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Article

Design and Construction of Tools for Fertilizing Palawija Plants

Mohd.Asrul Baroqah[1], Emon Azriadi[2], Hanantatur Adeswastoto[3]

Industrial Engineering Study Program, Faculty of Engineering, Pahlawan Tuanku Tambusai University (1,2)
Civil Engineering Study Program, Faculty of Engineering, Pahlawan Tuanku Tambusai University (3)
E-mail: mohdasrulbaroqah25@gmail.com.

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A B S T R A C T

Corn (Zea mays L.) is one of the important food crops widely cultivated in various parts of the world, including Indonesia. This plant has high economic value and serves as a source of food, animal feed, and industrial raw materials. This research aims to design and create a corn fertilizer tool utilizing easily obtainable materials such as pipes, used buckets, and hoses. This fertilizer tool is designed using SolidWorks 2020 software to ensure precise and functional design. In the testing process, this tool was evaluated to measure the accuracy and efficiency of fertilizer distribution. The tank on this tool has a capacity of 10 kg, which is sufficient to meet the fertilization needs with a dosage of 300 kg per hectare. With a corn plant population of 71,000 plants per hectare, each corn plant requires about 4 grams of NPK fertilizer. The tool testing was conducted in Salo Timur Village, and the results showed that this tool can effectively and efficiently distribute fertilizer according to the needs of each corn plant.

Keywords

Ergonomics;
Palawija;
Corn;
Design;
Anthropometry

1. BACKGROUND

1.1 Introduction

Corn is a food commodity which is a staple food in Indonesia and is a food crop after rice and wheat as a source of carbohydrates (Dewi et al, 2020). Corn producing areas are almost evenly distributed throughout the archipelago.

The corn farming sector in Indonesia is not free from problems which every year always make it difficult for farmers, one of which is agricultural technology.

Agricultural technology in planting corn greatly determines the quality of corn yields and can make it easier for farmers to manage corn plants to increase corn agricultural productivity, considering the increasingly extensive expansion of corn land in Indonesia.

The growth of corn plants is greatly influenced by various factors, one of which is the fertilization process. For optimal corn growth there are several requirements, one of which is the tools used in the planting process, such as human power, animals and other tools (Imanudin et al., 2020).

The process of planting corn from the start of seeding to the harvesting process is very tiring and takes a long time because it is done entirely manually or using human power. After planting, the next stage is the maintenance process. The most important maintenance in corn cultivation is fertilization. Every week and completely manually. This fertilization process is carried out by bending over and spreading fertilizer over the plant area.

With this, it greatly affects health conditions and unergonomic body postures in carrying out the planting process. One of the impacts of risks on occupational health and safety faced by corn farmers is complaints of musculoskeletal disorders (MSDs),

Anthropometry can be interpreted as a science that is specifically concerned with measuring the human body which is used to determine the dimensions or height or low of an instrument. Anthropometrics has an important role in the field of discussing agricultural tools and machines with the aim of ensuring harmony or conformity between humans and the tools being designed, so that when operating workers feel more comfortable, safe, and of course can

reduce work risks.

Based on the problems above, research was carried out on the design of tools to help fertilize crops for secondary crops. The aim of this research is so that workers no longer carry out fertilization manually but rather use semi-automatic fertilization tools.

1.2 Research Purposes

a. What is the anthropometry of workers regarding fertilization equipment?

b. How to design corn fertilization equipment based on worker anthropometry?

c. How to make an ergonomic corn fertilizing tool?

2. LITERATURE RIVIEW

2.1 Design Concept

According to Shofa et al.(2021) product design and manufacture is a large part of engineering activities. This activity begins with obtaining a perception of human needs, which is then followed by a concept, then designing, developing and perfecting the product, ending with product creation.

Ergonomics Approach in Designing Products/Work Facilities. Ergonomics, which is generally defined as "the study of work", has been able to bring about significant changes in implementing the concept of increasing productivity through efficient use of labor and division of work based on the specialization of human work skills.

The steps for taking an ergonomic approach (ergonomic methods) in terms of designing products and work facilities in general can be shown in the following chart/picture:

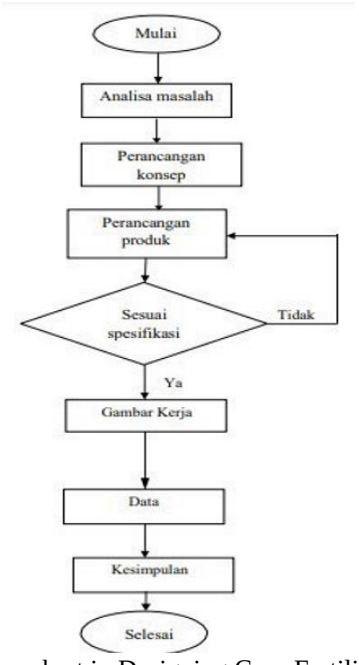

Figure 1 Flowchart in Designing Corn Fertilizer Equipment

2.2 Morphological Analysis of Fertilizer Equipment Design

According to Faudy and Sukanta (2022) Morphological analysis is a systematic and structured approach to finding alternative solutions using a simple matrix. This morphological analysis was made as a systematic consideration to select the best tool components and mechanisms. Tool specifications can be categorized into two, namely: Requirements (demands) abbreviated as D, namely the absolute requirements that the tool must have (if not met then the tool is an unacceptable solution). Desires (wishes) are abbreviated as W, namely conditions

that can still be considered in order to be possessed by the designed tool.

2.3 Anthropometrics

The term anthropometry comes from "anthropos" which means human and "metrikos" which means measurement. Anthropometry is a science that discusses the measurement of the human body, especially body dimensions. Data on anthropometry includes measurement and modeling of human body dimensions. There are two dimensions discussed in anthropometry, namely structural and functional dimensions. Structural body dimensions are measurements of the human body in a stationary (static) state. Meanwhile, functional body dimensions are measurements of the human body when it is in motion. There are several widely available anthropometric data, namely:

a. Design of work equipment such as machines, equipment, and tools.
b. Work area design.
c. Physical work environment design.
d. Design of products such as chairs / tables, computers, etc.

2.4 Percentiles

Designing based on the average price concept will only result in 50% of the population using it, while the other 50% cannot use the design properly.

For this reason, a design is carried out based on a certain value of the size of the human body. For example, 95% of the population is equal to or lower than the 95th percentile, and 5% of the population is equal to or lower than the 5th percentile (Wignjosoebroto, 2006).

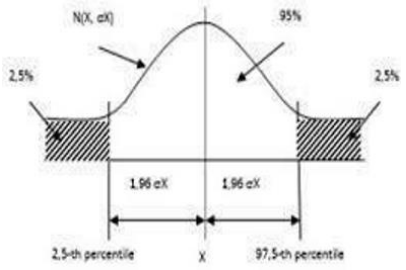

Figure 2. 7 Presentile Concepts
Source (sulistiyowati & astuti, 2019)

3. METHODOLOGY

Research on the design of tools for fertilizing secondary crops was carried out in stages. The research started from documentation, interviews and observations carried out simultaneously to obtain a choice of tools, materials and processes for making tools to fertilize secondary crops. The design stage of the tool design using the help of the AutoCAD application. The next stage is making tools to fertilize secondary crops. Followed by testing tools for fertilizing secondary crops

The data analysis technique was carried out by testing the tool for fertilizing secondary crops with 10 kg of fertilizer. The fertilizer dose given is 300 kg per hectare, with a total of 71,000 trees per hectare.

3.1 Material Selection

a. Design of tools to assist in fertilizing secondary crops


Figure 4.5 Drill


Figure 4.6 Grinder


Figure 4.7 Ruler


Figure 4.8 Meter


Figure 4.9 Pipe


Figure 4.10 Valve


Figure 4.11 Bucket

Figure 4.12 Glue


Figure 4.13 Tires


Figure 4.14 Hose

3.2 Design Process

This corn fertilizer tool is designed with fairly simple materials. In this corn fertilizer tool, the author made it as a final assignment in the design of all parts of the tool and its components. The design dimensions will be designed using the AutoCAD application..

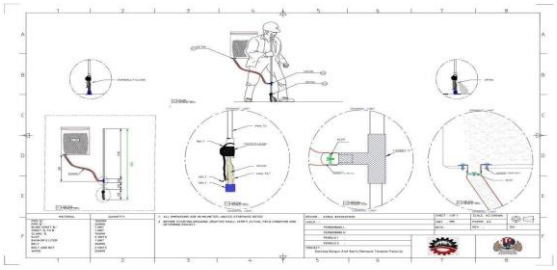

Figure 2 Design Concept

4. RESULT AND DISCUSSION

4.1 Process of Making Fertilizers for Secondary Crops

1. Stove frame

The plastic tank frame is shaped like a paint bucket used to support fertilizer. The fertilizer supported is around 10 kilos, this tank ensures stability and safety during use so that the fertilizer does not spill. There is a channel under the tank for the fertilizer to come out. The function of this component is as the main frame.

Figure 3 Assembly in the pipe section

2. Exhaust Valve

This exhaust valve functions to exit the tank, this can be used to control the flow of fertilizer out of the tank, and can be used to adjust how much fertilizer comes out.

3. Protector

The back of the tank is equipped with additional protection such as a retaining layer located behind the back, this aims to prevent the back from feeling sore.

Figure 4 protector

4. Pipes and Hoses

This pipe and hose connects the tank to the fertilizer outlet so that the fertilizer comes out perfectly. Shown in the picture below.

Figure 4 pipe and hose

5. Results of the Building Framework

Figure Results of the Building Framework

4.2 Results and Testing of Secondary Crop Fertilization Aids

1. Testing Process of Fertilizing Tools for Secondary Crops

The purpose of testing Production Capacity To design a tool using the specified components, the next step is to start with an experiment using one variation in the tank. This tank has a capacity 10 kg of fertilizer. The fertilizer dose given is 300 kg per hectare, with the number of trees as many as 71,000 per hectare.

$$jumlah\ \ pupuk/h\ a$$

1 stalk of corn : [redacted]$jumlah$

$$poh\ on/h\ a$$

$$300\ kg/h\ a$$

1 stalk of corn : $71{,}000/h\ a$ = 4 gr

So, 1 stalk of corn requires 4 grams of NPK fertilizer

5. CONCLUSION

1. Corn fertilization tools based on worker anthropometry aim to create comfortable and efficient tools by considering body size, posture, and worker comfort.
2. Corn fertilization tools that prioritize anthropometric aspects will provide more comfort, minimize the risk of injury, and increase worker efficiency and productivity in carrying out fertilization tasks.

3. Ergonomic corn fertilization tools are made to fit the worker's posture, reduce fatigue, and reduce the possibility of injury during use.

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