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Workload Analysis on Harvesting Activities in Oil-Palm Plantation in Riau, Indonesia

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1. Introduction

Oil palm plantation (*Elaeis guineensis* Jacq.) has become the main commodities in Indonesia because of producing palm oil. The growing demand of palm oil for food industries and bio-fuel has been challenging the palm oil industries for increasing the productivity of the oil-palm plantation. Harvesting activity is the most important task to gain the good productivity and quality of palm oil (CPO and PKO) [1]. Nowadays, harvesting process is still done manually where conducted in many areas with various kind of topography. In addition, there is a harvest's target that must be achieved by the labors. This condition led to many variations in productivity and quality of harvest, fatigue or physical disorder.

Therefore, an increase in productivity and work for the welfare of the harvesters has to be done by the approach and application of ergonomics. Application of ergonomics in the workplace is expected to improve productivity through improvement of safety, effectiveness, efficiency and comfort of the works [2]. This study aimed to know the rate of energy consumption and level of fatigue in the harvesting activity. The work capacity of the harvesters will be also analyzed. By comparing the level of workburden and energy consumption of work against the workforce capacity harvesters then could be designed the proper work targets for optimal productivity in accordance with energy harvesting capacity.

2. Materials and Methods

There are three stages of the research i.e. observing harvesting working procedure in oil-palm plantation, workload analysis conducted by the method of heart rate analysis and work capacity analysis. This study was conducted at 8 male harvesters that have been observed as subjects that grouped by age, variations in topography and the use of harvesting equipment. First step of workload analysis is doing calibration with step test method to determine the characteristics of the subject in the receiving of a workload that is different from each other. The step calibration test using a four-step cycle 15 cycle/minute, 20 minute cycle/min, 25 cycle/min, 30 cycle/minute that are known to influence the rate of increase in the workload of the heart rate. From the results of the measurement of the dimensions of subject , heart rate and its rate on the step test, calibration will be retrieved in the form of a power equation Y = ax + b, where Y is the value of IRHR (Increase Ratio of Heart Rate), and X is the value of the TEC (Total Energy Cost, kcal/min). The equation is working to find out the value of the TEC when working by inserting the value of IRHR while working. After that the total of standard energy for harvesting process can be obtained by converting TEC in kcal/minute to kcal/bunch. Work capacity analysis conducted by compared the recommended daily allowance (RDA) with standard energy consumption for harvesting oil palm.

3. Results and Discussion

Harvesting activity is the process to cut the bunch from the tree. However, the process of harvesting actually consisted of several sub systems of work i.e. verify the maturity of fruit (Ve), preparation (Pr), cutting fruit and stem of (Cu), cutting stem (Ba), chop the base of the stalk of fruits (Ck), picking up the fallen fruit *(berondolan)* (Br), load (lo), moving (Mo) and unloading (Un) [2]. All of that process showed in Fig. 2

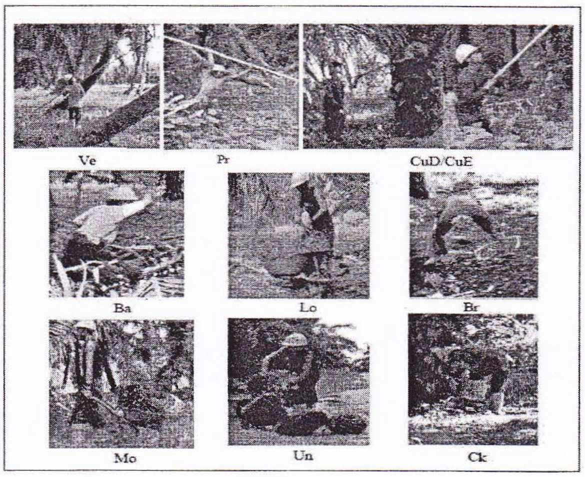

Fig 2. Sub system on the harvesting process

The level of fatigue is known as the value of qualitative workload. That value is indicated by IRHR (Increase Ratio of Heart Rate). If a work has a value of IRHR higher than 2.0, so that work can be categorized under heavy workload [3]. From the data, can be seen that Cu, Mo and Un are categorized under heavy work because they have the value of IRHR more than 2.0. The other sub system of work are categorized as a moderate workload because the value of its ranges from 1.5 to 2.0. That result happen in all various topographic areas.

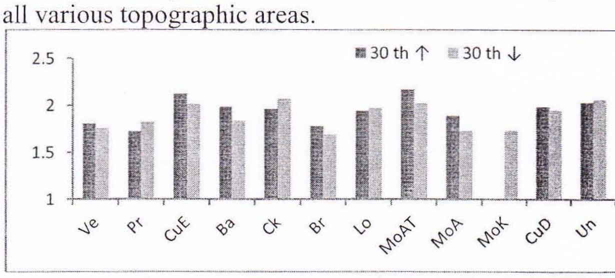

Fig 3. Graph of Increase ratio of Heart Rate (IRHR)

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Quantitative workload value indicated by the value of the WEC and TEC. IRHR produced values of each subject when doing the activity is incorporated into the power equation to find out the value of the WEC. WEC Value (Work Energy Cost) is the value of an increase in energy consumption as a result of doing the activity. Generally, each individual has the physical characteristics and physiology is different and specific, including BME (Basal Metabolic Energy). BME is the consumption of energy required to perform a minimum of the physiological function [2]. The value of the total energy consumption (TEC) can be obtained by summing the values of BME and WEC value while working. From the data can be seen that the average value of each subject for TEC moving is the largest i.e. 3.90 kcal/minute. The value is the second-largest on the TEC cutting fruit and stem of activities (Cu). Unloading (Un), chop the base of the stalk of fruits (Ck) and cutting stem (Ba) values it's almost the same, approximately 3.5 kcal/minute.

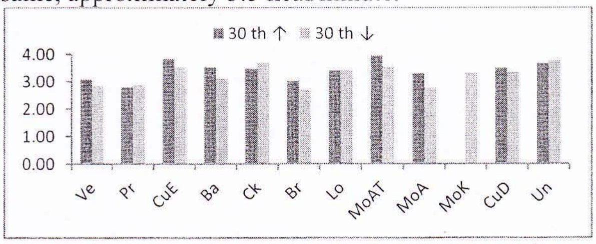

Fig 5. Graph of Total Energy Cost (TEC)

TEC' value need to know to find the value of calculated TEC on each subject by eliminating the body weight factor. Energy consumption is proportional to the weight of a person, the greater the weight of a person, then energy consumption gets larger, so instead at the time the work is relatively the same. Therefore, to know the value of the workload of an accepted objective when someone does work then the influence of the weight needs to be normalized. Thus the total energy cost can be obtained without the factor of greatest weight in the moving (Mo) 0.07 kcal/kg.minute and the other subsequent like unloading activities (un), the cutting of fruit and stem of (Cu), cutting steam (Ba) and chop the base of the stalk of fruits (Ck) approximately 0.06 kcal/kg.minute.

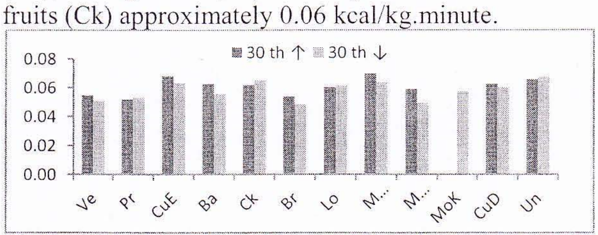

Fig 6. Graph of Total Energy Cost without the factor of weight (TEC')

Almost of the values IRHR, WEC, TEC and TEC'obtained a tendency that subjects with age above 30 years has a value of IRHR, WEC, TEC and TEC' larger than subject that under 30 years of age. But for subject that under 30 years of age, unloading and chop the base of the stalk of fruits (Ck) has the value of IRHR, WEC, TEC and TEC' larger than subject that above 30 years of age, because that sequent was the last sequent which means that the production of energy for subject under 30 years of age less stable than subject above 30 years of age. Of all the harvesting process, an activity that has high workburden level and high energy consumption was moving (Mo), unloading activities (un), the cutting of fruit and stem of (Cu), cutting stem (Ba) and chop the base of the stalk of fruits (Ck) so that the necessary mechanization or repair tool. If the work manually, energy consumption are issued only the energy from human beings, on the working of the energy consumption of mechanically removed is the energy of man and machine are subsitutioned so that the work of the harvesters will be lighter and minimize work accidents.

The total of standard energy consumption for harvesting process can be obtained by converting the value of TEC from each sub system of harvesting process in kcal/minute to kcal/bunch then summing all of that value. The result showed in table 1.

Table 1. Total of standard energy consumption

Land Condition	Total of standard energy (kcal/bunch)	
	> 30 years	< 30 years
T-K-E	8.98	8.34
F-K-E	6.22	6.91
T-K-D	6.84	7.55
F-B-D	5.08	6.01

After that the proper target for harvest activity can be obtained by compared the recommended daily allowance (RDA) with standard energy consumption for harvesting oil palm. The result showed in table 2

Table 2. Harvest Capacity

Land Condition	Total of standard energy (kcal/bunch)	
	> 30 years	< 30 years
T-K-E	84	90
F-K-E	121	109
T-K-D	110	99
F-B-D	148	125

4. Concluding Remarks

The workburden level or the physical workload of subjects based on the value of IRHR for all sub work system be at the interval 1.62 to 2.17 with classification workload at the level of moderate to heavy. The value of IRHR for Cu, Ba, Lo, Mo and Un has a value of IRHR more than 1.8. which means that can be categorized under heavy workload. The largest consumption of energy is in MoAT and next row are Cu, Un, Ba, Ck, Lo, MoA, MoK, Pr, Br, Ve, The value of the average energy consumption for all sub work harvesting systems on the subject above 30 is 0.060 kcal/kg.minutes, while the subject is under 30 years of age is 0.058 kcal/kg.minutes. Thus, the value of TEC subject from above 30 years higher than subjects under 30 years old. This indicates that the subject from above 30 years of age consume the energy higher than the subject under 30 years of age on the same activity, but there are several sub system of harvest that the subject under 30 years consume the energy higher than the subject under 30 years of age on the same activity, It means that work experience is comparable to the physical burden.

References

[1]. The Ministry Of Agriculture. 2010. The Statistics of Plantation Indonesia 2007-2010. The Directorate General of Plantations, The Ministry Of Agriculture. Jakarta

[2]. Syuaib, M.F. 2003. Ergonomic Study on the Process of Mastering Tractor Operation Agricultural Engineering. Tokyo University of Agriculture and Technology, Tokyo.

[3]. Syuaib *et al.*(2012). Laporan Kajian Ergonomika untuk Penyempurnaan Sistem dan Produktivitas Kerja Panen-Muat Sawit di kebun Atra Agro lestari. FATETA. IPB