ERGONOMICAL EVALUTION OF MANUALLY OPERATED WEEDER

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Abstract:

For increase the productivity per unit area of small land holdings and considering the economic condition of Indian farmers, it is quite necessary to have suitable agricultural implements which farmers can use and also allow them to use for custom hiring. Weeding is an important agricultural unit operation. Delay and negligence in weeding operation affect the crop yield up to 30 to 60 per cent. Hence present investigation was undertaken with an objective to evaluate performance of manually operated weeder from ergonomics point of view. Present investigation was undertaken in Nagpur, Maharashtra state during the year 2010-2011. For this investigation farmers and farm workers are selected randomly from Nagpur district. Ergonomically parameters like heart rate, oxygen consumption rate and energy expenditure are evaluated while performing the weeding activity. Heart rate readings of form workers show that manually operated weeder is comfortable for farm workers in weeding operation. That's why increase the efficiency of farm workers and increase the productivity of work. This shows that manually operated weeder is the instrument of drudgery reducing technology for form workers. At each level of moisture content heart rate and energy expenditure rate was greater in traditional method of weeding (khurpi) than weeding by manually operated weeder.

Keywords: Weeder, heart rate, oxygen consumption rate and energy expenditure.

Note: This research is part of first authors Ph.D. work

INTRODUCTION:

Weeding is one of the most important farm operations in crop production system. Weed growth is a major problem for dry land and wet land crops causing a considerable lower yield. Manual weeding requires huge labour force and accounts for about 25 per cent of the total labour requirement. In India this operation is mostly performed manually with khurpi or trench hoe that requires higher labour input and also very tedious and time-consuming process. Moreover, the labour requirement for weeding depends on weed flora, weed intensity, time of weeding and soil moisture at the time of weeding and efficiency of worker. Often several weeding are necessary to keep the crop weed free. Reduction in yield due to weed alone is estimated to be 16-42 % depending on crop and location and involves 1/3 rd of the cost of cultivation (Rangasamy et al, 1993). Weeding and hoeing is generally done 15-20 days after sowing. The weed should be controlled and eliminated at their early stage. Depending upon the weed density, 20-30 per cent loss in grain yield is quite usual which might increase up to 80 per cent if adequate crop management practice is not observed.

Various types of cutting blades are used for manually operated weeder. Where weeders are continuously pushed, V–shape sweep is preferred and tool geometry of these cutting blades is based on soil-tool-plant interactions. Due to fragmented land holding the use of mechanized weeders are very limited. Though many manually operated weeders are available they are not popular because farmers feel it to be heavy as compared to conventional hoes For mechanical control of weeds, mostly human and animal powers are utilized. Mechanical weed control not only uproots the weeds between the crop rows but also keeps the soil surface loose, ensuring better soil aeration and water intake capacity. Manual weeding can give a clean weeding, but it is a slow process (Biswas, 1990).

Singh (1992) developed a wheel hoe weeder with ergonomic considerations to improve its design and for commercialization through small-scale manufacturers. It required 60-110 manh/ ha for weeding in black heavy soil and 25 man-h/ha in light soil. Kumar et al., (2000) evaluated hand weeder operation on ergonomic basis using simulated actuary motion. Subjects with distinct anthropometric characteristics were evaluated ergonomically on the simulator with loading of 20 to 120 N increased in steps of 20 N. The subjects' responses were also studied while operating the weeders in the field. The results indicated that the pushpull actuation of manual weeders contributed the maximum continuous load application of 60 N with least fatigue. The simulation studies on actuary motion were able to assess the

man machine interaction accurately. Hence present investigation was undertaken with an objective to evaluate performance of manually operated weeder from ergonomics point of view.

MATERIAL AND METHODS:

Present investigation was undertaken in Nagpur , Maharashtra state during the year 2010-2011. For this investigation farmers and farm workers are selected randomly from Nagpur district. The field performance of the developed weeder was evaluated in the field of cotton, soyabean and groundnut crops.

The present study was conducted in order to evaluate manually operated weeder with ergonomic point of view. To meet the objectives of the present study the following procedure was adopted.

1. Selection of Subjects

The subjects selected were in the age group of 18-45 years because they usually attain their highest strength level between 20-45 years.

2. Calibration of the Subjects

The subjects were calibrated in the laboratory with a treadmill to determine their maximum sustainable heart rate (HR max) and oxygen consumption rate (VO2 max). The resting heart rate (HR rest), oxygen consumption rate at rest (VO2 rest) and the blood pressure was measured at rest and 15 minute prior to any experiment.

3. Measurement of HR, OCR, and EER

The HR work and the OCR (VO2 work) was measured between 6th to 20th minute of work of each subject as it is considered that the heart rate gets stable after 3-5th minute of the work. The average HR and OCR has been taken as representative value for each subject for the working duration. The HR was measured by polar heart rate monitor (Model S-810) of Polar make with an accuracy of ± 1 beat/min. The polar transmitter detects the HR and transmits it to the wrist receiver. Twenty observations were taken between 6-20th minutes and the average was taken as the representative HR. The OCR had been measured by Metamax – II having volume transducer, oxygen and CO2 analyzer, and temperature and pressure sensors. The accuracy of the oxygen analyzer is 0.1 % by volume. Twenty observations were

taken between 6-20th minutes and the average will be taken as the representative OCR. The blood pressure shall be measured by a sphygmomanometer (Novaphon-300).

The energy expenditure was calculated from the heart rate responses of the subjects using the formulae given by Varghese.

Energy Expenditure (kj/min) = 0.159 x HR – 8.52

Where,

EER measured in kj/min; and

HR is the heart beat rate in beats/min.

RESULT AND DISCUSSION:

Table No. 1. General Information of Land Holders (N=500)

Sr. No.	General Information	Frequency	Percentage
1.	Land holders		
	a) Marginal farmers (up to 1 ha)	69	13.80
	b) Small farmers (1-2 ha)	173	34.60
	c) Medium farmers (2-6 ha)	218	43.60
	d) Big farmers (6 ha & above)	40	8
2.	Annual income of land holders (yearly)		
	a) Low (up to Rs. 25000)	227	45.40
	b) Medium (Rs. 2500-7500)	221	44.20
	c) High (Rs. 7500 and above)	52	10.40
3.	Type of land		
	a) Dry land	368	73.60
	b) Wey land	132	26.40

Table shows that 13.80 percent land holders are having 1 ha land, whereas 34.60 percent land holders are having 1-2 ha land, 43.60 percent land holders are having 2-6 ha land and 8 percent land holders are having 6 ha and above land respectively.

Annual income shows that 45.40 percent land holders are belongs to low income group while 44.20 percent land holders are belongs to medium income group and 10.40 percent land holders are belongs to high income group respectively. Type of land shows that 73.60 percent of land holders are having dry land whereas 26.40 percent are having wet land.

Table No. 2. Economical evaluation of farm workers in weeding operation on cotton cropped by developed manually operated weeder

Subject	**Heart beats (beats/min)**	**ΔHR (beats/min)**	**Increase in heart rate (beats/m^2)**	**Output m^2/h**
Subject – 1	123.99	29.44	11.45	154
Subject – 2	124.12	29.78	13.18	135
Subject – 3	122.48	32.97	13.81	143
Subject – 4	127.59	36.44	20.24	108
Subject – 5	128.29	29.24	14.62	120
Subject – 6	124.84	35.28	18.40	115
Subject – 7	124.96	32.35	12.70	150
Subject – 8	127.38	28.19	15.66	120
Subject – 9	123.56	28.09	12.48	135
Subject – 10	126.62	28.80	14.45	122
Mean	125.39	31.05	14.70	130
S.D.	4.78	2.42	1.92	6.12

Note: Readings shows average of five replication.

Table shows that ergonomical evaluation of farm workers in weeding operation on cotton crop. For the ergonomical evaluation of farm workers polar heart rate monitor is used. Readings in the table shows average of 5- replication. Mean value of heart rate were 125-39 beats/min while mean value of ΔHR were 31.05 beats/min, mean value of increase in heart rate were 14.70 beats/m^2 and workout put of form workers is 130m^2/h.

Table conclude that heart rate readings of form workers shows that developed manually operated weeder is comfortable for farm workers in weeding operation. That's why increase the efficiency of farm workers and increase the productivity of work. This shows that developed manually operated weeder is the instrument of drudgery reducing technology for form workers. Yadav and Pund (2007) reported the Peak heart rate were 143, 142 and 150 beats/min for subjects 51, 52 and 53 respectively.

Table No.3. Ergonomical Performance of Weeding Activity at Various Soil Moisture Content.

Preatments	**Moisture Content (%)**	**Increased heart rate (ΔHR) (Beats/min)**	**oxygen consumption rate(Vo2) (li./min.)**	**Energy Consumption Rate (kj/min)**
Weeding by traditional method (khurpi)	13.52	31.27	1.82	24.75
	11.63	33.28	1.98	33.11
	9.52	38.42	2.49	47.14
Weeding by developed manually operated weeder	13.52	14.38	0.45	9.28
	11.63	18.72	0.82	14.56
	9.52	23.34	1.89	27.73

It was observed that with decrease in soil moisture content, the ΔHR of all the treatments increased. At 9.52 percent moisture content, ΔHR was found to be maximum followed by 11.63 and 13.52 percent moisture content for all the treatments. The lowest ΔHR at 13.52 percent moisture content due to the soft condition of soil that required less effort during weeding operation. It was observed that oxygen consumption rate (Vo2) of all the treatments increased with decrease in moisture content and were highest at 9.52 percent

moisture content. This may be due to the reason that with decrease in moisture content hardness of soil increased and the worker had to push the weeder at comparatively greater force. Energy consumption rate was determined for all the treatments and it was found that at each level of moisture content, the energy expenditure rate was highest.

Table conclude that at each level of moisture content HR, and energy expenditure rate was greater traditional method of weeding (khurpi) than weeding by developed weeder.

Goel et al (2008) reported that ergonomics parameters like increased heart rate, oxygen consumption rate and energy consumption rate increase with decrease in soil moisture content for all the treatments.

CONCLUSION:

Heart rate readings of form workers show that developed manually operated weeder is comfortable for farm workers in weeding operation. That's why increase the efficiency of farm workers and increase the productivity of work. This shows that developed manually operated weeder is the instrument of drudgery reducing technology for form workers. At each level of moisture content HR, and energy expenditure rate was greater traditional method of weeding (khurpi) than weeding by developed weeder.

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