

Redesign of rice planting tools using an ergonomics approach

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Abstract

Farmers' work in planting rice is always with a bent posture, causing complaints of musculoskeletal disorders, this is a problem in research. The aim of the research is to identify farmers' complaints of musculoskeletal disorders when planting rice and determine the size of ergonomic tools. The method used is standard Nordic questionnaires to determine the point of complaint among farmers, anthropometry and percentiles are used to design the tool. Statistical tests are used to see valid, uniform, and normal data. Results and discussion, in the standard Nordiq questionnaire, it was found that farmers experienced more than 50% complaints of severe pain in the waist, left calf, right calf, left ankle, right ankle, left foot, and right foot. The design uses eight anthropometric dimensions: standing elbow height, palm length, palm width, middle finger length, shoulder width, body thickness, upper arm length, and hand length. All anthropometric dimensions were declared uniform, in the data adequacy test they were declared valid, and in the normality test, all data were declared normally distributed. The 5th percentile is used for the dimensions of shoulder width, standing elbow height, and palm length, and the 95th percentile is used for the dimensions of palm width, middle finger length, body thickness, upper arm length, and hand length. In conclusion, complaints of musculoskeletal disorders were identified as very painful, located at the point of complaint of the waist. The rice planting tool has ergonomic dimensions, the height of the tool is 88.1 cm, the diameter of the tool handle is 8.13 cm, the length of the handle is 11.4 cm, and the distance between the handle and the brake is 9.32 cm. The dimensions of the rice seed bag are 33.70 cm wide, the distance between the front and back of the bag is 23.19 cm, the bag height is 35.64 cm, and the bag length is 20.5 cm.

Keywords:

Anthropometry, ergonomic approach, standard Nordic questionnaires.

1 Introduction

Aceh Tamiang is a promising area for increasing business in the agricultural sector, by the government's program to increase development in the agricultural sector, one of Indonesia's main commodities in agriculture is *Oryza sativa* or what is usually called rice.

Despite the large role of farmers in Indonesia's rice needs, farmers are less aware that poor working posture can affect their perceived health in the short and long term. When planting rice, farmers do their work in a bent position for a long time and use their backs as the main support. The danger that can arise when workers ignore ergonomic factors is Musculoskeletal Disorders (MSDs)[1].

Musculoskeletal Disorders (MSDs) are a group of pathological conditions that affect the normal function of the musculoskeletal system's soft tissues, including nerves, tendons, muscles, and supporting structures such as intervertebral discs[2]. Complaints in the MSDs system are complaints in the musculoskeletal part that are felt by a person ranging from very mild to very painful complaints[3]. MSDs disorders can cause harm to workers so that work becomes unproductive due to incorrect work postures[4].

The survey results show that farmers' posture when planting rice, Aceh Tamiang still uses human power with manual and traditional processes. The farmer's posture when planting rice as shown in Fig. 1.

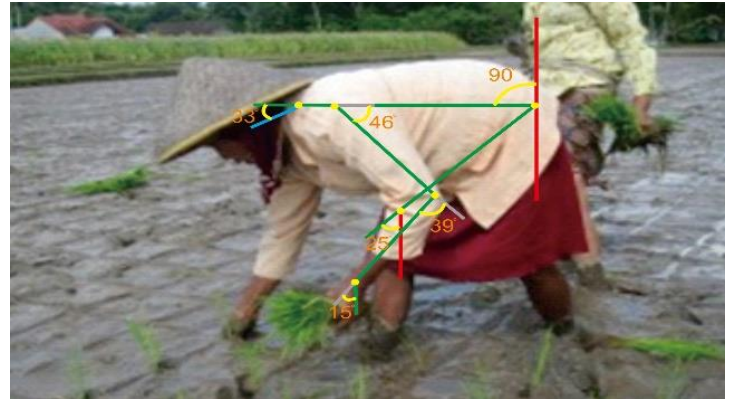


Fig. 1. Farmer's posture when planting rice.

Fig. 1 shows the farmer's posture when planting rice, the neck is bent at an angle of 33° , the legs are at an angle of 25° , the body is bent at an angle of 90° , the farmer's wrists are at an angle of 15° , the hands are at an angle of 39° , so the research aims to determine complaints.

Musculoskeletal Disorders (MSDs) of farmers when planting rice and determining the dimensions of ergonomic tools for farmers when planting rice.

2 Method

Design is an activity of assembling various components of knowledge/problems into one whole, therefore design is called an assembling activity[5]. According to the [6] good design can be produced by knowing humans' characteristics, habits, and abilities. Humans play a central role in their activities, namely as planners, designers, and evaluators in every activity (work). Humans as a source of labor are still dominant in the production process, especially repetitive activities. Ergonomic equipment design needs to be carried out based on ergonomic principles[7]. In short, it can be said that ergonomics is the adjustment of work tasks to the condition of the human body to reduce the work stress faced[8][9]. The basic function of ergonomics is to fulfill human needs for work design that provides safety for the people who work in it[10][11]. Based on recommendations from National Institute for Occupational Safety and Health (NIOSH), there are several ways to control ergonomic hazards that occur, namely the first emphasis is eliminating or reducing risks (elimination), replacement, engineering control, administrative control (work rotation), and the use of personal protective equipment [12].

The farmers who are research subjects are farmers who are carrying out rice planting work. The respondents obtained during the research were 100 farmers. All respondents were aged between 30-65 years and had worked for more than 10 years with 8 hours of work activity each day. The variables studied include human body dimensions and percentiles as independent variables, and redesign of rice planting equipment as the dependent variable.

The research method used in this research is an anthropometric approach by distributing questionnaires to farmers in Pahlawan Village, Karang Baru District, Aceh Tamiang to analyze which parts of the body lead to the design of rice planting tools using an

anthropometric approach. The questionnaire distributed is a questionnaire from the Standard Nordiq Questionnaire (SNQ) method.

Several steps in using the anthropometric method are:

1. Determining body dimensions in farmers.
2. Measurements were carried out using the Martin anthropometry tool.
3. In statistical testing, in processing anthropometric data you must first determine the minimum and maximum values, then carry out data testing such as data uniformity tests, data adequacy tests, and data normality tests. In work measurement activities, a 95% level of confidence and a 5% degree of accuracy are usually taken[13].
4. In determining percentiles, most anthropometric data is expressed in percentile form. In statistics, the normal distribution can be formulated based on average and standard values combined with existing percentile values such as, for example, the 95th percentile for the height of a population is 165 cm, this shows that 95% of the population is the same as or lower than 165 cm or it could be said that 5% of the population is more than 165 cm tall[14].
5. In designing a rice planter using graphic design, the aim is to know the shape and size more clearly.

This research was conducted to develop a tool created using ergonomic approaches, namely by using the Standard Nordic Questionnaires (SNQ) questionnaire to determine the level of musculoskeletal complaints in farmers and using anthropometric measurements so that this tool can be more comfortable to use.

3 Results and Discussion

3.1 Identify Complaints with the SNQ Questionnaire

Measuring musculoskeletal complaints is carried out using the SNQ method to determine the parts of the muscle that are experiencing complaints with complaint levels ranging from Not Painful, Slightly Painful, Painful, and Very Painful[15].

This research focuses on rice farmers' complaint points, and several farmers' problems, namely first looking at farmers' complaint points using the Standard Nordiq Questionnaire (SNQ) method. SNQ data is in Fig. 2.

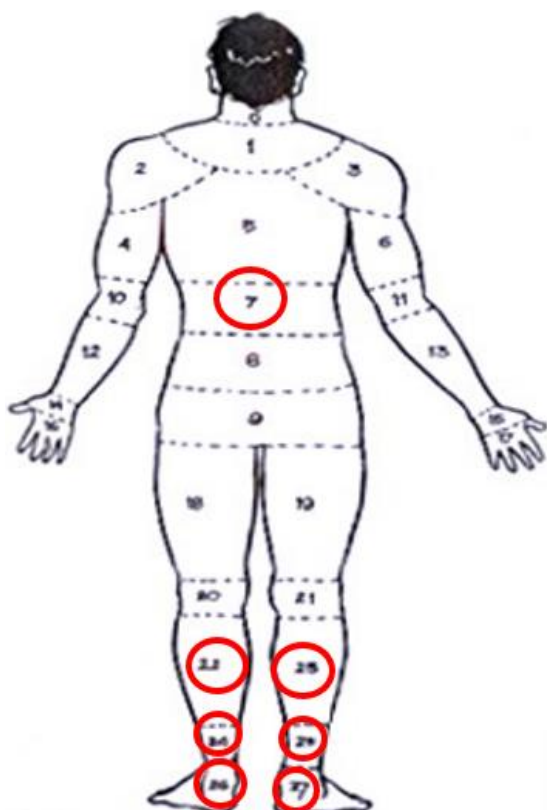


Fig. 2. Body parts that experience very painful complaints.

Fig. 2 shows complaints of severe pain marked with red circles, namely at the waist, left calf, right calf, left ankle, right ankle, left foot, and right foot, the percentage of complaint points is in Fig. 3.

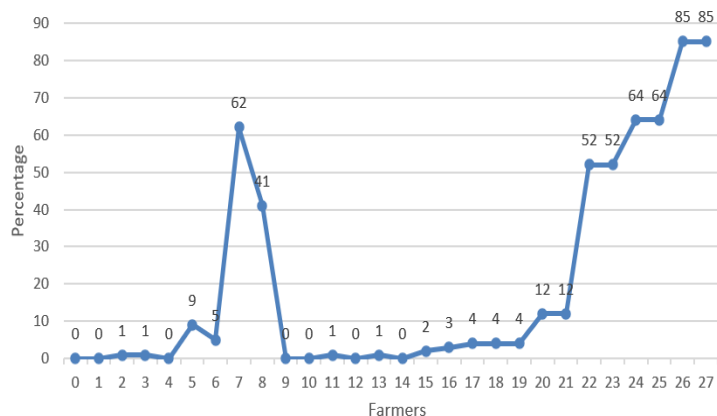


Fig. 3. Percentage of complaint points.

Fig. 3 shows that the percentage complaint points for very pain is at complaint points 26 and 27, namely complaints of very painful pain in the left leg and right leg.

3.2 Anthropometric Identification

Pre-existing tools have flaws that need to be fixed. The previous product was made of iron and weighed 3.5 kg and was 92 cm long. The product consists of cylindrical body parts, a plated handle, a flat brake, a brake hook, and a short conical tip as shown in Fig. 4.

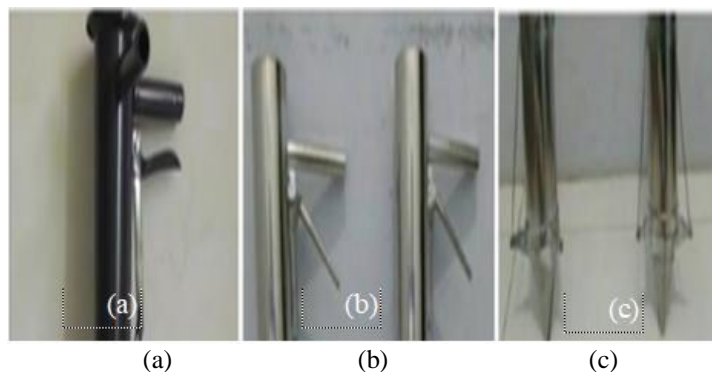


Fig. 4. Previous products. (a) a flat brake, (b) a brake hook, and (c) a short conical tip

In previous research, there were no rice seed bags. In this research, the data collected is farmer anthropometric dimension data, shown in Table 1.

Table 1. Antropometric dimensions

Dimensions	Aim
Standing elbow height	Height of the rice planter
Palm length	The diameter of the handle of the rice planting tool
Palm width	Handle length
Middle finger length	Distance between handle and brake
Shoulder width	Width of the bag for rice seeds.
Body thickness	The distance between the front and back of the rice seed bag.
Upper sleeve length	Rice seed bag height
Hand length	Length of rice seed bag

Table 1 shows that of the eight dimensions, standing elbow height is the dimension used to determine the length of the rice planting tool, and the dimension of upper arm length is the dimension used to determine the height of the rice seedling bag.

3.2.1 Data Reliability Test

Eight dimensions were tested for data reliability. Test the reliability of standing elbow height dimensional data, the data is declared uniform because it is not outside the upper control limit or lower control limit as shown in Fig. 5.

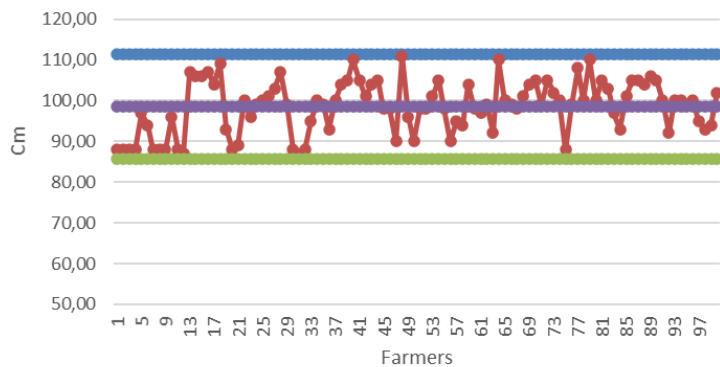


Fig. 5. Standing elbow height dimensions.

Fig. 5 shows the data reliability test for the height of a uniform standing elbow because there is nothing outside the upper control limit or lower control limit. The data uniformity test for palm length dimensions is in Fig. 6.

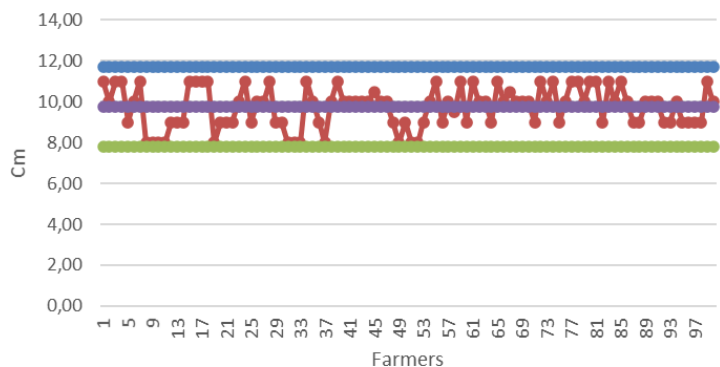


Fig. 6. Palm length dimensions.

Fig. 6 shows all palm length dimension data in the data reliability test which is declared reliable because there is nothing outside the upper control limit or lower control limit. The data reliability test for palm width dimensions is in Fig. 7.

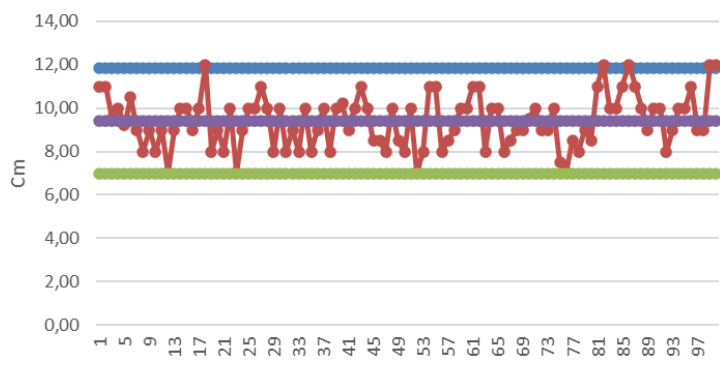


Fig. 7. Dimensions of palm width.

Fig. 7 shows the data reliability test for palm width dimensions. The data is declared uniform because it is not outside the upper control limit or lower control limit. The data uniformity test for the dimensions of finger length is in Fig. 8.

Fig. 8 shows that in the data reliability test for the length of the middle finger, the data is declared reliable because it is not outside the upper control limit or lower control limit. The shoulder width dimensions for testing data uniformity are in Fig. 9.

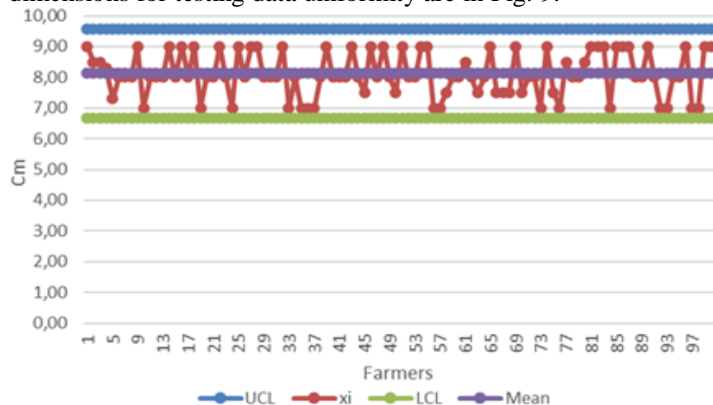


Fig. 8. Dimensions of middle finger length.

Fig. 9 shows that in the shoulder width dimension data reliability test, the data is declared reliable because it is not outside the upper control limit or lower control limit. The data reliability test for body thickness dimensions is in Fig. 10.

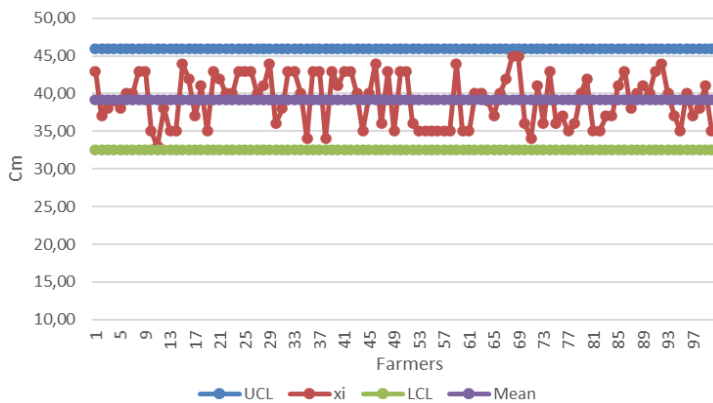


Fig. 9. Shoulder width dimensions.

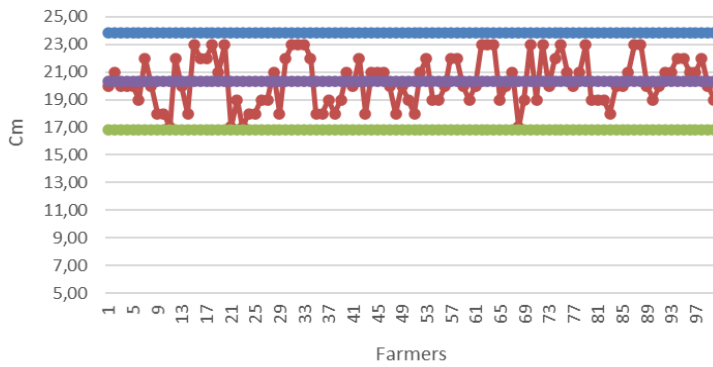


Fig. 10. Body thickness dimensions.

Fig. 10 shows the test for reliability of body thickness dimension data. The data is declared reliable because it is not outside the upper control limit or lower control limit. The data reliability test for the upper arm length dimension is in Fig. 11.

Fig. 11 shows the dimensions of the length of the upper arm for the reliability test. The data is stated to be reliable because there is nothing outside the upper control limit or lower control limit. The data uniformity test for the hand length dimension is in Fig. 12.

Fig. 12 shows the test for reliability of hand length dimension data which is stated to be reliable because all data is between the upper control limit and the lower control limit.

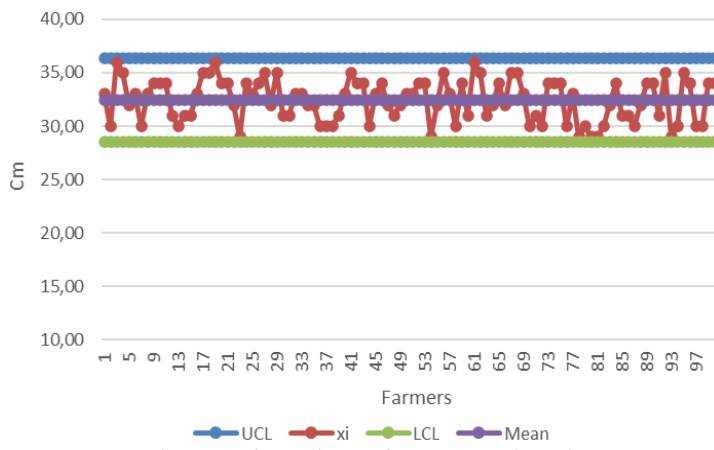


Fig. 11. Dimensions of upper arm length.

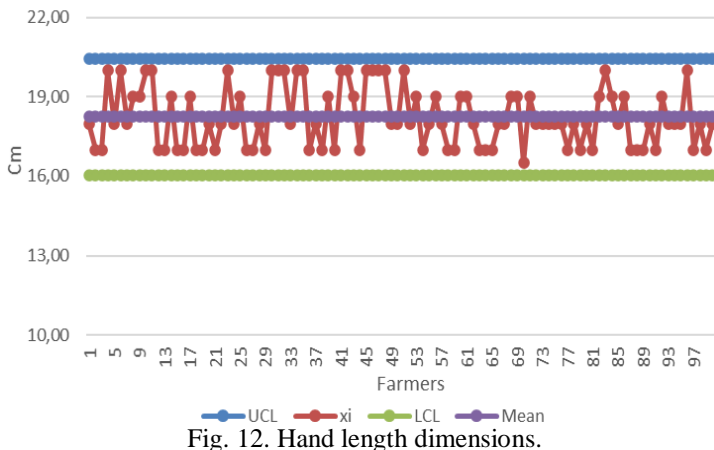


Fig. 12. Hand length dimensions.

3.2.2 Data Validity Test

After the data uniformity test has been carried out, it will be continued by carrying out a data adequacy test to determine whether the amount of data used in this measurement is representative of the observed population. With a confidence level of 95% and an accuracy level of 5%, it shown in Table 2.

Table 2. Recapitulation of data validity test

Dimension	N	N'	Explanation
Standing elbow height	100	2.46	Valid
Palm length	100	4	Valid
Palm width	100	5.13	Valid
Middle finger length	100	3.53	Valid
Shoulder width	100	3.43	Valid
Body thickness	100	3.42	Valid
Upper sleeve length	100	2.40	Valid
Hand length	100	2.42	Valid

Table 2 shows all values of $N' < N$, so the data is declared valid, the results of these calculations can be concluded that all body dimension data obtained is valid for conducting research.

3.2.3 Normality Test

The normality test was carried out using the Kolmogorov-Smirnov method, to find out whether the data obtained was normally distributed or not. The test criteria are as follows: H_0 = normally distributed data if the significance is more than $\alpha = 0.05$, H_1 = data is not normally distributed if the significance value is less than $\alpha = 0.05$. After determining the hypothesis in this research, the researcher then calculated the significance value using SPSS 26 software as shown in the Table 3.

Table 3. Normality test for rice planting tools

Kolmogorov-Smirnov Test		Unstandardized Residual
N		100
Normal Parameters ^{a,b}	Mean	.0000000
	Std. Deviation	.56239455
Most Extreme Differences	Absolute	.076
	Positive	.067
	Negative	-.076
Test Statistic		.076
Asymp. Sig. (2-tailed)		.174 ^c

a. Test distribution is Normal.

Table 4. Normality test for rice seed bag data

Kolmogorov-Smirnov Test		Unstandardized Residual
N		100
Normal Parameters ^{a,b}	Mean	.0000000
	Std. Deviation	1.23468525
Most Extreme Differences	Absolute	.043
	Positive	.034
	Negative	-.043
Test Statistic		.076
Asymp. Sig. (2-tailed)		.174 ^c

a. Test distribution is Normal.

Tables 3 and 4 show the normality test results in which the significance value for all dimensions is > 0.05 . It can be concluded that the distribution is normal.

3.2.4 Percentile

Percentile aims to determine the user population for a product. Percentiles are determined in the design so that the tools designed can make farmers work comfortably. The determination of percentiles is in Table 5.

Table 5. Recapitulation of percentile calculations

Dimension	Percentile	
	5	95
Standing elbow height	92.18	112.96
Palm length	8.13	11.34
Palm width	7.43	11.41
Middle finger length	6.94	9.31
Shoulder width	36.10	48.00
Body thickness	17.47	23.19
Upper sleeve length	29.22	35.64
Hand length	16.42	20.05

Table 5 shows the 5th and 95th percentile values which will then be used to redesign the rice planting equipment and rice seedling bags.

3.3 Results of Redesign of Rice Planting Equipment

The redesign of the rice planting tool as shown in Fig. 13.

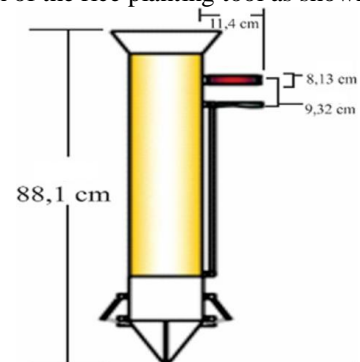


Fig. 13. Rice planting equipment.

Fig. 13 shows the proposed design of this rice planter to minimize MSDs complaints such as pain, muscle weakness, and injuries to the waist and legs.

3.4 Results of Redesign of Rice Seedling Bags

The design of the rice seed bag as shown in Fig. 14. The design of this rice seed bag is to minimize MSDs such as pain, muscle weakness, and injuries to the waist and legs.



Fig. 14. Rice seedling bag.

4 Conclusion

Based on the results of data processing it can be concluded:

1. This study identified farmers' MSDs complaints when planting rice through the Standard Nordiq Questionnaire (SNQ) questionnaire. It was found that farmers experienced complaints of severe pain, more than 50% of which occurred in the waist, left calf, right calf, left ankle, right ankle, and left foot. and the right foot when carrying out rice planting activities.
2. The dimensions of the rice planting tool are the height of the tool 88.1 cm, the diameter of the tool handle 8.13 cm, the length of the handle 11.4, distance between the handle and the brake 9.32 cm. The dimensions of the rice seed bag are 33.70 cm wide, the distance between the front and back of the bag is 23.19 cm, the bag height is 35.64 cm, and the bag length is 20.5 cm.

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