

CHAPTER 1 INTRODUCTION

I.1 Background

Sorghum can be used as a versatile plant source. Sorghum has a very high nutritional value such as protein, carbohydrates, fat, calcium, and phosphorus. Sorghum can be used to replace a food source and it can be used as animal feed. Sorghum stalk are very useful for animal feed because they do not cause side effects on livestock, because this plant has a high nutritional value so it is good for the growth of livestock such as cattle. The use of sorghum stems and sorghum leaves is almost equivalent to elephant grass which was already popular as animal feed ingredients (Suwarti et al., 2017).

In Indonesia, sorghum is the third food cereal crop after rice and corn. However, its use as food and industry is still limited. In addition, this sorghum plant has not received attention to be developed, even though its economic potential is very promising. Zubair (2016) said about the difficulty of obtaining the latest data from 2010 to 2019 for national sorghum production in Indonesia, both in BPS and FAO data. This indicates that the development of sorghum plants still needs to be improved. The amount of sorghum production can still be seen from the data in certain areas, such as East Java. East Java's sorghum production in 2013 decreased from 4,180 tons in 2012 to 3,898 tons. Then in 2014 it increased to 4,188 tons and increased again in 2015 to around 4,197 tons. In terms of productivity, the productivity of sorghum is 29.56 kw/ha in 2012, 28.41 kw/ha in 2013, 28.17 in 2014, and around 28.22 kw/ha in 2015 (Bappeda East Java, 2015) . These data indicate that the productivity of sorghum in East Java fluctuates which tends to decrease. Complete data on the development of sorghum from 2012 to 2015 is presented in Table 1

Table I. 1 Production Development, Harvested Area and Productivity of Sorghum in East Java.

Year	Production (ton)	Harvested Area (ha)	Productivity (ton/ha)
2012	4.180	1.452	2.956
2013	3.898	1.490	2.841
2014	4.188	1.487	2.817
2015	4.197	1.487	2.822

Source: Bappeda Provinsi Jawa Timur, 2015.

The development of sorghum in Indonesia has not been optimal due to various problems. Even though its cultivation among the community is still low and the commodity is not highly regarded, efforts need to be made to maximize the existing potential. One of the obstacles to the supply of forage in Indonesia is the supply of forage is not continuous throughout the year, in the rainy season forage production exceeds the need, and in the dry season forage production is less than the need. These obstacles can be overcome through efforts to preserve forage when production is abundant with the application of fermentation technology in the form of silage technology.

Silage is animal feed that still has a high water content as a result of preserving forage or ingredients through a fermentation process assisted by microorganisms under anaerobic conditions (without oxygen) either with the addition or without the addition of preservatives. The steps for making silage can be seen in Figure 1.

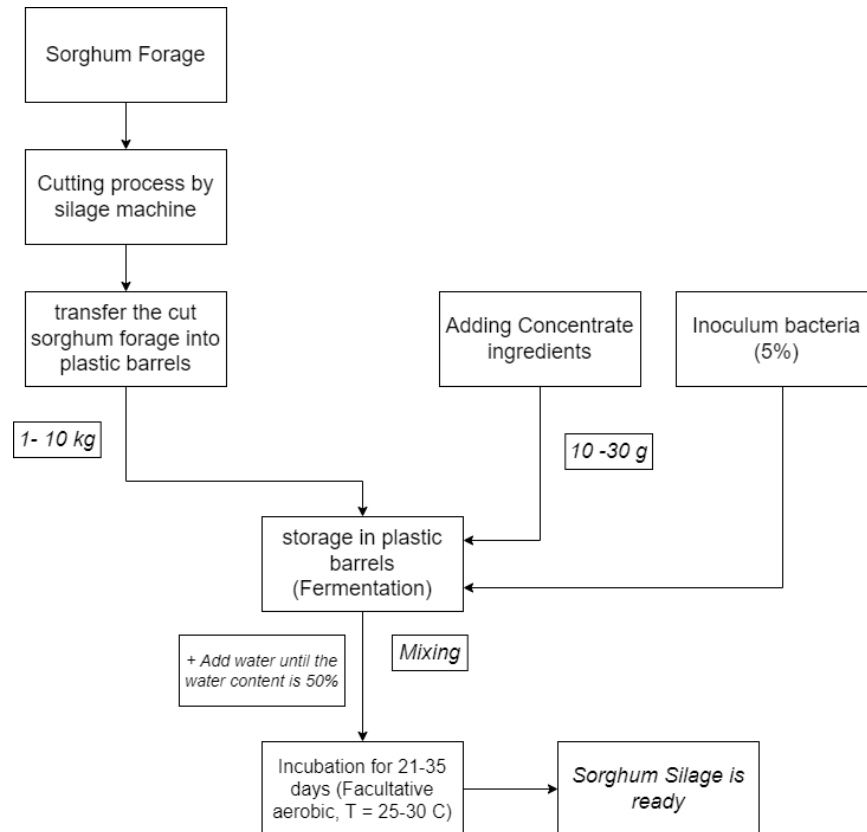


Figure I. 1 Steps for making sorghum silage

In the process of making sorghum silage, there is one step that needs to be improvised, namely the process of transferring sliced sorghum into plastic barrels. The process of transferring sliced sorghum into plastic barrels takes a lot of time, and this process is repeated over a long period of time. Coupled the transfer process is still done manually using bare hand and a traditional shovel.



Figure I. 2 Transforming the Sliced Sorghum

Based on the results of direct interviews with workers in the Purabaya field managed by CV Sarah, located in Purabaya District, Sukabumi Regency. Workers who work for the sorghum silage process work from 08:00 to 15:00 with a break from 12:00 to 13:00 at harvest time. Because some of the workers do not pay attention to the ergonomic size of the shovel. As a result, most of the total 7 workers experienced back pain (85.7%), waist (85.7%), and arms (71.4%). The second complaint of pain was felt in the shoulder, and calf (71.4%), and the last pain was felt in the neck (28.5%).

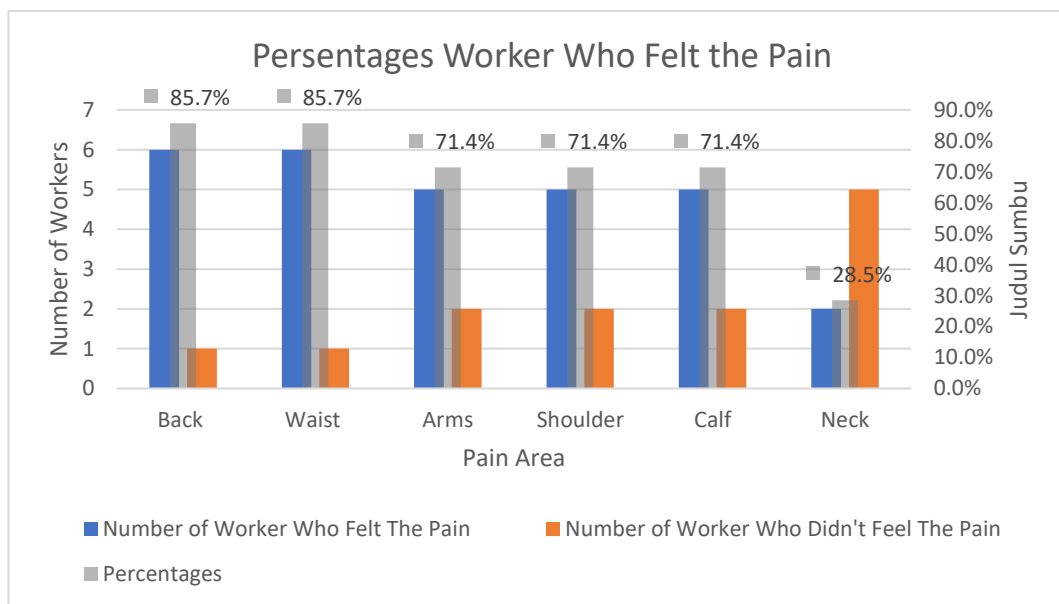


Figure I. 3 Percentages of workers who felt the pain

The lack of knowledge of the value of ergonomics makes most shovels still not meet anthropometric measurements. Therefore, it is necessary to select the appropriate shovel size for workers in the Purabaya Field which is managed by CV Sarah and is located in Purabaya District, Sukabumi Regency.

According To Wibowo (2016) In farming activities, they are injured due to the use of agricultural equipment. Most injuries are in the hands. Farmers' bodily injuries consisted of injuries to their hands, arms, legs, thighs, and feet. In addition, farmers also complained of suffering from fatigue in the upper back, middle back, and lower back

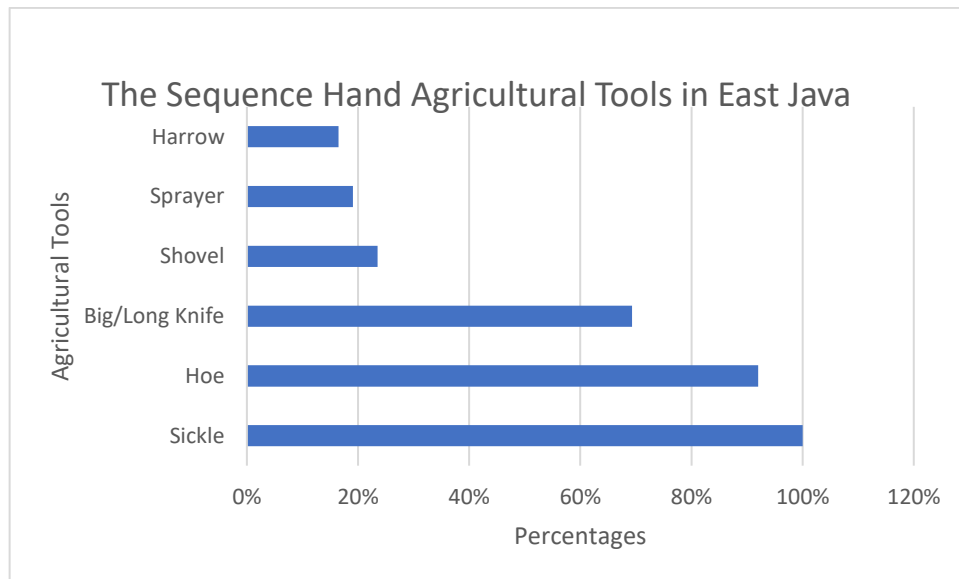


Figure I. 4 The sequence used of hand agricultural tool in east java

Based on Figure 1.4 a shovel is a farming tool that is still commonly used, especially in the process of clearing land, transferring crops and harvesting processes for plants that grows in the soil such as potatoes, carrots and others.

The injuries of the body of farmers consist of injury in hand, arms, legs, thighs, and feet. The injuries on hands, arms, legs, thighs, and feet of male and female farmers were 40.24, 34.86, 4.38, 3.59, 4.38, 2.59, 1.00, 0.60, 33.07 and 10.56 % respectively.

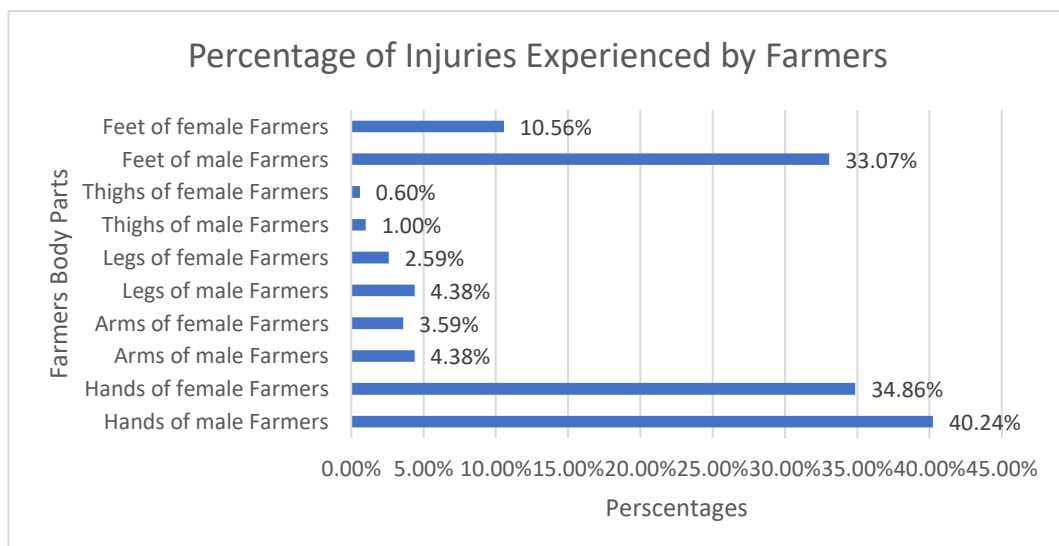


Figure I. 5 Percentage of injuries experienced by farmers

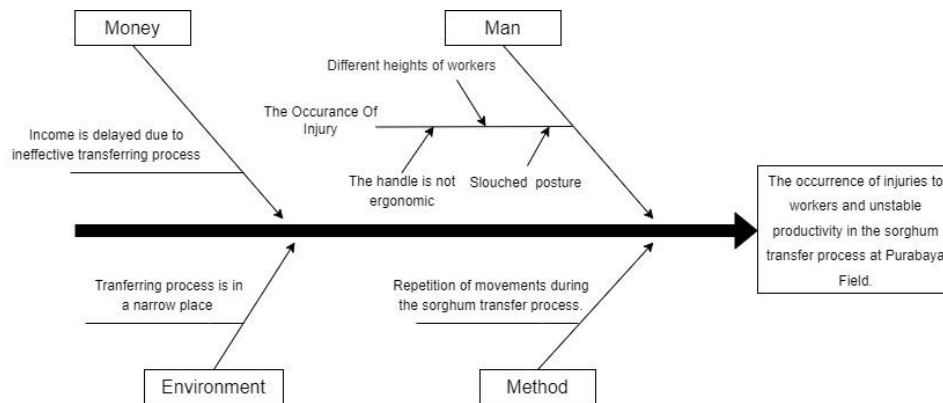


Figure I. 6 Fishbone diagram

Based on the analysis of the fishbone diagram, several problems were found which were grouped into man, money, method, and environment. In the man section, the problems that occur are because of the different heights of workers, the handle of shovel is not ergonomic and the bending posture of workers when using a shovel to transfer the sorghum that has been sliced. In the money section, the problem that occurs is delayed in income due to ineffective transferring process. Meanwhile, in the method section, the process of removing the sliced sorghum is repeated. Finally, in the environment section, the problem found was that the process of moving sorghum that had been sliced was carried out in a narrow space. .

The initial investigation focused on the process of transferring the sliced sorghum onto the plastic. Because the posture utilized at this stage corresponds to all parts of the body, the REBA (Rapid Entire Body Assessment) value computation technique is applied. After the computation, the REBA value is 11, indicating that it is high risk and need to be corrected.

The process of making sorghum silage is carried out right after harvest, this is done so that the sorghum which will be sliced later has good quality. The amount of sorghum that is successfully harvested every week is never the same, with an average weekly yield of 8 tons for 1 hectare. The selling price of sorghum silage is Rp. 1,500,000/ton. If the average is taken, CV Sarah is able to get a profit of Rp 12,000,000/ha for one harvest. This silage sales procedure is that the goods are

sent first to the consumer, then if it is received by the consumer, the consumer will weigh the sorghum again and if it is fixed, CV Sarah will receive the purchase money. However, it is not uncommon for the delivery of the goods to be delayed 1 to 2 days, due to CV Sarah's unpreparedness to send, this is because the process of transferring sorghum to be used as silage which takes quite a long time, especially if the yields are high. This transferring process has a direct impact on sales because consumers themselves are not always ready to receive it anytime, if the delivery of sorghum is late then the money received by CV Sarah will also be late. Therefore, the transfer process is a process that affects the production of sorghum silage, if the transfer process cannot be carried out optimally, the productivity in the production and sales of sorghum will decrease and cause a loss of money, time and energy for CV Sarah.

The design process uses in this case is a rational method. The rational method was chosen because its one of the method that is systematic and directly related to workers as tool users, which provides more customized products with shorter lead times, lower prices, perfect quality and reliability, The design method can use the product's overall required function provided by the customer to generate a set of embodiment designs capable of obtaining this function. After the data is processed using a rational method, the next step is to create a design prototype.

I.2 Alternative Solution

Based on the problems found in the background, an alternative solution was obtained from problem solving as follows:

Table I. 2 Alternative Solution

No	Root Causes	Potential Solution
1	Different operator height	Design a shovel handle that can be adjusted to the user's height
2	Slouched posture	Design an ergonomic shovel based on movement of shoveling activity
3	The Handle is not ergonomic	Selection of the right dimension and material to make the shovel handle
4	Income is Delay to due to ineffective transferring process	Propose an ergonomic shovel that can help increase the productivity level
5	Process transforming sorghum which is done repeatedly	Design a comfortable and ergonomic shovel handle so that workers will still feel comfortable even though

		they work with repetitive movements.
6	The process of moving the sliced sorghum is carried out in a narrow space	No hoarding of the sliced sorghum, so it doesn't take up much space

I.3 Problem Definition

Based on the background above, the following problems definition can be formulated:

1. How to design a shovel with a size that is suitable for anthropometry in sorghum silage proses at the Purabaya field?
2. How to design a shovel to increase the productivity of workers in the Purabaya field?

I.4 Research Objective

The Objectives of this research are as follows

1. Designing an ergonomic shovel to prevent injury in sorghum silage proses at the Purabaya Field
2. Designing an ergonomic shovel to increase productivity in the Purabaya Field

I.5 Benefits of Research

The benefits of this research are:

1. For Students
Can apply Industrial Engineering science from learning during lectures to help problems that occur in society, especially in Purabaya's Field
2. For the Company
Can create a healthy and safe environment for workers, especially in the transferring of making sorghum silage process, besides that it also reduces the production time sorghum silage and increase the productivity.
3. For Related Workers
The proposed tool can ease the work of the worker so that it can reduce the risk of fatigue and work accidents, especially in the transferring of making sorghum silage process

I.6 Systematics

The following is the Systematics of writing this research:

Chapter I Introduction

This chapter discusses background issues in the cassava peeling process, particularly for operators. Also included in this chapter are issue conceptualization, research objectives, research advantages, problem bounds, and writing systematics.

Chapter II Literature Review

This chapter includes references to a literature study from past studies relevant to the challenges that exist in this research, as well as the rationale for selecting the theory.

Chapter III Problem Solving Methodology

This chapter provides a detailed description of the research steps indicated as a guide for data collecting and processing in this study..

Chapter IV Integrated System Design

This chapter describes how to obtain data, namely through reading and field investigations. This study's data was separated into two categories: primary and secondary. Following the collection of data, data processing is carried out in accordance with the technique employed. In addition, all actions related to the creation of an integrated system for issue resolution are documented in this chapter. Data gathering and processing, data testing, and solution creation are examples of activities that may be carried out.

Chapter V Result Analysis and Evaluation

This chapter analyzes the design data for the suggested tool design, particularly in terms of ergonomics, using the approach adopted.

Chapter VI Conclusion and Suggestion

In this chapter, a comparison is done between current tools and planned tools in order to make a judgment as a kind of guidance to the companies under consideration.