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Model Design of Manual Rice Planter Through Ergonomic Approach to Increase Work Productivity

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Abstract:
This rice planter model is designed to make it easier for farmers to plant rice quickly, easily, and very effectively. This tool is designed not to use a motor or engine drive, this can save costs because it does not incur fuel consumption costs. This rice planter is made with a size that is not too large, so it is easy to use on narrow land, saves maintenance costs and is simple to use. This tool can be lifted by only 2 people or do not need to use heavy equipment. The design model and working principle of this rice planter uses a paddy hook and pusher to anchor rice seeds to the ground, equipped with a push lever that can be pushed easily, as well as a rice seed holder that moves to the left fully and then to the right (once the rotation) , each paddy planting lever is operated so that the rice seeds can be evenly attached to the hook, and the way this tool is operated is by pulling the frame lever with the left hand and walking backwards and the right hand operating the paddy planting lever. The results of testing the work productivity of farmers through an ergonomic approach are obtained that: a). The average difference between musculoskeletal disorders before work and after work before using the rice planter was 28.90 (±3.31). The increase in farmers' average skeletal muscle disorders increased by 42.21%; b) The difference between complaints of fatigue before work and after work before treatment is 23.6 (±3.31) or an increase of 45.33%; c) The average resting pulse of farmers before work is 69.84 (±2.31) bpm and the average working pulse is 105.96 (±1.46) bpm and the increase in working pulse is 37.53 (±2.98) dpm or 54.48%; and d) The calculation result of work productivity is 94.21±3.09.

Key Word*:rice planter model; ergonomics; workproductivity.*

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I. Introduction

A little more than 90% of Indonesia's population relies on rice as a daily dietary staple [1]. Makarim and Las [2] assert that increasing productivity through careful selection of technological components while taking into account the biotic environmental conditions, abiotic environmental conditions, and optimal land management are effective and efficient ways to increase national rice production in a sustainable manner. Cropping system technology in rice cultivation is anticipated to have an impact on production outcomes, which will ultimately have an impact on food farmers' revenue. According to Yoshie and Rita [3], using high-yielding cultivars is simply one aspect of using optimal agricultural technology. Appropriate planting techniques must also be used. Overall costs may be reduced in the manufacturing sector by planning the assembly process to reduce the need for raw materials and procedures [4].

Planting rice seeds in areas where the bent-over posture is still used can lead to an increase in complaints of exhaustion and skeletal muscle soreness in the legs, back, waist, and neck, as well as an increase in the sensation of melting. Additionally, personnel expenditures are high and prolonged effort is ineffective. There are still numerous traditional rice planting techniques used in Indonesia, such as planting rice backwards, which raises laborers' earnings. Finding rice planters is also becoming increasingly difficult, and many planters feel that the task is too demanding for the income they receive.

To solve this issue, manual rice cultivation methods are being offered to farmers, especially small farmers whose yields are typically low to medium, in an effort to make the cost more reasonable, boost productivity, and maximize rice planting while reducing planting expenses. Farmers may find it simpler to swiftly, simply, and very successfully cultivate rice if a rice planter is available. This rice planter is made without a motor or engine drive to save on fuel expenditures. It also has a straightforward work system, isn't too big, and requires very little maintenance. When you consider how difficult it is to access the rice fields by road, this gadget is relatively simple for two people to carry. The design model and operation of this rice planter uses rice hooks and pushers to stamp rice seeds into the ground. It is outfitted with a push lever powered by humans and a rice seed holder that moves all the way to the left and then to the right (once the rotation). Each rice planting lever is operated so that the rice seeds can be evenly attached to the hook. To use this tool, pull the frame lever with the left hand while walking backward.

II. Material And Methods

2.1 Research Design

This research is a one-short case study with a pre and post-test design group [5]which was conducted observationally on the working process of manual rice planting model. Chart can be described as follows:

R ⟶ P0 ⟶ PI

Figure1. Research Design

Information:
R = random sample.
P0= the result of the pretest experimental unit.
PI = the result of the posttest experimental unit.

2.2Research Variable

The following factors will be assessed in this study: (1) workload as determined by the pulse of rice before and after work; (2) complaints of fatigue and skeletal muscle pain before and after work; and (3) work productivity as determined by a comparison between the work pulse (measured in beats per minute) and the amount of planted rice (in m^2). The information data of the beginning state and the end condition are measured as variables numbers (1) through (3), which are then compared to determine the comparison prior to utilizing a machine.

2.3Data Analysis

Based on the load capacity requirements of the rice seeds to be transported and planted in a single time and the ergonomic design of the machine holder, the design information for the ergonomic manual rice planter model is determined. The comparison test data of work productivity was studied based on working time/length of work, workload, subjective complaints, and work productivity which would then be analyzed descriptively to arrive at findings.

III. Results And Dicussion

3.1Product

In designing the tools, various building factors were taken into consideration, including ease of production, cost effectiveness, and aesthetic appeal. In order to receive the manual rice planter tool, follow these steps:

Figure 1: Alat PenanamPadi Manual

Specifications of manual rice planter: (a) Equipped with 5 (five) rice cultivators; (b) 40 cm high; (c) Width 130 cm; and (d) Length 65 cm.

3.2 How the Machine Works

There are two distinct work cycles in one movement of the eyeglass frame in this manual rice planting tool. The first cycle involves the eyepiece frame moving downward. The second cycle involves pressing the handle of the rice planter as the driver of the eyepiece frame. Pushing the handle of the rice holder, which is attached to a gear that moves the rice holder to the side so that the eye of the plug can hold the rice evenly, causes the eye of the plug to hook the rice in the rice holder and then plug it into the mud. The next cycle of the moving eye frame causes the eye of the plug to unhook the rice in the rice holder and then plug it into the mud. Next, pulling the handle of the rice paddies causes the lower frame to move back

3.3 The result of ergonomics test using roasted machine

3.3.1 Subjective Complaint

Due to the farmer's bent posture while working and exposure to external heat from radiation from the stove, sitting slumped over while labor increases musculoskeletal symptoms and tiredness complaints. A work posture that involves bending repeatedly for an extended period of time is not physiological. Muscle problems develop as a result of strain on the muscles from ongoing workloads without rest [6]–[8].

The results of measurements with a Nordic body map questionnaire for 10 farmer who were measured before and after work obtained the average difference between musculoskeletal disorders before work and after work before treatment was 28.90 and after treatment was 16.70. The decrease in the mean difference between musculoskeletal disorders before treatment and after treatment was significant ($p < 0.05$) or 42.21%.

Table 1. Measurement Results of Musculoskeletal Disorder

Descriptions	Everage difference musculoskeletal disorder		t	p
	Mean	Standard Deviation		
Manual planting race	28,90	3,31	6,578	0,00
Machine Rice Planting	16,70	4,30		

3.3.2Work Load

The average resting pulse rate of farmer in the manual work process (before using the roasting machine) is 69.84 (2.31) bpm and the average working pulse is 105.96 (1.46) bpm and the increase in work pulse is 37.53 (2 .98) bpm or 54.48%. The average resting pulse rate of farmer after using a Manual Rice Planting is 68.43 (1.71) bpm and the average working pulse is 97.08 (2.00) bpm and an increase in work pulse is 27.24 (1.64) bpm or 39.00 %.

Prior to therapy, the serundeng maker's working pulse averaged 105.96 (1.46) beats per minute, including the category of medium effort [7], [9]. Workload growth is brought on by employees working continually without breaks in a warm working environment owing to heat radiation from solar heat radiation.

Table 2. Resting Pulse, Pulse Working and Work Pulse

Descriptions	Manual roasting process		Machine roasting process		t	p
	Mean	SD	Mean	SD		
Resting Pulse	69.84	2.31	68.43	11.71	-1,53	0,16
Pulse Working	105.96	1.46	97.08	2.00	10.51	0.00
Work Pulse	37.53	2.80	27.24	1.64	15.55	0.00

SD : Standard deviation

3.3.3 Work Productivity

The ratio of output to input at a specific time unit is used to measure the work productivity of farmers throughout the process of planting rice. The amount of planted rice (m^2) produced by the farmer while he or she is working is the output, and the farmer's labor is the input. The result of the calculation of productivity after using the roasting machine is 152.69±3.37 while before using the Machine Rice Planting it is 94.21±3.09 or an increase of 62.07%. This increase in productivity is due to a decrease in workload and an ergonomic work posture so that fatigue and musculoskeletal complaints are reduced and production is increased. To increase productivity, according to Kimberly[9], it is necessary to change the work system to reduce the level of worker fatigue, so that working time is shorter and production can increase. Torik, et al. [10]also stated that the design of an ergonomic work system can reduce the level of worker fatigue.The work environment and equipment used when working can affect the work productivity of workers[11].

Table 3. Work Productivity of Farmer in The Planting Race Process

Descriptions	n	Mini-mum	Maxi-mum	Mean	Standard Deviation
Manual Planting Race Process	10	149	151	152.69	3.370
Machine Planting Race Process	10	91	102	94.21	3.091

The advice of ergonomics experts to improve working conditions for gamelan farmers can raise work productivity by 26.67%, and using ergonomics treatments can enhance work productivity by 54.88%.Increased worker productivity can be done by using ergonomic interventions[12]–[14]. According to Priambadi's research from 2012 and Bawa Susana's research from 2014[15], [16]. According to Setiawan's [17] research, work station design can boost productivity by 20.29%. Improvement of work tools, work stations, and work systems with an ergonomic approach will increase worker productivity[18].

IV. Conclusions

Based on the discussion that has been carried out, the following conclusions can be:

1. The work posture of Farmer in The Planting Race Proces by bend down causes an increase in musculoskeletal complaints and fatigue complaints due to the craftsman's bending work attitude accompanied by exposure to environmental heat due to radiation from the stove/stove. A work postur that bends over and over for a long time is a work postur that is not physiological.
2. The results of testing the work productivity of farmers through an ergonomic approach are obtained that: a). The average difference between musculoskeletal disorders before work and after work before using the rice planter was 28.90 (±3.31). The increase in farmers' average skeletal muscle disorders increased by 42.21%; b) The difference between complaints of fatigue before work and after work before treatment is 23.6 (±3.31) or an increase of 45.33%; c) The average resting pulse of farmers before work is 69.84 (±2.31) bpm and the average working pulse is 105.96 (±1.46) bpm and the increase in working pulse is 37.53 (±2.98) dpm or 54.48%; and d) The calculation result of work productivity is 94.21±3.09.

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