable code health_eff~s which stand for health effects pesticides coded to indicate How severe are the potential health effects of pesticide exposure that enables the respondent by simple Likert scale very low, low, moderate, high, and very high. Like wish the others variables presented in this table like frequency~es stands for frequency_pesticides, minimize_e~e stands for minimize_exposure, slips_trips~e stands for slips_trips_falls, and other 34 variables are explained as well.

For the 49 observations to obtain the severity and frequency of each ergonomic risks the mean, standard deviation, minimum and maximum result of the gathered data is generated from stata version 15. The mean value of each variable in this generated summary represent that the average of the collected data according to the questioner that calculated by dividing the sum of collected data by the total number of respondent. The standard deviation is the average amount of variability in the dataset. It tells on average, how far each value lies from the mean. A high standard deviation means that values are generally far from the mean, while a low standard deviation indicates that values are clustered close to the mean. The minimum value of the generated result indicates the smallest value in the data set. The maximum value of the generated result indicates the largest value in the data set.

For instant the first variable contact__ pe~s which stands for the question number one that says do workers come into contact with pesticides during strawberry harvesting? And the mean value is 0.6326521 which means that from 49 respondent around 31 respondent are into contact with pesticides during strawberry harvesting. The 0.4870779 standard deviation show that values of the collected answers are generally closer to the mean value. The minimum value 0 indicates the smallest value in the data which represent “No” and maximum value 1 indicates the largest value in the data which

represent “Yes” is presented on the Table for the yes or no questions and for the others accordingly.

4.1.3 Risk Ranking, Prioritization, and Intervention Considerations

Risk Ranking and Prioritization for Investigation of Workplace Risk and Ergonomic Intervention for Agricultural Harvest Workers: A case of Agri-Flower strawberry harvesting workers in Holeta

To effectively prioritize the investigation of workplace risks and ergonomic interventions for Agri-Flower strawberry harvesting workers in Holeta, a risk ranking and prioritization process should be followed. This process involves assessing the severity and likelihood of each identified risk and assigning a priority level based on the potential impact on workers' health and safety.

4.1.3.1 Severity Evaluation

Using Stata 15; the severity of each identified risk by considering the potential consequences on workers' health and well-being.

Table 4. 3 Severity Stata result

Variable	Obs	Mean	Std. Dev.	Min	Max
health_eff~s	49	3.693878	1.004243	1	5
severity_i~s	49	3.204082	.7632057	2	5
severity_m~l	49	4.653061	.5609152	3	5
severity_i~y	49	1.612245	.4922875	1	2
severity_h~t	49	3.877551	.6961996	3	5
severity_a~c	49	3.244898	.7508499	2	5
severity_i~p	49	3.428571	.5773503	2	4
severity_b~s	49	1.734694	.6700594	1	3
severity_c~l	49	3.469388	.9596449	2	5
severity_d~y	49	2.571429	.7071068	1	4

The variables listed under Table 4.3 are the abrivated codes of the question that focuses on the severty of the risks given under Table 4.1. The variable code health_eff~s

is stand for How severe are the potential health effects of pesticide exposure that enables the respondent to answer by simple Likert scale very low, low, moderate, high, and very high. Here the mean value 3.693878 which is pretty close to 4 indicate that there is a potential health effects of pesticide exposure. The minimum value 1 indicate that the smallest value in the data set which represent "very low" and maximum value 5 indicates the largest value in the data set which represent "very high".

On the other hand severity_i~p is stand for How severe are the potential injuries from sharp tools that enables the respondent to answer by simple Likert scale very low, low, moderate, high, and very high. Here the mean value 3.428571 which is pretty close to 3.5 indicate that there is a potential injuries from sharp tools. The minimum value 2 indicate that the smallest value in the data set which represent "low" and maximum value 4 indicates the largest value in the data set which represent " high". The rest is defined in the same fashion we did for health_eff~s and severity_i~p.

4.1.3.2 Frequency Evaluation

Assess the likelihood of each identified risk by considering the probability or frequency of occurrence.

Table 4. 4 Frequency of happening stata result

Variable	Obs	Mean	Std. Dev.	Min	Max
frequency~es	49	2.836735	.8501701	1	5
frequency~ls	49	2.612245	.5329293	2	4
frequenc~tal	49	4.44898	.5025445	4	5
frequenc~ery	49	1.489796	.5050763	1	2
frequency_~t	49	2.387755	.7857143	1	4
frequency_~c	49	3.387755	.9961661	2	5
frequency_~p	49	2.530612	.8921426	1	4
frequency~gs	49	2.469388	.6487822	1	4
frequenc~cal	49	2.142857	.6123724	1	3
frequenc~ory	49	3.795918	.6763749	3	5

The variables listed under Table 4.4 are the abrivated codes of the question that focuses on the frequency of the risks happening given under Table 4.1. The variable code frequency~es is stand for How frequently are workers exposed to pesticides that enables the respondent to answer by simple Likert scale very low, low, moderate, high, and very high. Here the mean value 2.836735 which is pretty close to 3 indicate that there is a frequency the workers exposed to pesticides. The minimum value 1 indicate that the smallest value in the data set which represent "very low" and maximum value 5 indicates the largest value in the data set which represent "very high".

On the other hand frequency_~p is stand for how frequently do injuries from sharp tools occur that enables the respondent to answer by simple Likert scale very low, low, moderate, high, and very high. Here the mean value 2.530612 which is pretty close to 3 indicate that there is the frequency of injuries from sharp tools occurs. The minimum value 1 indicate that the smallest value in the data set which represent "low" and maximum value 4 indicates the largest value in the data set which represent " high". The rest is defined in the same fashion we did for frequency~es and frequency_~p.

4.1.3.3 Risk Level Calculation and Ranking:

Multiply the mean severity rating by the mean frequency rating to calculate the risk level for each identified risk. This will provide a numerical value that represents the overall risk associated with each hazard.

Table 4. 5 Risk calculations and risk ranking

Sn	List of Risks	Mean Severity Evaluation	Mean Frequency Evaluation	Risk Level calculation	Risk Ranking
1	Pesticides	3.693878	2.836735	10.47855	3
2	Slips, trips, and falls	3.024082	2.612245	7.899643	7
3	Musculoskeletal disorders	4.653061	4.44898	20.70138	1
4	Machinery-related accidents	1.612245	1.489796	2.401916	10
5	Heat stress	3.877551	2.387755	9.258642	5
6	Allergic reactions	3.244898	3.387755	10.99292	2
7	Injuries from sharp tools	3.428571	2.530612	8.676383	6

8	Bee stings	1.734694	2.469388	4.283633	9
9	Chemical exposure	3.469388	2.142857	7.434402	8
10	Dust and respiratory hazards	2.571429	3.795918	9.760934	4

According to Table 4.5 Musculoskeletal disorders is the first ranked risk which have higher risk level value 20.70138, The second is Allergic reactions which have risk level value10.99292, The third is Pesticides which have risk level value10.47855, The forth is Dust and respiratory hazards which have risk level value 9.760934, The fifth is Heat stress which have risk level value 9.258642, The sixth is Injuries from sharp tools which have risk level value 8.676383, The seventh is Slips, trips, and falls which have risk level value 7.899643, The eighth is Chemical exposure which have risk level value 7.434402, The ninth is Bee stings which have risk level value 4.283633, The tenth is Machinery-related accidents which have risk level value 2.401916.

4.2 Assessing Musculoskeletal Disorder of a Strawberry Harvesters

Musculoskeletal disorders (MSDs) are a significant concern in various occupational settings, including agriculture. Strawberry harvesting, in particular, is a physically demanding task that involves repetitive motions, awkward postures, and prolonged periods of bending and reaching. These factors can contribute to the development of MSDs among strawberry harvesters.

Assessing the musculoskeletal health of strawberry harvesters is crucial for identifying potential risk factors, implementing preventive measures, and improving overall worker well-being. By understanding the specific ergonomic challenges faced by strawberry harvesters and evaluating their impact on musculoskeletal health, interventions can be designed to reduce the risk of MSDs and enhance the productivity of workers.

The assessment of MSDs among strawberry harvesters involves a multidimensional approach that considers various factors, including body part ergonomic rating, productivity rating, and injury rates. Body part ergonomic rating involves evaluating the ergonomic conditions and body postures adopted by harvesters during the task. This assessment helps identify areas of high strain and potential risk for MSDs.

Productivity rating focuses on evaluating the efficiency and output of strawberry harvesters. It considers factors such as training, experience, work organization strategies, and task allocation, which can impact productivity levels. Understanding the relationship between productivity and musculoskeletal health is crucial for developing strategies to optimize work processes and enhance worker performance.

Injury rates are another essential aspect of assessing MSDs among strawberry harvesters. Analyzing the prevalence, causes, and patterns of injuries can provide valuable insights into the specific hazards and risks associated with strawberry harvesting. This information can guide the development of targeted interventions and safety measures to mitigate injury risks and promote a safer working environment.

This study aims to assess the musculoskeletal health of strawberry harvesters through a comprehensive evaluation of body part ergonomic rating, productivity rating, and injury rates. By examining the existing literature, identifying relevant studies, and analyzing the findings, this research seeks to contribute to the understanding of MSDs among strawberry harvesters and provide insights into effective preventive measures and interventions.

The results of this assessment can help inform policymakers, agricultural stakeholders, and occupational health professionals about the specific needs and challenges faced by strawberry harvesters. Ultimately, the goal is to create a safer and healthier work environment, reduce the incidence of MSDs, and enhance the overall well-being and productivity of strawberry harvesters.

4.2.1 Body Part Ergonomic Rating:

This represents the rating or assessment of the ergonomic conditions related to different body parts during the strawberry harvesting process. It is a subjective measure or rating provided by the workers to indicate the level of physical strain or discomfort they experience in various body parts such as their back, shoulders, and wrists while performing strawberry harvesting tasks. The rating can be on a scale of 1-10, with 1 being low strain and 10 being high strain. Identify and list the different body parts that are involved in the task of strawberry harvesting such as hands, arms, back, legs, etc.

Evaluate the ergonomic conditions for each body part during the task. Assign a rating on a scale of 0 to 10 for each body part based on the perceived level of ergonomic strain or discomfort experienced during the task. A rating of 0 indicates no strain or discomfort, while 10 indicates maximal strain or discomfort. Calculate the average rating across all body parts to get the overall body part ergonomic rating for the strawberry harvester.

4.2.2 Productivity Rating:

This represents the rating or assessment of the workers' productivity during the strawberry harvesting process. It is a subjective measure provided by the workers to indicate their perceived level of productivity or efficiency in picking strawberries. The rating can be on a scale of 1-10, with 1 being low productivity and 10 being high productivity. It reflects the workers' own perception of how well they are able to perform their tasks and meet their targets. Assess the productivity of the strawberry harvester based on predetermined criteria or performance indicators this indications are the number of strawberries harvested per hour, efficiency of sorting and packing, etc. Assign a rating on a scale of 0 to 10 for productivity based on the observed performance. A rating of 0 indicates low productivity, while 10 indicates high productivity.

4.2.3 Injury Rating:

This represents the rating or assessment of the work-related injury rates during strawberry harvesting. It is a subjective measure provided by the workers to indicate their perception of the safety and injury rates associated with their work. The rating can be on a scale of 1-10, with 1 indicating a low risk of injuries and 10 indicating a high risk of injuries. It reflects the workers' perception of the effectiveness of safety measures and the overall safety conditions during strawberry harvesting. Identify and list the potential injuries or risks associated with strawberry harvesting such as repetitive strain injuries, back pain, cuts, etc. Assess the likelihood and severity of each potential injury or risk. Assign a rating on a scale of 0 to 10 for each injury or risk based on the perceived likelihood and severity. A rating of 0 indicates no likelihood or severity, while 10 indicates high likelihood or severity. Calculate the average rating across all injuries or risks to get the overall injury rating for the strawberry harvester.

4.2.4 Data presentation

Data taken for this part of the study is on job observation and interview directly with workers. Accordingly, using the Borg-10 scale ergonomic assessment the study has taken insight by primary data. The source of this questioner is borg, G.(1998. Borg's perceived exertion and pain scales human kinetics. Figure 4.2 is used make clear which part of the body every single respondent are in risk while collecting the data from the respondent and their answer response is filled at Table 4.7. Finally everything is summarized in the Table 4.6.

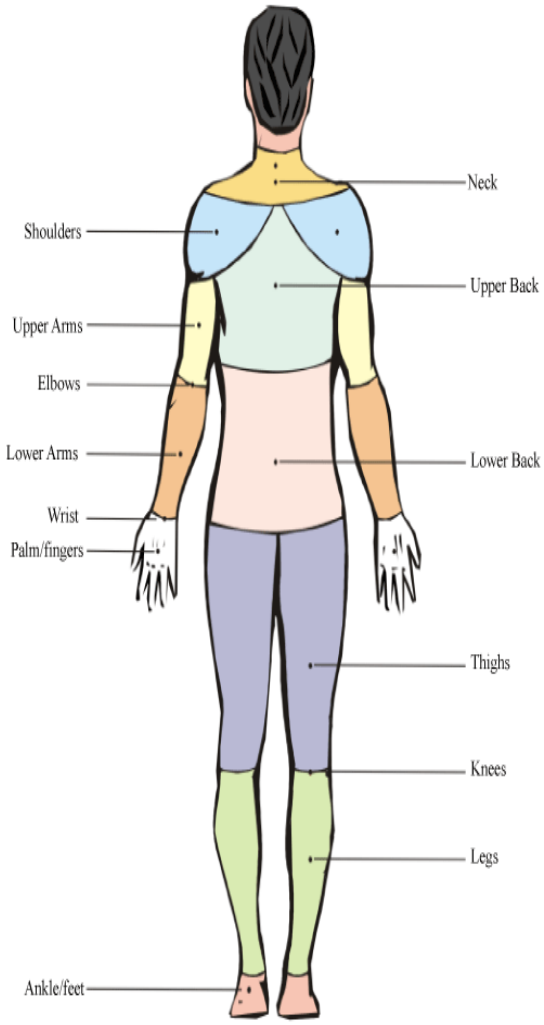

Figure 4. 1 Body parts to be assessed

Table 4. 6 Borges 10-Scale Body Ergonomic Questioner

Part Two: Borges 10-scale body ergonomic questioner for Agri-flower strawberry workers **Instruction:-**Evaluate each part of the body pain you feel from one to ten by **using (√) symbol for answering**. One is for rest and ten is extremely hard pain you feel.											
	Rest(0)	Extremely easy(1)	Very easy(2)	Easy(3)	Moderate(4)	Somewhat hard(5)	Moderately hard(6)	Hard(7)	Very hard (8)	Very, very hard(9)	Extremely hard(10)
Neck		3		2			15				
Shoulder			5	4	1			10			
Upper back					6	14					
Upper arm				1	6	13					
Elbow				5		13	2				
Lower back				4	6	1		9			
Lower arm				2		8	8				
Wrist							11	9			
Palm/fingers					12	2	6				
Thigh											
Knee				2	7	5	6				
leg						4	3	13			
Ankle/feet							12	8			

Table 4.6 indicate that the answers of 20 respondent evaluate each part of the body pain they are feeling. When it comes to the neck pain out of 20 respondent only 3 respondent are feeling extremely easy pain, 2 respondent feels easy pain and 15 respondent feels moderately hard pain around there neck. The pain that occurs around neck is due to their work culture they have. One of the work culture they have is caring the cut grass, the harvesting cart, the seeds and other things to be carried as well. In addition to the neck the assessments are don on the other body parts such as Shoulder, Upper back, Upper arm, Elbow, Lower back, Lower arm, Wrist, Palm/fingers, Thigh, Knee, leg and Ankle/feet.

Table 4. 7 Data Summary

	Respondent 1	Respondent 2	Respondent 3	Respondent 4	Respondent 5	Respondent 6	Respondent 7	Respondent 8	Respondent 9	Respondent 10	Respondent 11	Respondent 12	Respondent 13	Respondent 14	Respondent 15	Respondent 16	Respondent 17	Respondent 18	Respondent 19	Respondent 20
1. Education	0	0	0	2	9	0	0	5	5	11	3	0	7	2	7	4	6	2	0	5
2. Sex	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
3. Age	58	37	36	30	55	65	37	20	26	21	20	36	25	26	18	27	25	21	37	22
4. Experience	11	11	9	.25	15	17	6	.25	5	1	.5	5	5	5	.9	9	5	5	4	5
5. Working time hour	8		8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	10	10
6. House-working time hour	9	10	9	8	8	8	8	9	8	8	7	8	8	9	8	9	8	8	8	7
7. Sleeping time hour	7	6	7	8	8	8	8	7	8	8	9	8	8	7	8	7	8	8	6	7
8. BMI kg/cm	50//155	45 / 145	65 / 167	50 / 155	50 / 160	50 / 163	47 / 154	58 / 163	52 / 144	49 / 149	65 / 153	42 / 150	49 / 156	50 / 152	49 / 147	51 / 152	64 / 154	47 / 150	55 / 148	50 / 157
9. Body part Ergonomic rating	8	7	6	9	8	5	7	6	8	9	6	7	8	5	7	6	8	9	6	7
10. Productivity rating	9	6	7	8	9	7	6	5	9	8	7	6	9	7	6	5	9	8	7	6
11. Injury rating	3	5	4	2	3	6	4	5	2	3	4	5	3	6	4	5	2	3	4	5

4.3 Discussion

Strawberry harvesting is a labor-intensive agricultural activity that exposes workers to various occupational risks. This study aims to identify, rank, and quantify the risks faced by strawberry harvesting workers by assessing their severity and frequency. The results are then compared with existing literature to provide a comprehensive understanding of the hazards associated with this occupation.

4.3.1 Identification and ranking of Workplace Risks in Agri-Flower Strawberry Harvesting

The identification and ranking of risks aligns with the existing literature on strawberry harvesting and other agricultural activities. According to table 4.5 the high ranking of musculoskeletal disorders (MSDs) reflects the physical demands of strawberry harvesting, involving repetitive movements, prolonged bending, and heavy lifting. Studies by Paul et al., (2019) and Poochada et al., (2022) have also highlighted the prevalence of MSDs among agricultural workers, emphasizing the need for ergonomic interventions to reduce the risk of such disorders.

Pesticide exposure ranks third in this study, indicating its significant risk to workers. This finding is consistent with studies by Bureau et al., (2022), which underline the potential health hazards associated with pesticide use in agriculture. The literature emphasizes the importance of proper training, use of protective equipment, and adherence to safety protocols to minimize pesticide-related risks.

Allergic reactions, dust and respiratory hazards, and heat stress rank high in this study, indicating the need for proper protective measures. A study by M Ricco et al., (2017)have highlighted the risks of respiratory illnesses and heat-related illnesses among agricultural workers, emphasizing the importance of personal protective equipment, allergen control measures, proper ventilation, and adequate hydration.

Slips, trips, and falls were identified as a significant risk, highlighting the importance of maintaining clear walkways, appropriate footwear, and regular inspections to prevent accidents. Chemical exposure, bee stings, injuries from sharp tools, and machinery-related accidents rank lower in this study. While their risk levels are comparatively lower,

it is still important to implement safety measures, training, and regular maintenance to prevent these hazards.

This study provides valuable insights into the risks faced by strawberry harvesting workers, ranking them based on their severity and frequency. Studies have shown that agricultural workers, including strawberry harvesters, have a higher prevalence of MSDs compared to workers in other industries. The physical demands of the job, such as repetitive motions involved in picking strawberries or carrying heavy loads, can lead to overuse injuries and musculoskeletal imbalances. Common MSDs reported among agricultural workers include back pain, shoulder injuries, tendonitis, and carpal tunnel syndrome. The consequences of MSDs can be significant, both for the affected workers and the industry as a whole. Workers may experience pain, reduced mobility, and decreased productivity, which can lead to absenteeism and increased healthcare costs. Moreover, the physical demands of strawberry harvesting can be particularly challenging for older workers, who may be more susceptible to MSDs.

To address the risk of MSDs among strawberry harvesting workers, ergonomic interventions are crucial. Therefore, the next sub section assesses the MSDs of strawberry harvesters in a greater detail.

4.3.2 Assessing musculoskeletal disorder of agri-flower Strawberry harvesters

4.3.2.1 Body Part Ergonomic Rating vs. Productivity Rating:

Workers with higher ergonomic ratings tend to have higher productivity ratings, indicating a positive correlation between ergonomic rating and productivity rating. For example, Workers 1, 4, 5 have higher ergonomic ratings (8-9) and higher productivity ratings (8-9), suggesting that better ergonomic conditions contribute to increased productivity. Workers with lower ergonomic ratings tend to have lower productivity ratings, indicating a moderate correlation between ergonomic rating and productivity rating. For example, Workers 2, 3, 20 have lower ergonomic ratings (6-7) and lower productivity ratings (6-7), suggesting that improvements in ergonomic factors may enhance their productivity. Workers with higher ergonomic ratings tend to have higher productivity ratings. For example, Workers 1, 4, 5, 9, 10, 13, 17, and 18 have higher

ergonomic ratings (8-9) and higher productivity ratings (8-9). This suggests a positive correlation between ergonomic rating and productivity rating, indicating that better ergonomic conditions may contribute to increased productivity.

There is a positive correlation between body part ergonomic rating and productivity rating. Workers with higher ergonomic ratings tend to have higher productivity ratings. This suggests that providing better ergonomic conditions for workers can potentially enhance their productivity levels. Implementing ergonomic interventions and ensuring proper ergonomic design in the workplace may lead to improved worker performance and efficiency.

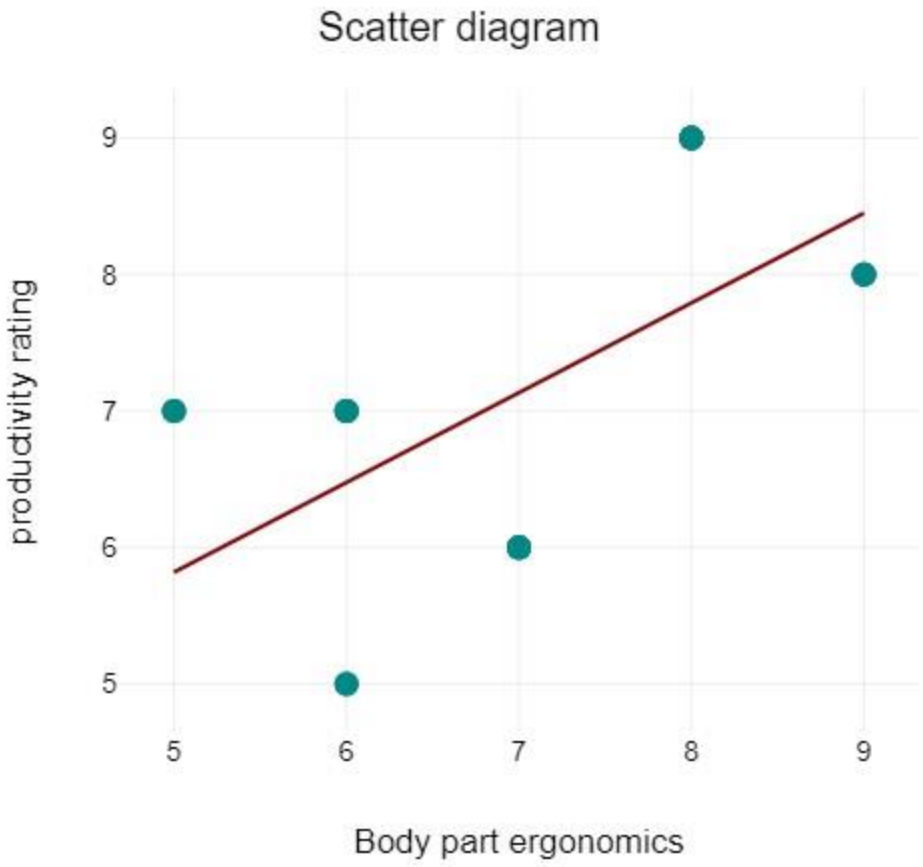

Figure 4. 2 Body part ergonomic rating vs productivity rating

A Pearson correlation is performed to determine if there is a correlation between variables Body part ergonomics and productivity rating. There is a high, positive correlation between variables Body part ergonomics and productivity

rating with r= 0.61. Thus, there is a high, positive association between Body part ergonomics and productivity rating in this sample.

The result of the Pearson correlation showed that there was a significant correlation between Body part ergonomics and productivity rating, *r* (18) = 0.61.

4.3.2.2 Body Part Ergonomic Rating vs. Injury Rating:

Workers with higher ergonomic ratings tend to have lower injury ratings, indicating a negative correlation between ergonomic rating and injury rating. For instance if we look at Workers 4, 5 have higher ergonomic ratings (8-9) and lower injury ratings (2-3), suggesting that better ergonomic conditions can help reduce the risk of injuries. Workers with lower ergonomic ratings tend to have moderate injury ratings, indicating a moderate correlation between ergonomic rating and injury rating. For instance if we look at, Workers 2, 3, 20 have lower ergonomic ratings (6-7) and moderate injury ratings (4-5), suggesting that improvements in ergonomic factors may potentially reduce their risk of injuries.

Workers with higher ergonomic ratings tend to have lower injury ratings. For example, Workers 4, 5, 9, 10, 13, 17, and 18 have higher ergonomic ratings (8-9) and lower injury ratings (2-3). This suggests a negative correlation between ergonomic rating and injury rating, indicating that better ergonomic conditions may help reduce the risk of injuries.

There is a negative correlation between body part ergonomic rating and injury rating. Workers with higher ergonomic ratings tend to have lower injury ratings. This indicates that better ergonomic conditions contribute to a reduced risk of work-related injuries. By prioritizing ergonomic factors and designing workstations and tasks to minimize physical strain and discomfort, employers can potentially mitigate the risk of injuries and promote worker safety.

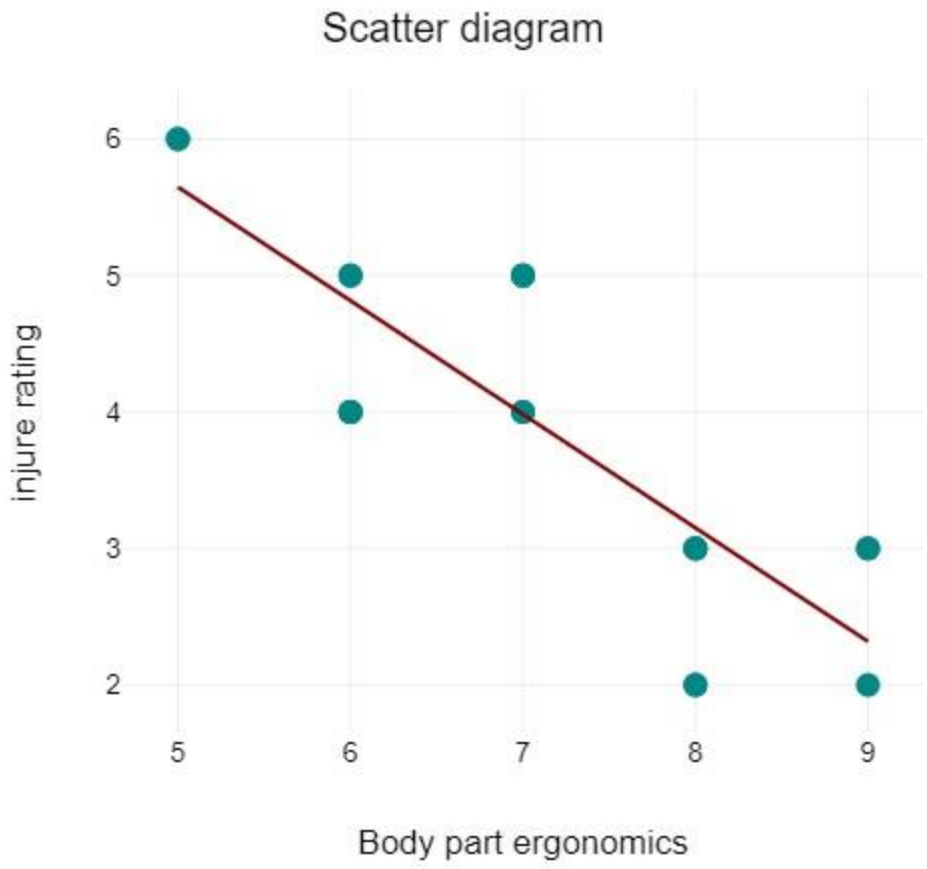

Figure 4. 3 Body par ergonomic rating vs injury rating

A Pearson correlation is performed to determine if there is a correlation between variables Body part ergonomics and injure rating. There is a very high, negative correlation between variables Body part ergonomics and injure rating with r= -0.83. Thus, there is a very high, negative association between Body part ergonomics and injure rating in this sample.

The result of the Pearson correlation showed that there was a significant correlation between Body part ergonomics and injure rating, $r(18) = -0.83$.

4.3.2.3 Productivity Rating vs. Injury Rating:

A Pearson correlation was performed to determine if there is a correlation between variables productivity rating and injure rating. There is a very

high, negative correlation between variables productivity rating and injure rating with r= -0.76. Thus, there is a very high, negative association between productivity rating and injure rating in this sample.

The result of the Pearson correlation showed that there was a significant correlation between productivity rating and injure rating, r (18) = -0.76

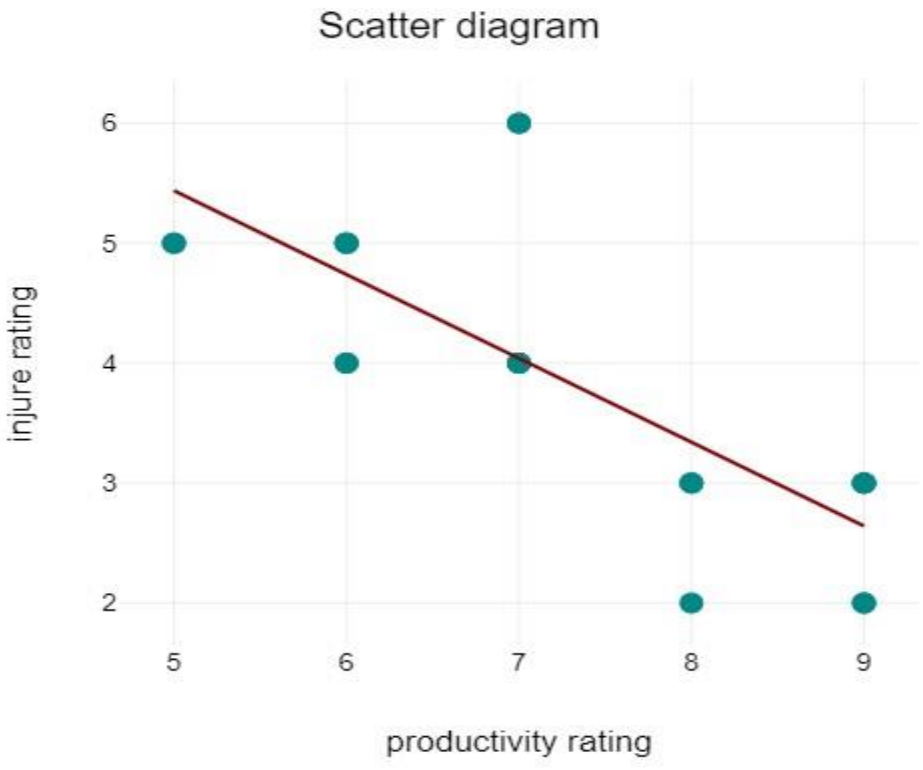

Figure 4. 4 Productivity rating vs injury rating

Chapter five
5. Proposed Intervention for Agri-flower Strawberry harvesting Company in Holeta

5.1 Engineering Interventions

Here the study provided engineering interventions for musculoskeletal disorders (MSDs) in Agri-Flower strawberry harvesting company in Holeta. These interventions aim to improve the ergonomic conditions and reduce the risk of MSDs for workers in this industry.

One of the key interventions is ergonomic workstation design. This involves redesigning workstations to promote proper body alignment, minimize excessive reaching or bending, and provide adjustability to accommodate workers of different heights. Work surfaces, seating, and footrests are adjusted to appropriate heights and angles to reduce musculoskeletal strain. Mechanical aids are also introduced or improved to assist with manual handling tasks. Trolleys, carts, or lifting devices can be provided to reduce the physical strain of lifting and carrying. Conveyor belts or automated sorting systems can also be implemented to reduce the need for repetitive lifting and carrying.

Upgrading or replacing tools and equipment with ergonomic designs is another intervention. Tools with improved handle designs, grip size, weight distribution, and vibration damping features can help reduce the risk of musculoskeletal strain. Automation and robotics are explored as potential solutions to reduce the physical demands of strawberry harvesting tasks. Technologies such as robotic arms for picking or packing strawberries can significantly reduce the need for manual handling. Task redesign is another strategy to minimize repetitive movements, awkward postures, and excessive force requirements. Work processes can be modified or tasks can be rotated to reduce the risk of overuse injuries.

Providing workers with ergonomic work tools, such as cushioned knee pads, adjustable hand tools, can minimize the risk of musculoskeletal strain. Improving lighting conditions in work areas is also important.

Adequate lighting fixtures, utilization of natural light, and even illumination throughout the workspace can reduce eye strain and optimize visual tasks. Noise control measures are implemented to reduce worker exposure. Soundproofing enclosures, or personal protective equipment (PPE) can be utilized to mitigate the effects of noise from machinery and equipment.

Training and education programs on ergonomic principles, safe work practices, and proper tool and equipment use are provided to workers. This ensures that they are aware of the risks associated with MSDs and understand how to mitigate them through proper ergonomics. Continuous improvement is emphasized, with regular reviews and assessments of the effectiveness of engineering interventions. Feedback from workers is sought to make necessary adjustments and further optimize ergonomic conditions, ultimately reducing the risk of MSDs in Agri-Flower strawberry harvesting. Implementing engineering interventions in Agri-Flower strawberry harvesting can help reduce the risk of MSDs by improving workstation design, introducing mechanical aids, upgrading tools and equipment, and implementing automation and robotics. These interventions aim to minimize physical strain, optimize work processes, and enhance worker comfort and safety. Regular evaluation and continuous improvement will ensure that the interventions remain effective over time.

5.2 Administrative Interventions

From the study result here is an administrative interventions for musculoskeletal disorders (MSDs) in Agri-Flora strawberry harvesting. These interventions focus on managing work schedules, providing training and education, optimizing work organization, and promoting worker engagement and well-being.

One of the key interventions is implementing a work schedule that allows for regular breaks and rest periods. This helps reduce the risk of overuse injuries by providing workers with adequate time to rest and recover. Task rotation can also be implemented to vary the physical demands placed on workers and prevent repetitive strain. Comprehensive training on safe work practices, proper lifting techniques, and ergonomics awareness is essential. Workers need to understand the importance of

maintaining good posture, using proper body mechanics, and reporting any discomfort or pain. This training ensures that workers have the knowledge and skills to perform their tasks safely and reduces the risk of MSDs.

Workload management is crucial to prevent excessive work demands that may lead to fatigue and increased risk of MSDs. Assessing and managing workloads to ensure they are reasonable and manageable for workers is important. Optimizing work organization and workflow can minimize unnecessary movements and reduce the risk of musculoskeletal strain. Streamlining processes, improving communication, and eliminating non-essential tasks or steps helps create a more efficient and ergonomic work environment. Job rotation is another intervention that provides workers with opportunities to perform different tasks and reduces the risk of overuse injuries. Rotating workers between physically demanding tasks and less physically demanding tasks allows for recovery and reduces the strain on specific muscle groups or joints.

Implementing stretching and warm-up programs before starting work or engaging in physically demanding tasks is beneficial. These programs help prepare the muscles and joints for the work to come and reduce the risk of injury. Establishing feedback and reporting systems allows workers to provide input on ergonomic issues and report any discomfort or pain related to their work. Encouraging workers to report concerns promptly ensures that appropriate actions can be taken to address them. Supervision and monitoring play a crucial role in ensuring that workers are following proper ergonomic practices and using tools and equipment correctly. Regular observation of work processes and providing feedback to workers helps reinforce safe work behaviors.

Establishing a process for reporting and investigating work-related injuries, including MSDs, is important. This ensures that workers are aware of the reporting procedure and that investigations are conducted to identify root causes and implement corrective actions. Implementing health and wellness programs that promote overall worker well-being is beneficial. These programs can include initiatives such as physical fitness, nutrition education, and stress management, which support the prevention of MSDs.

Overall, administrative interventions aim to create a supportive work environment that emphasizes safe work practices, encourages reporting of injuries and discomfort, and incorporates strategies to reduce the risk of MSDs in Agri-Flower strawberry harvesting. Regular evaluation and feedback from workers will help ensure the effectiveness of these interventions.

5.3 Personal Protective Equipment (PPE)

Personal Protective Equipment (PPE) plays a vital role in reducing the risk of musculoskeletal disorders (MSDs) in Agri-Flower strawberry harvesting. The following interventions outline the use of specific PPE to protect workers from potential injuries:

Back support belts are provided to reduce the risk of lower back injuries during manual handling tasks. It is important to ensure that these belts are properly fitted and used according to manufacturer guidelines. These gloves should be the appropriate size and provide sufficient vibration damping properties.

Cushioned knee pads are provided to reduce strain on the knees during tasks that involve kneeling or squatting. The knee pads must be properly fitted and comfortable for prolonged use.

Elbow supports are supplied to reduce strain on the elbows during tasks that involve repetitive or forceful arm movements. These supports should be properly fitted and allow for a full range of motion.

Wrist supports are provided to reduce strain on the wrists during tasks that involve repetitive or forceful wrist movements. Proper fitting and comfortable movement are crucial for effective wrist support.

Appropriate footwear is supplied to provide support and cushioning, reducing the risk of foot and ankle injuries. The footwear must be slip-resistant and meet safety standards.

Impact-resistant gloves are provided to protect hands from injuries caused by impacts or crushing hazards. These gloves should be properly fitted and allow for

dexterity. Hearing protection, such as earplugs or earmuffs, is supplied to reduce exposure to excessive noise levels from machinery or equipment. Proper fitting and adequate noise reduction are important considerations. Eye protection, such as safety glasses or goggles, is provided to protect against flying debris or chemical splashes. The eye protection should be properly fitted, provide sufficient coverage, and meet safety standards.

Training is provided to workers on the proper use, care, and maintenance of PPE. It is essential that workers understand how to correctly use and maintain their PPE for optimal protection. Regular inspection, replacement of damaged PPE, and proper storage when not in use are important aspects of PPE maintenance. Ensuring that PPE is in good condition and readily available is crucial for worker safety.

By implementing these PPE interventions and providing appropriate training and maintenance, the risk of MSDs in Agri-Flower strawberry harvesting can be significantly reduced. Personal Protective Equipment (PPE) should be considered as a last resort after implementing engineering and administrative controls. It is important to ensure that PPE is suitable for the specific tasks and hazards involved in Agri-Flower strawberry harvesting. Regular training, proper fitting, and maintenance of PPE are crucial for its effectiveness in reducing the risk of MSDs.

5.4 Training and Education Programs

Training and education programs are essential for preventing musculoskeletal disorders (MSDs) in Agri-flower strawberry harvesting. The following interventions outline the key components of these programs:

Ergonomics awareness training is provided to educate workers on the principles of ergonomics and the importance of maintaining proper body mechanics. Workers learn how to identify and address ergonomic hazards in their work environment to prevent MSDs. Safe lifting and manual handling techniques are taught to minimize the risk of back injuries and strains. Workers learn how to assess loads, use their legs instead of their back, and avoid twisting or jerking movements during lifting and carrying tasks.

Body mechanics and posture training focuses on correct body mechanics and postures to reduce the risk of musculoskeletal strain. Workers are guided on maintaining neutral spine alignment, avoiding excessive reaching or bending, and using proper hand and wrist positions. Tool and equipment use training ensures that workers know how to safely and properly use the tools, equipment, and machinery involved in strawberry harvesting. Emphasis is placed on using ergonomically designed tools, adjusting handles or grips for comfort, and maintaining equipment in good working condition.

Stretching and warm-up programs teach workers stretching exercises and warm-up routines to prepare their muscles and joints for physically demanding tasks. Regular stretching breaks are encouraged throughout the workday to prevent muscle fatigue and reduce the risk of MSDs. Task-specific training provides workers with specific ergonomic guidance for strawberry harvesting activities. Workers learn proper body positioning, movement techniques, and strategies to minimize repetitive motions or excessive force.

Training and education programs play a vital role in preventing and managing MSDs in Agri-Flower strawberry harvesting. By providing workers with the necessary knowledge and skills, they can make informed decisions, practice proper ergonomics, and contribute to a safer work environment. Regular refresher training and updates ensure that workers stay up-to-date with the latest information and best practices.

5.4.1 Designed Training to prevent MSDs in Agri-Flora Strawberry Harvesting

Designing an effective training program for Agri-Flower strawberry harvesting workers required a systematic approach that involved several key steps. Each step was crucial in ensuring that the program addressed the specific needs and challenges of the workers, while also promoting the prevention and management of musculoskeletal disorders (MSDs).

The first step in designing the training program was to conduct based on the above research output. This involved gathering information through interviews, surveys, and observations to identify the specific training needs of the strawberry harvesting workers. Ergonomics and MSD prevention were the primary focus areas, as these were

crucial for minimizing occupational risks in their physically demanding occupation. By understanding the workers' current knowledge, skills, and challenges related to ergonomics, could tailor the training program to effectively address their needs.

Once the needs assessment was completed, clear and measurable objectives were established for the training program. These objectives served as guiding principles throughout the design process, ensuring that the program's outcomes were aligned with the desired goals. For example, the objectives might include improving workers' understanding of proper body mechanics, teaching them effective lifting techniques, and promoting regular stretching exercises to prevent MSDs.

With the objectives in mind, the next step was to determine the specific content that needed to be covered in the training program. This content was carefully selected based on its relevance to the tasks and work environment involved in strawberry harvesting. Topics such as proper body mechanics, lifting techniques, and other ergonomics principles were identified as essential components of the training program. Additionally, information on the common MSD risks associated with strawberry harvesting tasks, as well as strategies for their prevention and management, were included in the content.

To ensure the training program's effectiveness, a blend of delivery methods was chosen. This blended learning approach aimed to engage the workers actively and cater to different learning styles and preferences. Presentations, interactive discussions, hands-on demonstrations, and practical exercises were incorporated into the program. The use of multimedia elements, such as videos and case studies, was also included to enhance engagement and knowledge retention. The program's design aimed to create an interactive and dynamic learning environment that would enable workers to apply their knowledge and skills in realistic scenarios is attached to the appendix E.

5.4.2 Evaluation of training Intervention Effectiveness

To do that Questionnaire were developed that can be used to gather feedback from workers regarding the effectiveness of interventions for musculoskeletal disorders (MSDs) in Agri-Flower Strawberry Harvesting:

1. How comfortable do you feel during your work tasks after the implementation of the interventions? (Scale: 1-5, with 1 being very uncomfortable and 5 being very comfortable)
2. Have you noticed any change in your level of fatigue since the interventions were implemented? (Yes/No)
3. If yes, please describe how your level of fatigue has changed.
4. How satisfied are you with the training and education received for MSD prevention? (Scale: 1-5, with 1 being very dissatisfied and 5 being very satisfied)
5. What aspects of the training and education did you find most helpful in understanding and implementing ergonomic practices?
6. Have you experienced a reduction in musculoskeletal discomfort or pain since the interventions were implemented? (Yes/No)
7. If yes, please describe the improvements you have noticed.
8. Do you feel more confident in your ability to prevent MSDs and maintain good ergonomic practices? (Yes/No)
9. If yes, please explain how the interventions have contributed to your confidence.
10. Have you noticed any improvements in teamwork and communication regarding ergonomic issues in the workplace? (Yes/No)
11. If yes, please describe the changes you have observed.
12. Do you have any suggestions or feedback regarding the interventions for MSD prevention in Agri-Flora Strawberry Harvesting?
13. Would you recommend these interventions to other workers in similar industries? (Yes/No)
14. Please provide any additional comments or insights you would like to share regarding the effectiveness of the interventions.

Table 5. 1 Intervention assessment

Variable	Obs	Mean	Std. Dev.	Min	Max
Comfort	25	3.52	1.084743	2	5
Fatigue	25	.68	.4760952	0	1
Level_Fati~e	25	1.8	.8164966	1	3
Satisfacti~g	25	3.48	1.084743	2	5
Helpfulnes~g	25	2.6	1.080123	1	4
Reduction_~t	25	.68	.4760952	0	1
Confidence~s	25	3.16	.746101	2	4
Explanatio~e	25	.68	.4760952	0	1
Improvemen~k	25	4.04	.8406347	2	5
Explanatio~k	25	1	0	1	1

Based on the responses, it is evident that the implemented interventions have had a positive impact on the workers in Agri-Flower Strawberry Harvesting. The high average comfort level (i.e. mean value of 3.52), decrease in fatigue (i.e. mean value of 0.68), and reduction in with a remarkable musculoskeletal discomfort or pain indicate that the interventions have successfully improved the workers' physical well-being.

The high satisfaction rating (i.e. mean value of 3.48) with the training and education suggests that the workers found the program valuable and effective in teaching them about MSD prevention and ergonomics. The practical demonstrations and hands-on exercises were particularly helpful, enabling the workers to implement tangible techniques in their daily tasks.

The increased confidence (i.e. mean value of 3.16) in preventing MSDs and maintaining good ergonomic practices demonstrates that the interventions have empowered the workers to take ownership of their safety and health. This is further supported by the reported improvements in teamwork and communication, indicating that

supervisors and management have been receptive to the workers' feedback and have taken steps to address ergonomic challenges.

The suggestions and feedback provided by the workers, such as the need for regular refresher training sessions and adjustable equipment, offer valuable insights for further improving the interventions and ensuring their long-term effectiveness.

Overall, the high recommendation rate and positive comments regarding job satisfaction and well-being highlight the overall success of the interventions in promoting a safer and more supportive work environment for the workers in Agri-Flower Strawberry Harvesting.

The training and education program successfully achieved its objectives of preventing and managing musculoskeletal disorders among Agri-Flower strawberry harvesting workers. By identifying specific training needs, developing tailored content, promoting active engagement and practical application, and continuously evaluating and improving the program, workers were equipped with the knowledge and skills necessary to minimize occupational risks and promote their overall health and well-being. The intervention impact was evident through increased knowledge and skills, improved work practices, enhanced safety culture, and positive participant feedback.

5.4.3 Developing Intervention Model/Strategy

Linear model which contain input, processing, output, outcome and impact is developed depending on the mention intervention. The model is presented in diagram accordingly.

Figure 5. 1 Intervention Model Diagram

An engineering interventions, administrative interventions, personal protection equipment, training and educations are the inputs that are processed to bring an output that reduces Work place risk and hazard as well as improve work environment in order to get the long run outcome that improves the productivity and well-being. This outcome by itself by creating loop with inputs it become a driving force for the profitability of the

company. Accordingly the long term impact is creating sustainable work place safety and economic development.

Chapter Six

1. Conclusion and Future Works

1.1 Conclusion

Agriculture is extremely important for developing countries like Ethiopia. It is the backbone of the country's economy, employing over 80% of the population and contributing significantly to the GDP. Ethiopia has a predominantly agrarian society, with most people depending on agriculture for their livelihoods. Therefore, this huge workforce needs to be productive and healthy. That is why this study focused on this sector. Accordingly, ensuring ergonomic safety in agricultural workstations is crucial for employee well-being and productivity. Without proper ergonomics, employees are at a higher risk of developing musculoskeletal disorders. Designing workstations with ergonomics in mind can reduce physical stress and minimize injuries. Ergonomic workstations improve posture, reduce fatigue, and enhance productivity. Providing a safe and comfortable working environment boosts morale, job satisfaction, and employee engagement. By prioritizing ergonomic safety, employers can create a healthier and more productive work environment for agricultural employees.

In this study, a questionnaire with 39 questions was administered to 55 selected respondents. However, only 49 respondents fully completed the questionnaire and their entries were used for analysis. The risks associated with harvesting workstations have been evaluated based on mean severity and mean frequency. The risks include pesticides, slips, trips, and falls, musculoskeletal disorders, machinery-related accidents, heat stress, allergic reactions, injuries from sharp tools, bee stings, chemical exposure, and dust and respiratory hazards. The risks have been ranked based on their calculated risk levels. Musculoskeletal disorders have the highest risk level and are ranked as the most critical risk, while machinery-related accidents have the lowest risk level and are ranked as the least critical risk. These rankings can help prioritize the implementation of safety measures and interventions to address the identified risks in agricultural workstations.

Based on the conducted survey and analysis musculoskeletal disorders (MSDs) are a significant concern in strawberry harvesting and other physically demanding occupations. Assessing the musculoskeletal health of strawberry harvesters is crucial for identifying risk factors and implementing preventive measures. From this assessment ergonomic conditions, productivity levels, and injury rates was evaluated. After analyzing these factors, interventions have been designed to reduce the risk of MSDs and improve worker well-being.

Accordingly, Training and education programs are designed. These designed training and education programs are crucial for preventing musculoskeletal disorders (MSDs) in Agri-Flower strawberry harvesting. These programs include ergonomics awareness training, body mechanics and posture training, tool and equipment use training, stretching and warm-up programs, and task-specific training. These interventions aim to educate workers on ergonomics principles, safe lifting techniques, proper body mechanics and postures, correct tool and equipment use, and stretching exercises. Regular refresher training and updates help workers stay informed and maintain a safe work environment.

1.2 Recommendation

Based on the findings of the study, the following recommendations suggested improving ergonomic safety and preventing musculoskeletal disorders (MSDs) in Agri-Flower strawberry harvesting and similar agricultural settings:

Provide Training and Education Programs:

Use the developed comprehensive training programs on ergonomics awareness, safe lifting techniques, proper body mechanics and postures, correct tool and equipment use, and stretching exercises.

Conduct regular training sessions for all strawberry harvesting workers, including new hires and existing employees.

Include refresher training and updates to ensure that workers stay informed about best practices and maintain a safe work environment.

Encourage Regular Breaks and Stretching:

Emphasize the importance of taking regular breaks during work shifts to rest and stretch.

Educate workers on the benefits of stretching exercises to reduce muscle fatigue and prevent MSDs.

Provide designated areas for stretching and encourage workers to incorporate stretching routines into their daily work activities.

Conduct Regular Ergonomic Assessments:

Regularly assess workstations and job tasks to identify potential ergonomic hazards and risks.

Involve workers in the assessment process to gain insights into their experiences and challenges.

Use the assessment findings to implement targeted interventions and improvements.

Provide Personal Protective Equipment (PPE):

Ensure that workers have access to appropriate PPE, such as gloves, goggles, and masks, to protect against chemical exposure, allergens, and respiratory hazards.

Train workers on the proper use and maintenance of PPE to maximize its effectiveness.

Regularly Evaluate and Update Safety Policies and Procedures:

Periodically review and update safety policies and procedures based on changing regulations, best practices, and new research in the field of ergonomics.

Involve workers and relevant stakeholders in the evaluation and update process to ensure their input is considered.

By implementing these recommendations, Agri-Flower strawberry harvesting and similar agricultural companies can significantly improve ergonomic safety, reduce the risk of MSDs, and create a healthier and more productive work environment for their employees.

1.3 Future work

As a future work in the prevention and management of musculoskeletal disorders (MSDs) in Agri-Flower strawberry harvesting could involve conducting longitudinal studies to track the long-term effects of ergonomic interventions, evaluating the effectiveness of specific interventions, exploring technology-based solutions, and implementing participatory approaches. By addressing these areas, we can enhance the understanding and prevention of MSDs, leading to safer and healthier work environments for strawberry harvesters.

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Appendix

Appendix A

Table for survey Questioners in English

No	Questionnaires
1.	Do workers come into contact with pesticides during strawberry harvesting? (Yes/No)
2.	How severe are the potential health effects of pesticide exposure? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
3.	How frequently are workers exposed to pesticides? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
4.	Are there measures in place to minimize pesticide exposure? (Yes/No)
5.	Are slips, trips, and falls common during strawberry harvesting? (Yes/No)
6.	How severe are the potential injuries from slips, trips, and falls? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
7.	How frequently do slips, trips, and falls occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
8.	Are safety measures in place to prevent slips, trips, and falls? (Yes/No)
9.	Are musculoskeletal disorders a concern among workers? (Yes/No)
10.	How severe are the potential musculoskeletal disorders? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
11.	How frequently do musculoskeletal disorders occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
12.	Are ergonomic measures in place to prevent musculoskeletal disorders? (Yes/No)
13.	Are machinery-related accidents a concern during strawberry harvesting? (Yes/No)
14.	How severe are the potential injuries from machinery-related accidents? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
15.	How frequently do machinery-related accidents occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)

16.	Are safety protocols and training provided for machinery operation? (Yes/No)
17.	Is heat stress a concern in the work environment? (Yes/No)
18.	How severe are the potential health effects of heat stress? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
19.	How frequently does heat stress occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
20.	Are measures in place to prevent and manage heat stress? (Yes/No)
21.	Are allergic reactions a concern among workers? (Yes/No)
22.	How severe are the potential allergic reactions? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
23.	How frequently do allergic reactions occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
24.	Are workers provided with protective equipment to prevent injuries from sharp tools? (Yes/No)
25.	How severe are the potential injuries from sharp tools? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
26.	How frequently do injuries from sharp tools occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
27.	Are workers trained in proper handling and use of sharp tools? (Yes/No)
28.	Are bee stings a concern among workers? (Yes/No)
29.	How severe are the potential health effects of bee stings? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
30.	How frequently do bee stings occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
31.	Are measures in place to prevent and manage bee stings? (Yes/No)
32.	Is chemical exposure a concern in the work environment? (Yes/No)
33.	How severe are the potential health effects of chemical exposure? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)

34.	How frequently does chemical exposure occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
35.	Are workers provided with appropriate personal protective equipment for chemical handling? (Yes/No)
36.	Are dust and respiratory hazards a concern during strawberry harvesting? (Yes/No)
37.	How severe are the potential health effects of dust and respiratory hazards? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
39.	How frequently do dust and respiratory hazards occur? (1. Very Low, 2. Low, 3. Moderate, 4. High, 5. Very High)
39.	Are workers provided with respiratory protection and training? (Yes/No)

Appendix B

Table for survey Questioners translated to Amharic

	መጠይቆች
1.	እንጆሪ በሚሰበሰብበት ጊዜ ሠራተኞች ከተባይ ማጥፊያ ጋር ይገናኛሉ? (አዎ አይ)
2.	ፀረ ተባይ መድኃኒቶች መጋለጥ የሚያስከትለው የጤና ጉዳት ምን ያህል ከባድ ነው? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
3.	ሰራተኞች ምን ያህል በተደጋጋሚ ለፀረ-ተባይ ይጋለጣሉ? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
4.	ፀረ-ተባይ መጋለጥን ለመቀነስ እርምጃዎች አሉ? (አዎ አይ)
5.	እንጆሪ በሚሰበሰብበት ወቅት መንሸራተት፣ ጉዞዎች እና መውደቅ የተለመዱ ናቸው? (አዎ አይ)
6.	በመንሸራተት፣ በጉዞ እና በመውደቅ ሊከሰቱ የሚችሉ ጉዳቶች ምን ያህል ከባድ ናቸው? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
7.	መንሸራተት፣ ጉዞዎች እና መውደቅ ምን ያህል ጊዜ ይከሰታሉ? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
8.	መንሸራተትን፣ ጉዞዎችን እና መውደቅን ለመከላከል የደህንነት እርምጃዎች ተዘጋጅተዋል? (አዎ አይ)
9.	በሠራተኞች መካከል የጡንቻኮላክቶልት ሕመም ችግሮች አሳሳቢ ናቸው? (አዎ አይ)

10.	ሊሆኑ የሚችሉ የጡንቻኮላኮች መዛባቶች ምን ያህል ከባድ ናቸው? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
11.	ምን ያህል በተደጋጋሚ የጡንቻኮላኮቶሌት በሽታዎች ይከሰታሉ? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
12.	የጡንቻኮስክሌትታል በሽታዎችን ለመከላከል ergonomic እርምጃዎች አሉ? (አዎ አይ)
13.	እንጆሪ በሚሰበሰብበት ወቅት ከማሽን ጋር የተያያዙ አደጋዎች አሳሳቢ ናቸው? (አዎ አይ)
14.	ከማሽን ጋር በተያያዙ አደጋዎች ሊከሰቱ የሚችሉ ጉዳቶች ምን ያህል ከባድ ናቸው? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
15.	ከማሽን ጋር የተያያዙ አደጋዎች ምን ያህል ይከሰታሉ? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
16.	ለማሽን ሥራ የደህንነት ፕሮቶኮሎች እና ስልጠናዎች ተሰጥተዋል? (አዎ አይ)
17.	በሥራ አካባቢ የሙቀት ጭንቀት አሳሳቢ ነው ? (አዎ አይ)
18.	የሙቀት ጭንቀት ሊያስከትሉ የሚችሉት የጤና ችግሮች ምን ያህል ከባድ ናቸው? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
19.	የሙቀት ጭንቀት በየስንት ጊዜ ይከሰታል? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
20.	የሙቀት ጭንቀትን ለመከላከል እና ለመቆጣጠር እርምጃዎች ተዘጋጅተዋል? (አዎ አይ)
21.	በሠራተኞች መካከል የአለርጂ ምላሾች አሳሳቢ ናቸው? (አዎ አይ)
22.	ሊከሰቱ የሚችሉ የአለርጂ ምላሾች ምን ያህል ከባድ ናቸው? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
23.	የአለርጂ ምላሾች ምን ያህል ጊዜ ይከሰታሉ? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
24.	በሹል መሳሪያዎች ላይ ጉዳት እንዳይደርስ ለመከላከል ሰራተኞች የመከላከያ መሳሪያ ተሰጥቷቸዋል? (አዎ አይ)
25.	በሹል መሳሪያዎች ሊደርሱ የሚችሉ ጉዳቶች ምን ያህል ከባድ ናቸው? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
26.	ስለታም መሳሪያዎች ጉዳቶች ምን ያህል በተደጋጋሚ ይከሰታሉ? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
27.	ሰራተኞቹ ስለታም መሳሪያዎችን በተገቢው አያያዝ እና አጠቃቀም የሰለጠኑ ናቸው? (አዎ አይ)

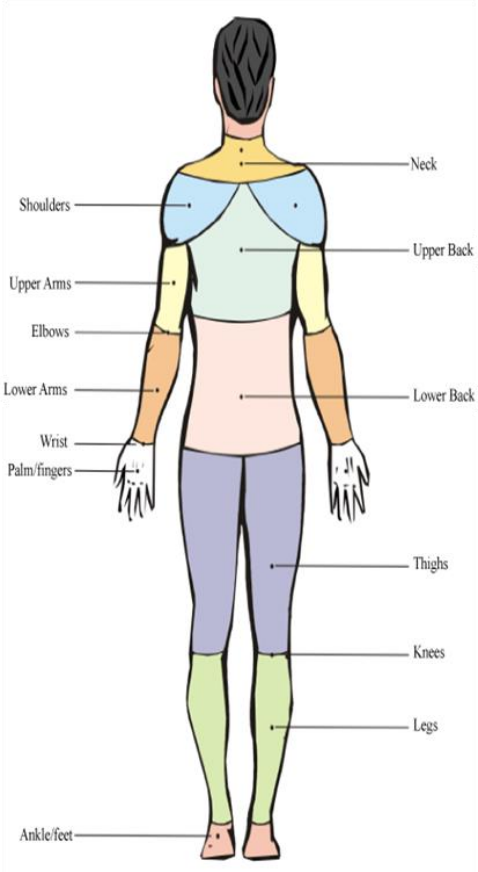
28.	የንብ ንክሻ በሠራተኞች ዘንድ አሳሳቢ ነው? (አዎ አይ)
29.	የንብ ንክሳት የጤና ችግሮች ምን ያህል ከባድ ናቸው? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
30.	የንብ ንክሳት ምን ያህል ጊዜ ይከሰታል? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
31.	የንብ ንክሳትን ለመከላከል እና ለመቆጣጠር እርምጃዎች ተወስደዋል? (አዎ አይ)
32.	የኬሚካል መጋለጥ በሥራ አካባቢ አሳሳቢ ነው? (አዎ አይ)
33.	ኬሚካላዊ ተጋላጭነት በጤና ላይ የሚደርሰው ጉዳት ምን ያህል ከባድ ነው? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
34.	የኬሚካል መጋለጥ ምን ያህል ጊዜ ይከሰታል? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
35.	ሰራተኞች ለኬሚካል አያያዝ ተገቢ የሆነ የግል መከላከያ መሳሪያ ተሰጥቷቸዋል? (አዎ አይ)
36.	እንጆሪ በሚሰበሰብበት ጊዜ የአቧራ እና የመተንፈስ አደጋዎች አሳሳቢ ናቸው? (አዎ አይ)
37.	የአቧራ እና የአተነፋፈስ አደጋዎች ሊከሰቱ የሚችሉ የጤና ችግሮች ምን ያህል ከባድ ናቸው? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
38.	በአቧራ እና በመተንፈሻ አካላት ውስጥ ምን ያህል ጊዜ አደጋዎች ይከሰታሉ? (1. በጣም ዝቅተኛ፣ 2. ዝቅተኛ፣ 3. መካከለኛ፣ 4. ከፍተኛ፣ 5. በጣም ከፍተኛ)
39.	ሰራተኞች የመተንፈሻ መከላከያ እና ስልጠና ተሰጥቷቸዋል? (አዎ አይ)

Appendix C

Table for assessing the workers status

s/n	Questions items
1	Your Company's name
2	Year of establishment of your Company's
3	Your highest education level
4	Your company type;
5	Respondent sex
6	Respondent Date of birth
7	Year of Experience on the job

8	Position of your work
	a) Removal of older leaves
	b) Clipping of needles runners
	c) Selection of tiny green berries
	d) Pesticide spraying
	e) Application of gibberellins
	f) Strawberry harvesting
	g) Sorting and packing strawberries into boxes
	h) Picking older stems
	i) Weeding
	j) Carrying the strawberry crate
	k) Carrying the seedling
	l) Watering
	m) Land preparation for planting
	n) Planting
9	Working time
10	House-working time
11	Sleeping time
12	BMI
13	Body part ergonomic rating
14	Productivity rating
15	Injury Rating



Part Two: Borges 10-scale body ergonomic questioner for Agri-Flower strawberry workers

Instruction:-Evaluate each part of the body pain you feel from one to ten by **using (√) symbol for answering**. One is for rest and ten is extremely hard pain you feel.

	Rest(0)	Extremely easy(1)	Very easy(2)	Easy(3)	Moderate(4)	Somewhat hard(5)	Moderately hard(6)	Hard(7)	Very hard (8)	Very, very hard(9)	Extremely hard(10)
Neck											
Shoulder											
Upper back											
Upper arm											
Elbow											
Lower back											
Lower arm											
Wrist											
Palm/fingers											
Thigh											
Knee											
leg											
Ankle/feet											

Appendix D

Intervention assessment questionnaire

1. ስልጠናው ከሰጠ በኋላ በስራዎ ውስጥ ምን ያህል ምቾት ይሰማዎታል? (ልኬት፡ 1-5፣ 1 በጣም የማይመች እና 5 በጣም ምቹ የሆነ)
2. ስልጠናው ከተሰጠ በኋላ በድካምዎ ደረጃ ላይ ምንም ለውጥ አስተውለዋል? (አዎ አይ)
3. አዎ ከሆነ፣ እባክዎን የድካምዎ ደረጃ እንዴት እንደተለወጠ ይግለጹ።
4. ባገኙት ስልጠና እና ትምህርት ምን ያህል ረክተዋል? (መመዘኛ፡ 1-5፣ 1 በጣም አለመርካቱ እና 5 በጣም ረክተዋል)
5. ጥሩ ልምምዶችን ለመረዳት እና ተግባራዊ ለማድረግ የትኞቹ የስልጠና እና የትምህርት ገጽታዎች በጣም አጋዥ ሆነው አግኝተሃል?
6. ስልጠናው ከሰጠ ጊዜ ጀምሮ የጡንቻኮላክቶሌት ህመም ወይም ህመም መቀነስ አጋጥሞዎታል? (አዎ አይ)
7. አዎ ከሆነ፣ እባክዎ ያስተዋሉትን ማሻሻያ ያብራሩ።
8. ጉዳት ለመከላከል እና ጥሩ ergonomic ልምዶችን ለመጠበቅ ባለዎ ችሎታ የበለጠ በራስ መተማመን ይሰማዎታል? (አዎ አይ)

9. አዎ ከሆነ፣ እባክዎን ስልጠናው ለእርስዎ እምነት እንዴት አስተዋጽኦ እንዳደረጉ ያብራሩ።
10. በስራ ቦታ ላይ ergonomic ጉዳዮችን በተመለከተ በቡድን ስራ እና ግንኙነት ላይ ማሻሻያዎችን አስተውለዋል? (አዎ አይ)
11. አዎ ከሆነ፣ እባክዎ ያዩትን ለውጦች ያብራሩ።
12. Agri -Flower Strawberry Harvesting ውስጥ MSDን ለመከላከል የተደረጉትን ጣልቃገብነቶች በተመለከተ አስተያየት ወይም አስተያየት አለዎት ?
13. እነዚህን ስልጠናዎች በተመሳሳይ ኢንዱስትሪዎች ውስጥ ላሉ ሌሎች ሰራተኞች ይመክራሉ? (አዎ አይ)
14. እባክዎን የስለጠናዎችን ውጤታማነት በተመለከተ ለማካፈል የሚፈልጉትን ማንኛውንም ተጨማሪ አስተያየት ይስጡ።

Appendix E

Training Module

Training and Education Programs for Musculoskeletal Disorders (MSDs) in Agri-Flower Strawberry Harvesting

Module 1: Introduction to Ergonomics and MSDs

- Understanding the importance of ergonomics in preventing MSDs
- Overview of common MSDs in Agri-Flower Strawberry Harvesting
- Recognizing the impact of MSDs on worker health and productivity

Module 2: Ergonomics Awareness Training

- Principles of ergonomics and body mechanics
- Identifying ergonomic hazards in the work environment
- Importance of early recognition and reporting of MSD symptoms

Module 3: Safe Lifting and Manual Handling Techniques

- Assessing loads and determining safe lifting techniques
- Proper body mechanics for lifting and carrying tasks
- Avoiding twisting and jerking movements during manual handling

Module 4: Body Mechanics and Posture Training

- Maintaining neutral spine alignment during work tasks
- Avoiding excessive reaching, bending, and stretching
- Using proper hand and wrist positions to reduce strain

Module 5: Tool and Equipment Use Training

- Safe and proper use of tools, equipment, and machinery
- Ergonomically designed tools and equipment for strawberry harvesting
- Importance of adjusting handles or grips for comfort and efficiency

Module 6: Stretching and Warm-up Programs

- Importance of stretching and warming up before physically demanding tasks
- Demonstrating stretching exercises for different muscle groups
- Implementing regular stretching breaks throughout the workday

Module 7: Task-Specific Training

- Ergonomic considerations for specific strawberry harvesting activities
- Proper body positioning and movement techniques for each task
- Strategies to minimize repetitive motions and excessive force

Module 8: Hazard Recognition and Reporting

- Identifying ergonomic hazards in the work environment
- Prompt reporting of hazards or discomfort to supervisors or safety personnel
- Importance of proactive hazard mitigation and control measures

Module 9: Teamwork and Communication

- Promoting a culture of teamwork and effective communication
- Encouraging workers to voice concerns and suggestions related to ergonomics
- Collaborating on finding solutions to ergonomic challenges

Module 10: Supervisor Training

- Recognizing and addressing ergonomic issues as a supervisor

- Supporting workers in implementing proper ergonomics and addressing MSD risks
- Ensuring compliance with ergonomic guidelines and regulations

Module 11: Injury Prevention and First Aid Training

- Strategies for preventing MSDs and promoting worker safety
- Recognizing early signs and symptoms of MSDs
- Basic first aid techniques for addressing minor injuries or discomfort

Module 12: Workstation Design and Modification

- Importance of proper workstation design for ergonomics
- Adjusting workbenches, chairs, and other equipment for optimal posture and comfort
- Worker involvement in making necessary modifications

Module 13: Environmental Factors and Hazard Controls

- Understanding the impact of environmental factors on MSD risks
- Minimizing temperature, lighting, and noise hazards
- Importance of regular breaks and hydration to prevent fatigue

Module 14: Health and Wellness Promotion

- Promoting overall health and wellness to prevent MSDs
- Importance of regular exercise, proper nutrition, and rest
- Encouraging participation in wellness programs or activities

Module 15: Job Rotation and Task Variation

- Benefits of job rotation in reducing the risk of MSDs
- Proper techniques for transitioning between different tasks
- Distributing physical demands evenly among workers

Module 16: Continuous Improvement and Feedback

- Fostering a culture of continuous improvement in MSD prevention
- Gathering and implementing feedback from workers
- Regular review and evaluation of training programs and practices

Appendix F

Photos at the site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AGH2