

Women Friendly Agricultural Implements for Drudgery Reduction

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ABSTRACT: Agricultural operations mostly done by women agricultural workers. Ergonomical parameters like Working heart rate, Oxygen consumption rate, Energy expenditure rate, Relative Cost of Work Load of women workers were evaluated. Twelve subjects from the age group of 18-45 years were selected for the above study. The mean height, weight or Body surface area were found 152 cm, 51.7kg and 1.52m². The VO₂ max and body max index of women subjects was to be in the range of 1.56 to 1.81 lit/min and 20.5 to 23.3 kg/m². These women workers were evaluated in different agricultural operation like weeding by mandwa weeders, transplanting by 4 row paddy transplanter, harvesting by improved sickle, threshing by pedal thresher and winnowing by winnower fan. The working heart rate and oxygen consumption rate were recorded to be 134.8 and 1.19, 128.4 and 0.85, 102 and 0.62, 124.3 and 0.76, 120.4bpm and 0.79 lit/min respectively for 4 row transplanter, mandwa weeder, improved sickle, pedal thresher and winnowing fan respectively. The mean value of energy expenditure rate was observed to be 24.9, 17.8, 13.0, 15.9 and 16.5 kJ/min for the above operations. The relative cost of work load was recorded to be maximum 70 percent in 4 row transplanter and lowest 36.5 percent in case of harvesting with improved sickle. Out of these selected operations transplanting and weeding operations required more effort and can be categorized as heavy type of operation. The maximum operating time for sickle was recorded highest 52 min where as the workers could operate the transplanter continuously for 20 min. Based on these results the four row paddy transplanter and winnower fan are to be modified for women workers for minimum physiological cost, muscular fatigue and less drudgery.

Index Terms: Ergonomics, Women, Working heart rate, Oxygen consumption rate, Energy Expenditure Rate, Drudgery.

INTRODUCTION

Over 70 per cent of Indian population resides in the villages engaged in farming and related activities. About 40 percent of the work forces engaged in agriculture are women. Women are involved in most of the farming and related activities. Besides their exclusive involvement in domestic life, women do the extremely tedious and labour intensive work from the land preparation (bund making), sowing, transplanting, weeding, harvesting, threshing, and transporting and post-harvest operations. These jobs involve considerable amount of drudgery because it is mostly done manually. The women not only contribute to crop production process but also in decision making as regard to crop management, marketing etc., hence are very important to Indian agriculture. The majority of women folk continue to use age-old local tools and implements, which are slow in operation and cause considerable fatigue and

drudgery during operation. Beating in bundles and bullock treading are still adopted in some parts of coastal districts of Orissa. Due to decrease of bovine population after the super cyclone the only way for paddy threshing operation is by manual method. Pedal operated paddy threshers are now available in Orissa, which are mostly operated by female workers. The drudgery and fatigue involved in these operations are necessary to be evaluated ergonomically. As many farm operations are done by female agricultural workers the drudgery, fatigue faced by them need to be intervened to make the work comfortable and productive. Agricultural ergonomics emerges as a potential discipline for whole range of applications in farming methods and practices. This discipline specifies application of those work sciences relating human performance to the improvement of work system in farming activity. It comprises the person, the jobs, the tools and implement and the working environment.

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A. Drudgery in Agricultural Operation

Human labour is the single costliest input in transplanting, weeding, harvesting and threshing operations contributing to major part of the total cost of cultivation. Hence, there is an urgent need to study the ergonomic aspects in detail to quantify the drudgery involved in the use of transplanters and threshers used by female agricultural workers. This would greatly help the researchers to appropriately design simple and labour effective gadgets considering ergonomic requirements. Such designs of implements would not only minimize drudgery during operation but also increase productivity at reduced cost of cultivation.

B. Review of Literature

A pedal operated dry bean thresher for small-scale farmers was designed by E.I. Lazaro (1997). This thresher was tested for its threshing capacity, threshing effectiveness and seed damage on two improved bean varieties Tmo-241 and Tmo-216. Results obtained gave a threshing capacity of 26.4kg/hr and 27.6kg/hr for Tmo-241 and Tmo-216 respectively. Threshing effectiveness was 93.4 and 93.1 for Tmo-241 and Tmo-216 respectively and seed damage was 1.5 percent for Tmo-241 and 1.4percent for Tmo-216. Studies carried out on comparative performance of rasp bar and wire loop cylinders and it was shown that in comparative study the wire loop, irrespective of feed rate and moisture content showed higher threshing efficiency at lower speed and at all concave settings. The rasp bar gave higher percentage of husked grain than wire loop for all levels of peripheral speeds and at all three concave settings. At lower concave clearance of 3.1 mm and peripheral speed of 33.35 m/s, the grain damage of rasp bar was 7 times than wire loop at dry m.c. and 8 times at wet m.c. However this difference decreased as the concave clearance increased and the peripheral speed decreased.

It was observed that to achieve reasonable income with a limited input of capital and human effort for managing and operating a farm, mechanization and realization of farm operations were necessary [8]. According to him the human factors especially application of ergonomics could assist the farmers to have a reasonable living. Further, he emphasized on coordination of ergonomic researches and exchange of information to obtain the necessary design data on farm machinery in order to realize man-machine relationship thereby enhancing the capacity and a favorable load on the worker. The relation between

the oxygen consumption and age of the workers. He found that the maximum percentage of work could be expected during 20 to 30 years [2].

A study was conducted on five young healthy industrial workers for estimating AWL for Indian workers. They concluded that the 'acceptable workload' for average young Indian worker while performing work under comfortable thermal environmental conditions would lie somewhere in between 30 - 40 percent of his maximum aerobic capacity [7]. The corresponding energy and heart rate would be around 18 KJ/min and 100 beats/min respectively. Generally a workload, which requires oxygen at a rate of about 35 percent of VO_2 max, is considered as the accepted workload for Indian workers and the values worked out to be 0.70 l/min and 0.63 l/min for male and female workers respectively [3] The corresponding heart rate values for this workload will be about 110 and 105 beats/min. [1] a scale (Borg-RPE) was developed for assessing the perceived exertion during dynamic work. The scale was so constructed that the ratings were linearly related to the heart rate expected for that level of exertion. (Excepted heart rate 10 times the rating given).

C. Materials and Methods

Twelve female subjects in the age group of 18 to 45 were selected for this study. The subjects selected were closely to the 5th, mean and 95th percentile value of stature taken from the anthropometric observations collected from all the agro-climatic zones of Orissa [5]. They were calibrated in the laboratory to assess their physiological parameters. The subjects selected for this study were engaged to perform different farm operations in OUAT farm. During this period the mean dry bulb temperature, relative humidity, air velocity were $29.3 \pm 3.1^\circ C$, $75.3 \pm 8.5\%$ and 3.4 to 5.5.m/sec respectively. The selected subjects had previous experience of using agricultural implements and machines as they are working in OUAT farm for many years. Everyday the experiment was conducted

Table 1
Physical Characteristic of the Selected Female Subjects

<i>Physical Characteristics</i>	<i>Mean</i>	<i>SD</i>	<i>Range</i>
Age, years	31.1	8.06	18 - 44
Weight, kg	51.7	4.91	53 - 59
Height, cm	152.0	7.61	142.1 - 162.2
BSA, m ²	1.52	0.12	1.38 - 1.69
HR _{rest} , beats/min	70.3	3.2	65 - 76
OCR _{rest} , l/min	0.19	0.02	0.16 - 0.23
VO _{2max} , l/min	1.70	0.08	1.56 - 1.81
Body Mass Index, kg/m ²	22.32	0.82	20.5 - 23.3

from 9.00 AM to 1.00 PM. The duration of each trial was kept 20 min continuously for recording of heart rate and oxygen consumption rate of subject. The heart rate, oxygen consumption rate during 6th to 20th min of work for each subject was measured as one's heart rate and oxygen consumption rate get stable after 3 to 5th minute of continuous operation [8]and [5]. The energy expenditure rate was computed by multiplying 28.86 kJ/ min with VO₂ for Indian workers [6].The weeding operation was done by mandwa weeders, transplanting by 4 row paddy transplanter, harvesting by improved sickle, threshing by pedal thresher and winnowing by winnower fan.

D. Result and Discussion

Twelve subjects in the age group of 18-45 years were selected. Their mean age and weight were recorded to be 31.1 years and 51.7 kg. Their body surface area was in the range of 1.38 to 1.69 m². Their heart rate at rest and oxygen consumption rest was recorded to be 70.3 beats/min and 0.19 l/min. The VO₂ max was varied in the range of 1.56 to 1.81 l/min with a mean value of 1.70 l/min. All the female subjected operated the four row paddy transplanter and it was observed

that their resting OCR was in the range of 0.22 to 0.26 l/min for all female workers. The working OCR was maximum 1.27 l/min for the aged worker (40 year) and minimum 1.11 l/min for the young worker (21 year).



Figure 2: Four Row Paddy Transplanter

The WHR increased from 120.3 bpm to 139.3 bpm with increase in age from 21 to 40 years. The work pulse was observed to be maximum 66.3 bpm for the aged workers (40 years). The ODR also observed to be maximum 7.5 for the aged worker. All the worker operated the four row transplanter above their AWL of 35% of VO₂ max, which varied in the range of 63.4 to 79.3% of VO₂ max of their respective maximum aerobic power. While operating with wheel finger weeder the VO₂ work and WHR was varied in the range 0.90 to 1.12 l/min and 108.4 to 120.3 bpm. The female workers operated the Wheel finger weeder in the range of 51.7 to 70.0% of their respective VO₂ max. Locally available sickle was evaluated with the selected female subjects. As it was operated in sitting and squatting posture lower OCR and WHR was

Table 2
Physiological Parameters of Female Workers

Activities	WHR, beats/min	Work Pulse, Beats/min	OCR, l/min	Energy expenditure rate, KJ/min	RCWL (%VO ₂ max)	Max. working time, min
Transplanting	131.7	60.5	1.1	24.9	70.2	20.2
Weeding	128.4	48.1	0.8	17.8	50.0	33.8
Harvesting	102.0	31.7	0.6	13.0	36.5	52.0
Pedal threshing	124.3	44.0	0.7	15.9	44.7	27.5
Winnowing	120.4	40.1	0.7	16.5	46.5	19.7



Figure 1: Measurement of VO₂ Max in Lab



Figure 3: Weeding by Mandwa Weeder



Figure 4: Weeding by Mandwa Weeder

recorded. The oxygen consumption rate and heart rate was recorded in the range of 0.51 to 0.67 l/min and 106 to 110 bpm respectively. The corresponding work pulse and ODR was in the range of 30 to 38 bpm and 2.5 to 3.0 for all female workers. While computing their data for AWL it varied in the range of 28.1 to 41.8% of VO_2 max.. The pedal operated paddy thresher was operated with the selected female workers and their working OCR and WHR was observed in the range of 0.91 - 0.97 l/min and 127.6 to 132.7 bpm. It was observed that the oxygen consumption rate and heart rate increases within increase in the age of the workers. Their AWL varied in the range of 59.0 to 79.7 per cent.

The drudgery and fatigue involved in these operating is categorized as per the tentative classification of strength While transplanting operation with four row manually transplanter comes under heavy type of operations, weeding with wheel



Figure 5: Pedal Thresher with Safety Cover

finger weeder can be categorized under moderately heavy type of operation. In case of sickle it is graded as light where as threshing with pedal thresher comes under moderately heavy type of operation.

CONCLUSIONS

The assessment of the ergonomic cost of farm activities on the basis of heart rate, energy expenditure rate and oxygen consumption rate showed that ergonomic cost while performing these activities was very high. The study concludes that all these activities are heavy and induce fatigue in some or other way to the women work force. Therefore the suitable low cost, improved technologies should be developed, existing equipments are to be modified and introduced to minimize the drudgery as per the anthropometric and strength data.

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