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**Amita Gautam**  
Ph. D Scholar (FMPE),  
Department of Farm Machinery  
and Power Engineering,  
SVCAET&RS, FAE, IGKV,  
Raipur, Chhattisgarh, India

**Dr. SV Jogdand**  
Ph. D Scholar (FMPE),  
Department of Farm Machinery  
and Power Engineering,  
SVCAET&RS, FAE, IGKV,  
Raipur, Chhattisgarh, India

**Omprabha**  
Ph. D Scholar (FMPE),  
Department of Farm Machinery  
and Power Engineering,  
SVCAET&RS, FAE, IGKV,  
Raipur, Chhattisgarh, India

**Corresponding Author:**  
**Amita Gautam**  
Ph. D Scholar (FMPE),  
Department of Farm Machinery  
and Power Engineering,  
SVCAET&RS, FAE, IGKV,  
Raipur, Chhattisgarh, India

## Ergonomic study of farm women for selected agricultural implements

**Amita Gautam, Dr. SV Jogdand and Omprabha**

### Abstract

Agricultural operations mostly done by women agricultural workers. In India 50-60% of women force is engaged in agriculture. Ergonomical parameters like working heart rate, oxygen consumption rate, energy expenditure rate of women workers were evaluated in different selected agriculture operation. The average working heart rate and oxygen consumption rate obtained were evaluated respectively for weeding by Ambika paady weeder and hand weeding, harvesting by serrated sickle and traditional sickle, threshing by paddy thresher and hand beating operation and also for winnowing operation. The mean EER were 9.3kJ/min, 9.9kJ/min, 8.8kJ/min, 9.5kJ/min, 7.5kJ/min, 9.5kJ/min, 8.6 kJ/min, and 9.3kJ/min for the above operations. Out of these operations weeding operation requires more effort and can be categorized as 'Moderate heavy' type of operation and threshing by paddy thresher was require less effort and categorized as 'Light' type of operation due to pattern of work.

**Keywords:** ergonomics, women, working heart rate, oxygen consumption rate, energy expenditure rate, drudgery

### Introduction

Rice is the staple food of India and its cultivation is the main occupation for generation. India is the world's second largest rice producer and consumer next to China. Chhattisgarh known for rice cultivation and called "rice bowl" Rice (*Oryza sativa* L.) is one of the most leading food crops in the world within the worldwide-cultivated cereals in terms of annual food consumption (Alizadeh, 2011) [1]. Female agricultural workers play dominant role in increasing production and productivity of Rice. They are involved in various agricultural operations like weeding, harvesting, threshing, winnowing and processing of the crop. Weeds can be potential carriers of infections, fungus, other diseases and insects, which can contaminate the crops. Weeding operation is one of the most labor involving activity. The participants vary with region, crops, commodities and socio-economic status. Many of the operation are arduous and require bent or crouched postures for extended hours of work. This is injurious to their health. (Behera and Swani, 2005) [2] reported that manually operated weeders have found acceptability due to their low cost. According to Nag and (Dutt, 1979) [6, 7], manually operated weeders need human effort to operate. Efforts are still on to reduce the drudgery in weeding operation (Khogare and Borkar, 2012) [5]. Rice harvesting is also a major task performed by farm women, Majority of the farm women perform this activity by local sickle with bending and squatting posture for longer time, this method is full of drudgery. If they continue to work in this posture for long duration without adopting any other posture due to which they reported severe pain in lower back, knees and cervical region (Jyotsna *et al.*, 2005) [4]. The performance of any machine especially manually operated ones could be considerably improved if ergonomic aspects are given due consideration (Gite, 1993) [3]. Present study was done for analyze the human energy expenditure and discomfort experienced by the female labours during operation of weeding by Ambika paddy weeder and manual weeding, harvesting by serrated sickle and traditional sickle, threshing by paddy threshing and hand beating operation and winnowing by fan winnowing and natural air stream operation of winnowing.

### Materials and Methods

#### Subjects and Field activity

Ten female subjects in age group 25-50 years were randomly chosen. They were designated as S<sub>1</sub>, S<sub>2</sub>, S<sub>3</sub>, S<sub>4</sub>, S<sub>5</sub>, S<sub>6</sub>, S<sub>7</sub>, S<sub>8</sub>, S<sub>9</sub> and S<sub>10</sub> respectively. They were screened for normal health with medical investigations. The medical investigations include blood pressure, pulse rate, etc. These subjects were used in the field trials for manual weeding, harvesting, threshing and winnowing operations. Each subject was replicated three times.

The subjects were required to do the rice farming operations namely, weeding by Ambika paddy weeder (Operation 1) and hand weeding (Operation 2), harvesting by serrated sickle (Operation 3) and traditional sickle (Operation 4), threshing by paddy thresher (Operation 5) and hand beating operation (Operation 6) and winnowing by Fan (Operation 7) and natural winnowing (operation 8) according to time. The field experiments were conducted two times a day, at different time intervals i.e., from 8 to 12 am and 2 to 5 pm in order to find out the change in energy expended and heart rate due to environmental condition. A randomized field layout design was considered. The field was according to crop requirement and without any lodging of crop

### Data collection and Analysis

All the ten subjects were equally trained in the different selected

operation before the actual experiment. In starting after 30 minutes of resting, the subject was asked to operate the Ambika paddy weeder (already started by another person) for weeding. The heart rate was measured and recorded using digital monitor for the entire work period. Each trial was carried out for 10-15 minutes of duration with rest and same procedure was repeated to replicate the trials for all the selected subjects. The physiological response of the subjects while selected operation were also assessed to compare the energy expenditure in manual and mechanized operation. From the obtained value mean values of heart rate (HR) observe during the trails, then corresponding value of oxygen consumption values were calculated by using formula.



**Fig 1:** Physiological cost assessment for female subject during different operation (a) Weeding by Ambika paddy weeder (b) manually weeding (c) harvesting by serrated sickle (d) hand beating

### Assessment of physiological cost of work

The physiological response of the subjects while selected operation. From the mean values of heart rate (beats/min) observed during the trials, the corresponding values of oxygen consumption rate (l/min) of the subjects were computed from the heart rate value of the operator and given by the following equation.

$$\text{Oxygen consumption rate (l/min)} = 0.0114 \times \text{HR (beats/min)} - 0.68 \quad \dots(1)$$

The energy expenditure (kJ/min) of the operations was also computed by the following formula proposed by Varghese *et al.* (1994) [9].

$$\text{Energy expenditure} = 0.159 \times \text{HR (beats/min)} - 8.72 \quad \dots(2)$$

The energy costs for all selected operations were graded as shown in Table 1. Varghese *et al.*, (1994) [9].

The results were statistically analyzed using an analysis of variance technique (ANOVA) by following Factorial randomized block design (FRBD) to assess the effect of mode of operation and time of operation on energy cost for Weeding, harvesting, threshing and winnowing operations.

**Table 1:** Classification of workload

Physical workload	Physiological variables	
	HR (beats/min)	EER (kJ/min)
Very light	Up to 90	Up to 5
Light	91 – 105	5.1-7.5
Moderately heavy	106-120	7.6-10.0
Heavy	121-135	10.1-12.5
Very heavy	135-150	12.6-15.0

## Results and discussion

Analysis of data indicates reduction in percentage of average working heart rate as well as energy expenditure with use of improved tools. It was clearly depicted that Ambika paddy weeder proved efficient on ergonomics parameters as it reduced average working heart rate and energy expenditure along with increased when compared with traditional method. The results showed that mode of operation and time of operation significantly influenced the physiological responses. It is observed that the average working heart rate and oxygen consumption rate were 113.1 beats/min and 117 beats/min, 110.4 beats/min and 114 beats/min, 103.8 beats/min and 114.5 beats/min and 109.1 beats/min and 113.1 beats/min, and 0.61 l/min and 0.65 l/min, 0.58 l/min and 0.62 l/min, 0.50 l/min and 0.63 l/min, and 0.56 l/min and 0.61 l/min,

respectively for weeding by Ambika paddy weeder and manual weeding, harvesting by serrated sickle and traditional sickle, threshing by paddy thresher and hand beating process and winnowing by fan and natural air stream winnowing operation respectively.

The mean working energy consumption obtained were 9.3 kJ/min, 9.9 kJ/min, 8.8 kJ/min, 9.5 kJ/min, 7.5 kJ/min, 9.5 kJ/min, 8.6 kJ/min, and 9.3 kJ/min same as above written operation. According to the Table1 given by Varghese *et al.*, (1994) [9] graded as Manual weeding is graded as 'Moderately heavy and threshing by paddy thresher was graded as 'Light' operation. Manual operation shows dangerous because due to bending and squatting position of the operator. It can be reduced by using improved machinery which are designed by the ergonomical consideration.

**Table 2:** Analyzed data in different operation performed in farm with farm women

Operations	Working Heart rate (beats/min)	$\Delta$ HR (beats/min)	Oxygen Consumption Rate (l/min)	Energy Expenditure rate (kJ/min)
Weeding by Ambika paddy weeder	113.1	39.7	0.61	9.3
Manual weeding	117.0	42.3	0.65	9.9
Harvesting by serrated sickle	110.4	35.7	0.58	8.8
Harvesting by traditional sickle	114.0	38.6	0.62	9.5
Threshing by paddy thresher	103.8	29.2	0.50	7.5
Hand beating operation	114.5	28.8	0.63	9.5
Winnowing by fan	109.1	35.8	0.56	8.6
Winnowing by natural air flow	113.1	38.1	0.61	9.3

## Conclusions

The value of all physiological parameters increases with the duration of operation. These values were higher in the afternoon session of work as compared to forenoon session. The highest energy expenditure was obtained was 9.9 kJ/min for manual weeding operation, this is due to bending posture of operators because during the whole process of hand weeding operation was done in bending position, due to this operator experience heavy energy expenditure. It was observed that use of improved tools, posture and efficiency of worker increase. The body discomfort reduced with use of Ambika paddy weeder because it employed standing posture eliminating muscular fatigue and excessive loading of inter-vertebral discs of backbone. This proved that weeder are ergonomically sound, women friendly, drudgery reducing and improves efficiency of women. Evaluation of drudgery level shows that manually weeding is the highest drudgery involving operation, whereas threshing by paddy thresher was found to be lowest drudgery involving operation. This dangerous operation leads to many serious health issues in operator to overcome this improved tool and machine should be adopted by the operator.

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