Operator Workload Analysis of Corn Seed Planting Equipment in Corn Planting

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ABSTRACT
The use of a push system planting tool to plant corn seeds requires a lot of energy because workers act as controllers, so it often creates a physical and mental workload. Workloads that are too heavy and exceed work capacity can cause fatigue. This fatigue will eventually cause pain. Therefore, the purpose of this study was to study the physical workload of operators in operating corn seed planting equipment. The parameters of the research observed were the worker's pulse before and after work, oxygen consumption, and the operator's physical workload. The results showed that the worker's pulse can describe the workload as a manifestation of muscle movement when doing work. The greater the muscle activity, the greater the fluctuation of the pulse movement that occurs. The operator's workload is in the light to medium category. Oxygen consumption of workers is influenced by the intensity of the work done. Based on oxygen consumption data, it is known that the workload of this corn seed planting tool is still relatively low because workers still feel comfortable and safe while doing planting work.

Keywords: *planting tools, workload, corn seeds, energy consumption*

1. INTRODUCTION

The process of planting corn seeds can be done easily if you use equipment that is suitable for the anthropometric conditions of the workers [1]. To create comfortable and safe working conditions, planting equipment should be designed based on the size of the worker's body posture and land conditions [2][3]. Some indicators of success in designing corn seed planting equipment are that farmers feel comfortable using the tool, can increase efficiency, and reduce labor [4].

Planting corn seeds is generally done by inserting the seeds into the planting hole at a certain depth [5]. If done using a planting tool, it requires a lot of energy because in its operation the worker acts as a source of power and controller, so that it often causes physical burden [6]. Working conditions like this require high energy to carry out the work of planting corn seeds and it is even more difficult if this work is carried out continuously without sufficient rest time [7]. Operators only take breaks by stealing time off during work [8]. This can cause a high workload. As a result, operator fatigue arises which can cause performance to decrease [9].

Physical work can be connoted with heavy work because these activities require strong human physical effort during the work period [10]. For physical work, energy consumption is the main factor that can be used as a benchmark for determining the weight or lightness of a job [11]. Physical work will result in energy expenditure associated with energy consumption. Energy consumption during work is usually determined by measuring the pulse rate [12].

Pulse rate is used to measure the dynamic workload of workers as a manifestation of muscle movement. The greater the muscle activity, the greater the fluctuation of the pulse movement that occurs [13]. Vice versa. According to [14], workload can be measured by pulse before and after work. In addition, pulse rate can also be used to estimate the physical condition or degree of physical fitness of workers. Pulse rate can also be used to measure a person's level of fatigue [15]. Another way that can be done to measure a person's pulse at work is using electromyography (EMG) [16].

The oxygen consumed by a person is influenced by the intensity of the work done [17]. This oxygen

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consumption is related to physical work capacity (PWC). According to [18], PWC describes the maximum amount of oxygen that can be consumed by workers at any time. A high percentage of PWC in a particular job will indicate the physical workload experienced [19].

The problem that is often experienced by farmers while planting corn using planting tools is that farmers have to walk while pushing this planting tool with a load of up to 7-10 kg [20]. This problem seems simple, but if it is done on a large area and for a long time, it can cause fatigue. Thus, the purpose of this study was to study the level of operator workload in operating corn seed planting equipment.

2. MATERIALS AND METHODS

2.1. Materials and tools

The material used in this research was Bisi variety corn seeds. The equipment used was a corn seed planting tool (Figure 1). While the research measuring instruments are digital tachometers, digital scales, stopwatches, measuring tapes, and roll meters.

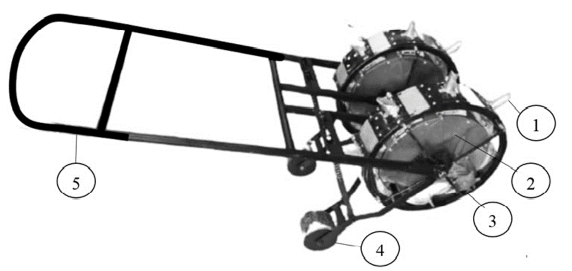

Figure 1 Isomeric view of the double row seed planter machine
Information:
1) Furrow opener
2) Planter hopper
3) Seed metering device
4) Drive wheels
5) The planter's handle

2.2. Research Parameters

The research parameters observed were pulse before and after work, oxygen consumption, and the operator's physical workload.

2.3. Research Procedure

a) Pulse rate measurement is done 5 times for each operator for 3 working days. The pulse before and after planting was measured by measuring the pulse in the wrist arteries with the 10 beat method using the following formula:

$$Pulse = \frac{10\ pulse}{times} \times 60 \quad (1)$$

b) Measuring energy consumption to determine the relationship between energy and pulse rate using the quadratic regression equation ():

$$(Y) = 1.80411 - 0.0229038\ X + 4.71733\ A \times 10^{-4}\ X^2 \quad (2)$$

c) Calculating physical workload based on the increase in work pulse rate compared to the maximum pulse rate using the formula [21]:

$$CVL = \frac{DNK - DNI}{DN_{max} - DNI} \times 100 \quad (3)$$

Where, CVL = *Cardiovascular Load (%)*, DNK = work pulse (pulse/min), DNI = resting pulse (pulse/min), and DN_{max} = maximum pulse (pulse/min).

d) Determine the classification of the physical workload following Table 1 [22].

Table 1 Classification of physical workload

Range (%)	Classification
< 30	No fatigue
30 - 60	Repair needed
60 - 80	Work in short time
80 - 100	Immediate action needed
>100	No activity allowed

2.4. Data Analysis

The data needed are pulse rate, energy consumption, and the operator's physical workload. These data are displayed in the form of tables and graphs to determine the relationship between research parameters and the operator's physical workload during work [23].

3. RESULTS AND DISCUSSION

3.1. Pulse measurement

The results of measuring the worker's pulse are presented in Table 2. This pulse rate can describe the operator's workload as a manifestation of muscle movement when doing work. The data in Table 2 shows that the greater the muscle activity, the greater the fluctuation of the pulse movement that occurs. According to Teo [24], the workload can be known based on the pulse of the worker. This pulse rate can also be used to measure the level of worker fatigue. In addition, pulse rate can also be used to estimate a person's physical condition or degree of physical fitness.

Table 2 The results of measuring the operator's pulse before and after work

Operator	Day to-	10 Pulse before Work (seconds)	10 Pulse after Work (seconds)
1	3	6.34	4.23
		6.83	4.46
		6.12	4.78
2	2	6.87	4.11
		6.84	4.67
		6.77	5.12
3	3	6.11	4.67
		6.23	4.82
		6.34	4.86

The results of calculating the operator's pulse rate using equation (1) obtained the worker's pulse for every minute, as presented in Table 3.

Table 3 The results of calculating the operator's pulse rate before and after work

Operator	Day to-	Pulse rate before work (pulse/min)	Pulse rate after work (pulse/min)	Maximum pulse rate (pulse/ min)	Pulse rate (pulse/ min)
1	3	94.64	141.84	167	47.21
		87.85	134.53	167	46.68
		98.04	125.52	167	27.48
2	3	87.34	145.99	175	58.65
		87.72	128.48	175	40.76
		88.63	117.19	175	28.56
3	3	98.20	128.48	190	30.28
		96.31	124.48	190	28.17
		94.64	123.46	190	28.82

Measurement of pulse rate is also used to determine the operator's workload both before and after work. Pulse rate is measured by measuring the speed of the pulse in the radial artery of the wrist. In addition, measurement of pulse during work is a method for determining the classification of workload based on the increase in the work pulse compared to the maximum pulse rate.

Figure 2 Labor position seed corn planter

3.2. Oxygen Consumption

Someone who is doing physical work will result in energy expenditure related to oxygen consumption. The relationship between energy and pulse rate can be used to calculate the oxygen consumption of each worker. The results of the pulse rate calculation using the 10 beats method obtained a recapitulation of workers' oxygen consumption as presented in Table 4. Based on the table it is known that the oxygen consumed by workers is influenced by the intensity of the work performed. Oxygen consumption can be used to determine the physical work capacity of workers (PWC). According to [25], PWC describes the maximum amount of oxygen that can be consumed by workers every minute [26]. A high percentage of PWC can indicate the physical burden experienced by workers is also high.

Table 4 Results of workers' oxygen consumption recapitulation.

Operator	Day to-	Pulse before work (pulse/min)	Oxygen Consumption (kcal/h)
1	1	47.21	1.77
		46.68	1.76
		27.48	1.53
2	2	58.65	2.08
		40.76	1.65
		28.56	1.54
3	3	30.28	1.54
		28.17	1.53
		28.82	1.54

Research data show that PWC decreases as workers age. The data obtained show that workers aged 53 years have lower PWC than workers aged 35 years. The same thing has been reported by Bugajska et al. [27], that the PWC of older workers is smaller than that of young workers. Our results also show the importance of PWC on workability. This is evidenced by the positive correlation between oxygen consumption and work ability. Based on the results of this test, it can be explained that work capacity decreases with increasing age of workers.

Several research results have also reported that the age of workers has a significant effect on work capacity [28]. Younger workers tend to have a higher work capacity than older workers. Workers in poorer health are more likely to retire early or move to less physically demanding jobs. The effect of age is often compromised with muscle strength due to the tendency of individuals to be lighter, healthier, stronger, with relatively stronger physical, muscular, and cardiorespiratory fitness [29].

3.3. Physical Workload Analysis

The results of measuring the physical workload using the pulse method are presented in Figure 2. Based on the figure, it is known that this type of work is classified as a low level of physical workload because workers do not experience fatigue during the work of planting corn seeds using planting tools.

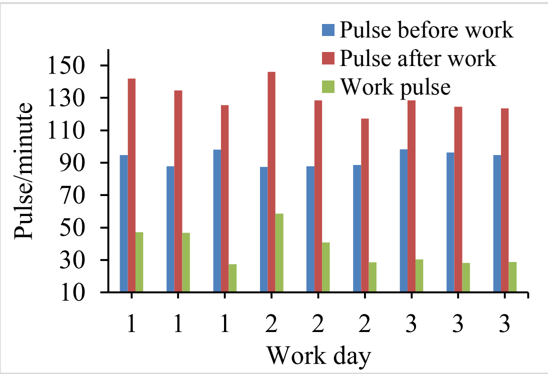

Figure 3 Physical workload for each operator

The workload analysis obtained from this study is still relatively comfortable and safe. If workers still feel comfortable in doing their jobs according to [30], it can improve performance, be more efficient, and cost less. From an ergonomics point of view, the demands of workload and work capacity must always be balanced to achieve optimal work performance. The workload should not be too low (underload) and should not be too excessive (overload) because both can cause saturation [6].

Workload is a burden that must be accepted by workers in completing work related to physiological conditions, such as noise, vibration (vibration), and the environment. If such working conditions are bad enough, there will be work stress with physical symptoms, such as high blood pressure, diarrhea, constipation [31]. The workload of farmers in using this planting tool is still in the light category. However, this cropping tool still needs to be redesigned for better refinement.

4. CONCLUSION

The worker's pulse indicates the workload as a manifestation of muscle movement during work. The greater the muscle activity, the greater the fluctuation of the pulse movement that occurs. The operator's workload is in the light to medium category. The worker's oxygen consumption is influenced by the intensity of the work done. The workload of this corn seed planting tool is still relatively low because workers still feel comfortable and safe while using the corn seed planting tool.

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