

## Ergonomic study of BRRi multi-row power weeder for rice cultivation

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### ABSTRACT

Weeds are the major biotic confinements of rice productivity. In Bangladesh, weeding operation is done manually pulling or by using simple tools like khurpi, push-pull Japanese weeder, BRRi, BARI and locally developed weeder. The main objective of the research work was to assess the ergonomic factors of BRRi multi-row power operated weeder. This study was carried out in the cultivators' land, Tarhat Para, Gazipur Sadar under silty loam soil condition during Boro season, 2018-2019. Three operators were casually selected for ergonomic evaluation. Heart rate was measured every 30 minutes during operation. Body mass index (BMI) values were found to be 24.05, 21.48 and 23.48 kg m<sup>-2</sup> for operators O<sub>1</sub>, O<sub>2</sub> and O<sub>3</sub> respectively. The mean working heart rate for operating BRRi multi-row power weeder was found to be 134.67, 137.33 and 138.67 beats min<sup>-1</sup> and the equivalent average energy expenditure rate was found to be 28.61, 29.72 and 30.28 kJ min<sup>-1</sup> during weeding operation for operators O<sub>1</sub>, O<sub>2</sub> and O<sub>3</sub> respectively. The oxygen consumption rate was differing from 0.86 to 0.90 l min<sup>-1</sup>. The rest pause during weeding operation was found to be 11 minutes followed by 30 minutes of operation. Based on the workload, the operation of BRRi multi-row power paddy weeder is ergonomically safe and it could be operated continually upto 8 hours of a long day if 11 minutes of work rest time to a operator may be taken after 30 minutes of operation.

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## I. Introduction

Weeds are unwanted and undesired plants which grow in the field crops. Weed growth is a major problem for wetland paddy condition. It competes with the main crop for their existence and total yield is lost by sharing space, water, nutrients and sunlight with the crop (Rao, 1999). The total crop production depends upon the utility and timely of weeding. The annual yield is lost 45% due to weeds which are lost 20% of diseases, 30% of insects and 5% of pest (Mungale, 2007). Weeding process is the most effectiveness activities in rice farming system. The crops are always protected from weed by weeding system for better yield. Weed management is an essential but labour crisis is severe in this

intercultural operation. About 25 % of the requirements of whole labour are needed to remove weeds (900–1200 man-hours/hectare) during a cultivation period (Yadav and Pund, 2007). The crop yield is affected by 30 to 60 percent in weeding operation due to delay and obliviousness (Singh, 1988).

There are some common methods for weed control such as manual, mechanical, chemical and biological. Weeding tools like hoes and *khurpi* are operated by manually which involves too much drudgery. Weeding is manually very efficient activity however it is exhausting, time wasting and costly in massive cultivation. Manual weeding is difficult in rainy season when rain fall continuously and sufficient labour is not available (Puniya et al., 2007). Now-a-days the weed controls by chemical are achieving popularity because the weed controls efficiency by chemical are very high. But the demerit of chemical weeding is environmental contamination, reduction of microorganism population during the crop season (Hossain, 2006). To get the advantage of mechanization, the weeding implements are used properly which human drudgery will be reduced. Therefore, mechanical weeding is the most suitable method in wetland paddy. In mechanical weeding process, the weeds are uprooted between the rice rows, the soil surface is kept loose, the aeration of soil and the intake capacity of water is good (Biswas, 1990).

The relation between man and machine is called ergonomic or human engineering. Ergonomic is also included its working condition. The working condition varies some factors such as temperature, relative humidity and velocity of air. The environmental parameters are not possible to control; hence the good design of equipment is necessary which can be adopted by the workers for controlling and reducing the drudgery during operation. The energy expenditures of operators, their physiological cost, their fitness for farmland and what times they can able to work continually except any rest are evaluated by ergonomically (Tewari et al., 1991). The agricultural equipment and technology were not become yet proper planned and promoted in ergonomically. The equipment and tools should be designed in considering ergonomic involvements wherein the safety of human body is not affected. Hence, the study of ergonomic in the agricultural equipment and tools is necessary to reduce human drudgery. The main objective of this research work was to assess the ergonomic factors of BRRI multi-row power weeder for its suitability before large scale dissemination.

## II. Materials and Methods

This research was carried out in the cultivators' land, Tarhat Para, Gazipur Sadar during Boro season, 2018-2019. Rice variety BRRI dhan28 was transplanted by hand with 20 × 20 cm distance. The land was arranged by a power tiller of 2-WT, which is two plowing, followed by two puddling and leveling under the flooding conditions. Fertilizer was used according to the recommendation of the Bangladesh Rice Research Institute (BRRI). Irrigation was delivered following the requirement of crop. 50 mm height and 49.8 mm diameter of a metal core was used to collect soil samples from three different places of 0-150 mm depth to identify soil textural class, soil fertility class, pH and organic matter. The analysis of soil samples was done in the Soil Analytical Laboratory, Bangladesh Rural Advancement Committee (BRAC), Gazipur. Soil particle analysis was found as sand (29.92%), silty (50.84%) and Clay (19.24%) while pH and organic matter were found 5.66 and 2.48% respectively. Textural class was determined as silty loam by the USDA Soil Texture Triangle.

### Description of BRRI multi-row power weeder

BRRI multi-row power weeder is an effective technology for proper weed management in line sowing paddy field. Weed can be controlled in more than one row (three rows) at the same time using this power weeder. This technology is manufactured and synchronized with a petrol engine, three rotors, mild sheet (MS) shaft for power transmission, gear, stainless steel (SS) body, stainless steel (SS) handle and covered of plastic. Recoil starting mode petrol engine (1.35 kW) was used as a power source. Engine power (6500 rpm) transmitted to rotors at 185 rpm of the weeder with the arrangement of a coupling spline shaft-bearing, worm gear and rotary shaft with engage-disengage facility. The specifications of BRRI multi-row power weeder are presented in Table 01.

### Operator's selection

Three operators were casually selected for this study. The operators were medically fit to undergo the trials and they were true representatives of the user's population for the operation of multi-row power

weeder. The range of operators' age varied in 25 to 35 years because the maximum strength level is attained in this range (Gite and Singh, 1997). The age of three operators were 32, 26, 35 years and bodyweight of 54kg, 64kg, 62kg respectively. Body mass index (BMI) values were 24.05, 21.48 and 23.48 kg m<sup>-2</sup> for operators O<sub>1</sub>, O<sub>2</sub> and O<sub>3</sub> respectively. Body mass index is a tool which measure of the body fat and is indicated healthy body weight and height of a person. Specifically, the BMI value is used to identify how much weight a person can be sickly, normal, heavy or obese. According to World Health Organization's (WHO) recommendation, the BMI value is used for men and women of age 18 or older. The normal range of BMI is 18.5 to 25 kg m<sup>-2</sup>. All of the operators, BMI value were normal. Hence, the operators were capable and eligible for this work. The measurements of physical feature of three operators are shown in Table 02.

**Table 01. Specifications of BRRRI multi-row power weeder**

Parameters	Specifications
Overall length × width × height (mm)	1417×762×807
Overall weight (kg)	20
Maximum output kW rpm <sup>-1</sup>	1.35/6500
Engine type	Petrol engine
Starting method	Recoil
Number of row	3
Row to row distance (mm)	200 to 300 (adjustable)
Number of rotor	3
Number of spike each rotor	18
Length of spike, mm	60
Type	Forward motion walking type
Field capacity (ha/hr)	0.16-0.20
Working life (yrs)	3-4
Fuel tank capacity, ml	900



**Table 02. Measurement of physical feature of each operator**

Parameters	Operators		
	I	II	III
Age, years	32	26	35
Weight, kg	54	64	62
Stature, cm	149.86	172.72	162.56
Body mass index, kg/m <sup>2</sup>	24.05	21.48	23.48
Normal heart rate, beats min <sup>-1</sup>	72	78	75
Resting oxygen absorption rate, l min <sup>-1</sup>	0.140	0.209	0.175
Blood pressure, mm of Hg	110/70	120/80	110/80
Eye height, cm	138.43	162.56	149.86
Acromial height, cm	121.92	139.7	129.54
Elbow altitude, cm	91.44	111.76	99.06
Knuckle altitude, cm	66.04	73.66	68.58
Finger trip altitude, cm	55.88	60.96	60.96
Sitting altitude, cm	77.47	86.36	83.82
Sitting eye altitude, cm	63.50	76.2	73.66
Sitting shoulder altitude, cm	48.26	58.42	53.34
Elbow rest altitude, cm	20.32	30.48	25.40
Knee height, cm	45.72	55.89	53.34
Popliteal height, cm	38.10	45.72	43.18
Shoulder width, cm	40.64	48.26	45.72
Shoulder –elbow distance, cm	26.67	30.48	33.02
Elbow-finger trip distance, cm	43.18	45.72	43.18
Upper limb length, cm	60.96	73.66	68.58
Hand length, cm	15.24	19.05	17.78
Hand width, cm	8.89	9.53	8.89
Instep length, cm	20.32	22.86	24.13
Instep width, cm	7.62	8.89	8.89
Span, cm	152.4	177.8	165.1

### Ergonomic evaluation

Ergonomical procedure of the power weeder was done in March. Mean temperature and relative humidities were 25.95°C and 62.05% respectively. The test was conducted during the morning time (10.00 AM). The study was set up on the same day as three operators. All operators were evenly skilled to operate this power weeder. Each operator has used a similar type of clothing and was taken similar foods. Three power weeders were taken in the field for weeding operation. The objectives and activities of the study were informed to the operators to enlist their full cooperation. Experiment related information on the physical condition of operators was taken before the starting of every trail as this information was compared with after work. Three operators operated the power weeder for 30 minutes. After completion of each trial heart rate data were taken for each of the three operators. The rest time was allowed until the heart rate data were returned to the initial position. A similar method was followed for all operators. During the power weeder evaluations following data were taken as pulse rate, blood pressure and computing oxygen absorption rate and thereafter rest pause during work and energy expenditure rate.

### Heart rate and blood pressure measurement

Initially, the heart rate of operators at rest condition was measured during field operation. The pulse was recorded manually and a wristwatch was used to receive the data (beat min<sup>-1</sup>). The heart rate was measured every 30 min during operation and the average reported. A stethoscope and sphygmomanometer (Model: ALP k2, made in Japan) was used to measure the blood pressure of the operators at the same time. A manual sphygmomanometer was used in conjunction with a stethoscope. The blood pressure of the operators was measured every 30 min during operation. [Figure 01](#) and [Figure 02](#) show the stethoscope and sphygmomanometer for measuring the blood pressure.



Figure 01. Stethoscope



Figure 02. Sphygmomanometer

### Oxygen consumption rate

The oxygen consumption is usually measured as the oxygen rate is uptaken in the lung of the human body. The normal value of oxygen consumption is 250 ml min<sup>-1</sup> or 3.5 to 4.0 ml kg<sup>-1</sup> min<sup>-1</sup> and it increases with the increasing metabolic rate. The oxygen consumption rate of the operator was calculated from the heart rate of operator using the following equation (1) ([Singh et al., 2008](#)).

$$\text{OCR} = (0.0114 \times \text{HR}) - 0.68 \dots \dots \dots (1)$$

Where,

OCR= Oxygen consumption rate (l min<sup>-1</sup>) and

HR= Heart rate (beat min<sup>-1</sup>)

### Energy expenditure rate

The energy expenditure rate was measured the stress level of body and it can be used to evaluate the level of effort of work until the rest period was necessary and to relate the efficiency of different tools and well organizing the work. [Tewari et al. \(1991\)](#) suggested that the heart rate at resting level and at 6<sup>th</sup> to 15<sup>th</sup> minute after operation were evaluated because of computing the physical reactions of the operators. The heart rates at 30 minutes of operation for each operator were used to calculate the mean

heart value. The energy expenditure rate of the operator was calculated from the heart rate values of operator using the following equation (2) (Saha et al., 1979).

$$EER = \frac{(HR - 66.0)}{2.4} \dots\dots\dots (2)$$

Where,

EER= Energy expenditure rate (kJ min<sup>-1</sup>) and  
 HR= Heart rate (beat min<sup>-1</sup>)

The physical workload of operators was categorized based on energy expenditure and heart rate depending on the stresses in different types of work given by the Indian Council of Medical Research (ICMR) report (Table 03).

**Table 03. Gradation of physical workload of operator**

Grading	Pulse rate (beats min <sup>-1</sup> )	Oxygen absorption (l min <sup>-1</sup> )	Energy expenditure (kcal min <sup>-1</sup> )
Very slight	<75	<0.35	<1.75
slight	75-100	0.35-0.70	1.75-3.5
Tolerantly heavy	100-125	0.70-1.05	3.5-5.25
Heavy	125-150	1.05-1.40	5.25-7.00
Very heavy	150-175	1.40-1.75	7.00-8.75
Unduly heavy	>175	>1.75	>8.75

**Rest pause during work**

The optimal work output can gain to require enough rest period during each laborious work in the field. The work rest period can be properly maintained to get better performance of the operators during any operation. The working rest period was obtained from the cessation of the workings until the pulse rate of the operator attains the resting level. The rest period to the operator was calculated by the following equation (3) (Murrell, 1965).

$$R = \frac{T(K-5)}{K-1.5} \dots\dots\dots (3)$$

Where,

R= Rest period, minute  
 T=Total workable time, minute and  
 K= Energy expenditure during workable task kcal min<sup>-1</sup>,  
 Value 5 kcal min<sup>-1</sup> is average level of energy expenditure as standard and  
 Value 1.5 kcal min<sup>-1</sup> is an approximation of resting level.

**III. Results and Discussion**

**Ergonomic evaluation of the operators**

**Heart rate variation**

Three operators were partaken in the study and the energy output rate was measured from the pulse rate during weeding operation. Each trial of all operators was worked out for 30 minutes of weeding. The heart rate of the operators increased erectly from the starting of the workable condition and became stable of 135 to 141 beats min<sup>-1</sup> after 30 minutes of the operation. The mean working heart rate was found to be 134.67, 137.33 and 138.67 beats min<sup>-1</sup> for operators O<sub>1</sub>, O<sub>2</sub> and O<sub>3</sub> respectively (Figure 03). Resting heart rate of all operators was found to be 72, 78 and 75 beats min<sup>-1</sup> respectively. The weeding operation was started; the heart rate of the operators was gradually increased within 30 minute. During rest time, the heart rate was gradually decreased and come back into initial situation.

Figure 03 shows that heart rate was positively and strongly correlated with the number of trials (R<sup>2</sup> = 0.986, 0.964 and 0.986 of three operators). For O<sub>1</sub>, the increased heart rate with no. of trial was less

compared to O<sub>2</sub> and O<sub>3</sub> because the body mass index (BMI) of O<sub>1</sub> was more than other operators. So heart rate depends on operator's BMI, age etc. The maximum heart rate was found 137 to 141 beats min<sup>-1</sup>. Therefore, these operators will not be operated more time without any rest time.

Figure 04 shows that the heart rate was strongly correlated with the revive time of different trials ( $R^2 = 0.98, 0.953$  and  $0.980$  of three operators). The rest time of 1<sup>st</sup> trial was revived to few times for each operator. The rest time of other trial was revived to more times than 1<sup>st</sup> trial. The no. of trial was increased with increasing rest time to come back into the previous normal heart rate condition.

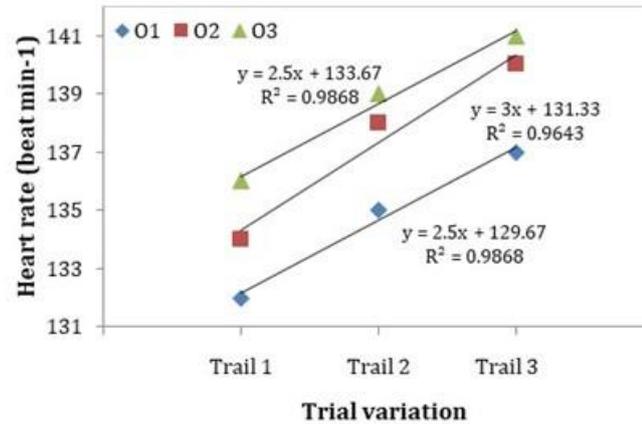


Figure 03. Heart rate variation with different trail

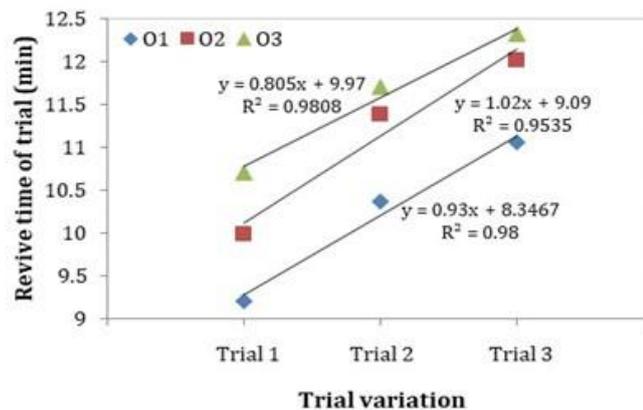
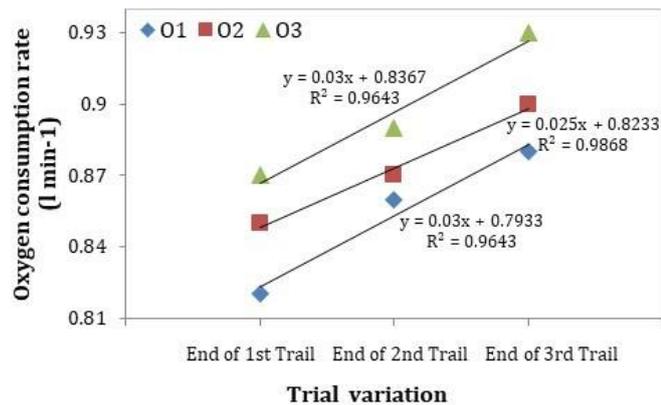


Figure 04. Revive time variation with different trail

### Oxygen consumption rate

The oxygen consumption rate is essentially an absolute measure of workload, whereas heart rate is an indicator of cardiac stress due to physical workload. The oxygen consumption rate was calculated from equation (1) and it was found to be 0.86, 0.89 and 0.90 l min<sup>-1</sup> for operators O<sub>1</sub>, O<sub>2</sub> and O<sub>3</sub> respectively. The highest oxygen consumption rate of 0.93 l min<sup>-1</sup> was observed for operator O<sub>3</sub>, followed by operator O<sub>2</sub> (0.92 l min<sup>-1</sup>) and operator O<sub>1</sub> (0.88 l min<sup>-1</sup>). Sam (2016) reported that the expected oxygen absorption rate was 0.971 l min<sup>-1</sup> as the aerobic efficacy was 47% and the permissible limitation of 35% of aerobic efficacy was high.

Figure 05 shows the oxygen consumption rate variation with end of different trials during weeding operation. It is clear from Figure 05 that the oxygen consumption rate was gradually increased with end of next trial. Oxygen consumption rate was strongly correlated with the number of end of trial ( $R^2 = 0.964, 0.986$  and  $0.964$  of three operators). The typical oxygen consumption rate value is usually 0.2 l min<sup>-1</sup>. During the field operation, the maximum oxygen consumption rate was reaching up 0.88 to 0.93 l min<sup>-1</sup>, hence operator must take periodic rest for efficient operation. The oxygen consumption rate of end of 2<sup>nd</sup> and 3<sup>rd</sup> trials was more compared to end of 1<sup>st</sup> trial because the heart rate of all operators of 1<sup>st</sup> trial was less than other trials in weeding operation.

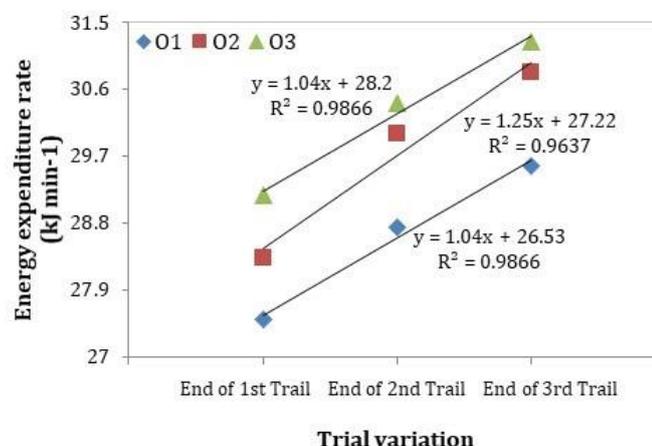


**Figure 05. Oxygen consumption rate variation with end of different trial during weeding operation**

### Energy expenditure rate

The energy expenditure for weeding operation by BRRRI multi-row power weeder for all the operators was worked out on the basis of the mean heart rate for the period of operation. The average workable heart rates were found to be 134.67, 137.33 and 138.67 beats  $\text{min}^{-1}$  for operators  $O_1$ ,  $O_2$  and  $O_3$  respectively. Sam (2016) reported that the mean workable heart rate of the operator was 110 beats  $\text{min}^{-1}$  and the expected oxygen absorption rate from the calibration graph was 0.971  $\text{l min}^{-1}$  and the equivalent energy expenditure was 20.27  $\text{kJ min}^{-1}$ . The rate of energy expenditure was worked out from equation (2) and it was found to be 28.61, 29.72 and 30.28  $\text{kJ min}^{-1}$  during weeding operation for operators  $O_1$ ,  $O_2$  and  $O_3$  respectively. Based on heart rate, the weeding operation was categorized as 'heavy'- work.

Figure 06 shows the energy expenditure rate variation with end of different trials during weeding operation. It is clear from Figure 06 that the energy expenditure rate was strongly correlated with the number of end of trial ( $R^2 = 0.986$ , 0.963 and 0.986 of three operators). The energy expenditure rate was gradually increased with the end of different trials. The energy expenditure rates of end of 2<sup>nd</sup> and 3<sup>rd</sup> trials were more compared to end of 1<sup>st</sup> trial because in weeding operation the heart rate of each operator of 1<sup>st</sup> trial was less than other trials. The maximum energy expenditure rate was found 29.58 to 31.25  $\text{kJ min}^{-1}$ . It was observed that the energy expenditure rate was varied among the operators of different trials for the same implement under similar conditions and it may be due to the variation of strength and skill level of the operators.



**Figure 06. Energy expenditure rate variation with end of different trial during weeding operation**

### Rest pause during work

The rest pause for weeding operation was presented in Table 04. The calculated rest pause was compared with the actual rest pause taken by the operators in the field to reach the heart rate to a normal level. After 30 minutes of work, the rest was given to the operators and it was found that a rest for 11 minutes was needed for each of the operators to recover to the normal position. Sam (2016) reported that all operators carried on the operation continually for the 30 minutes duration and 9 minutes rest of work could be taken to the operator for 8 hours of a day who was involved in operating system. Two operators were employed in cyclic system for weeding to enlarge the consolation of the operators and to maintain the efficiency of the implements.

**Table 04. The rest pause calculated for the operators during weeding operation**

Operators	Total working time (min)	Mean energy cost (kJ min <sup>-1</sup> )	Rest time (min)	Proposed work rest cycle
O <sub>1</sub>	30	28.61	10.23	30 minutes of work
O <sub>2</sub>	30	29.72	11.17	followed by 11 min rest
O <sub>3</sub>	30	30.28	11.61	with two operators

### IV. Conclusion

The ergonomic performance of BRRi multi-row power weeder was almost favorable condition for human body. Ergonomic parameters like heart rate, oxygen absorption rate and energy expenditure rate were increased during weeding operation for all the operators. The operation of BRRi multi-row power paddy weeder based on heart rate was graded of heavy. The weeding operation for the operator could be secure in ergonomically as 11 minutes of rest to operator may be taken to come to the normal heart rate after the operation of 30 minutes duration. Otherwise, the physiological condition of operators may be disordered due to more than 30 minutes of work continuously. It is suggested that the BRRi multi-row power paddy weeder under silty loam soil condition could be operated continually 30 minutes of operation followed by 11 minutes rest pause for 8 hours of a day. It is also proposed that two operators may be involved in an alternative to work for a long day with BRRi multi-row power paddy weeder.

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### References

- [1]. Biswas, H. S. (1990). Soil tool interaction for mechanical control of weeds in black soils. Unpublished Ph.D. thesis, Indian Institute of Technology, Kharagpur.
- [2]. Gite, L. P. and Singh, G. (1997). Ergonomics in agricultural and allied activity in India. CIAE Technical Bulletin No.CIAE/97/70, pp. 12-14.
- [3]. Hossain, S. M. A. (2006). Personal communication. Professor, Dept. of Agronomy, Bangladesh Agricultural University, Mymensingh.
- [4]. Mungale, A. D. (2007). Design and development of rotary power weeder. M. Tech (Agril. Engg.) Unpublished Dissertation Work submitted to CAET, JAU, Junagadh, pp. 71-73.
- [5]. Murrell, K. F. H. (1965). Human Performance in Industry. Reinhold Publishing Corporation, New York, USA.
- [6]. Puniya, R., Pandey, P. C., Bisht, P. S. and Singh, D. K. (2007). Nutrient uptake by crop and weeds as influenced by Trisulfuron, Trisulfuron + Pretilachlor and Bensulfuron-methyl in transplanted rice (*Oryza sativa* L.). Indian Journal of Weed Sci., 39(3&4), 239-240.
- [7]. Rao, V. S. (1999). Principles of Weed Science. Santa Clara California USA. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, 1-3, 1-58.
- [8]. Saha, P. N., Datta, S. R., Banerjee, P. K. and Narayane, C. G. (1979). An acceptance workload for Indian workers. Ergonomics, 22(9), 1059-1071. <https://doi.org/10.1080/00140137908924680>

- [9]. Sam, B. (2016). Development and ergonomic evaluation of a three row power paddy weeder for wetland paddy cultivation. *International Journal of Engineering Research and Development*. e-12(1), 68-73.
- [10]. Singh, G. (1988). Development and fabrication techniques of improved grubber. *Agricultural Mechanization in Asia, Africa & Latin America*, 19(2), 42-46.
- [11]. Singh, S. P., Gite, L. P., Majumder, J. and Agarwal, N. (2008). Aerobic capacity of Indian farm women using sub-maximal exercise technique on tread mill. *Agricultural Engineering International: The CIGR E-Journal*, 10.
- [12]. Tewari, P. S. and Gite, L. P. (1998). Human energy expenditure during power tiller operation. Paper presented during XXXIII Annual Convention of ISAE held at CIAE, Bhopal, September, pp. 21-23.
- [13]. Tewari, V. K., Datta, R. K. and Murthy, A. S. R. (1993). Field performance of weeding blades of a manually operated push-pull weeder. *Journal of Agricultural Engineering Research*, 55, 129-141. <https://doi.org/10.1006/jaer.1993.1038>
- [14]. Yadav, R. and Pund, S. (2007). Development and ergonomic evaluation of manual weeder. *Agricultural Engineering International: the CIGR Ejournal*. Manuscript PM 07 022, 9, 1-9.

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