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Full Length Research Paper

Ergonomic study of farm women during wheat harvesting by improved sickle

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A study was conducted in Chandangaon village of Chhindwara district of Madhya Pradesh in 2009 to 2010 to determine the physical fitness, time and activity profile and physiological stress of farm women during wheat harvesting activity. A technically prepared serrated sickle was tested on farm women to improve work efficiency and to reduce the drudgery of women. The results revealed that 19.5% of working efficiency is increased by using serrated sickle as an average, one farm woman harvested 50 bundles of wheat by using serrated sickle while only 39 bundles of wheat was harvested through local sickle and using serrated sickle average working heart rate of women was found to be 110 beats/min. Similarly, energy expenditure was found to be 12 kJ/s and about 19% saving in cardiac cost of workers per unit of output in comparison to the traditional practice of local sickle.

Key words: Heart rate, ergonomic evaluation, drudgery reduction, cardiac cost of worker.

INTRODUCTION

Agriculture is one of the important labour intensive activities, where maximum percentage of women work force in rural areas is dependent for their livelihood. She performs almost each and every field activity right from sowing to harvesting. During these activities the risk of developing musculo-skeletal problems is mainly due to the inconvenient work postures (Chauhan and Saha, 1999). Wheat harvesting is a major problem for farmers/farm women. Harvesting of crops has to be done carefully as the matured grains easily detach from the ear heads/pods and, therefore, cannot be harvested by fast working tools or machines. Majority of the farm women performed this activity by local sickle with bending and squatting posture for longer time.

Though, this method is very demanding of labour and full of drudgery. It is clear that poor posture and tool design can increase the discomfort of both the healthy and less fit individuals. During harvesting activity from morning till evening, women usually adapts squatting posture and they continue to work in this posture for long duration without adapting any other posture due to which they reported severe pain in lower back, knees and cervical region (Jyotsna et al., 2005). In order to ensure health, safety, well being and thereby improving the

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Plate 1. Comparison with method of harvesting showed that Serrated sickle was easy in operation, no squatting and bending position relaxed the women against back pain with increased work force.

quality of work life and achieving higher productivity, it is essential that working equipment must be designed ergonomically and should be user friendly. By promoting such small tools, the work and work environment can be improved, physiological workload can be reduced in the agriculture and the efficiency and work output can be improved significantly.

Hence a study was conducted in Chhindwara district to reduce the drudgery and increase working efficiency of farm women during wheat harvesting by introducing serrated sickle through the heart rate method. Heart rate is one of the most accurate means of studying the energy expenditure while performing any activity.

MATERIALS AND METHODS

The study was carried out with 20 farmwomen among normal health, without any major illness involved in wheat harvesting activity, each falling between the age group of 25 to 45 years. The field experiment was conducted in the month of April to May, 2009-2010 for wheat harvesting and bundling activity. A uniform time of 6 h was given for wheat harvesting activity by theoretically equipped serrated sickle and traditionally made local sickle and 1.5 h in bundling activity per day headed for farm women (Plate 1).

During the experiment, the anthropometric rod and weighing balance were used to measure the physical characteristics like height and weight. Stop watch was used for recording the time. The heart rate was recorded by using the heart rate monitor. Based on the heart rate records the following parameters were calculated:

i. Average heart rate during rest and work,
ii. The energy expenditure was estimated from the heart rate (Varghese et al., 1994). Energy expenditure (kJ/s) = 0.159 x Average heart rate (beats/min) – 8.72,
iii. ∆HR (beats/min) = Average working heart rate – average heart rate during rest,
iv. Output (m^2/h) = area covered x duration / average time,
v. Cardiac cost of worker per unit of output (beats/ m^2 area covered) = ∆HR x duration / output.

The results were statistically analyzed using test of significance (t-test at 5% level of probability) and simple regression (r) by the method proposed by Shnedecor and Cochran (1967).

RESULTS AND DISCUSSION

To evaluate the harvesting through ergonomic point of view, 20 respondents in the age group of 25 to 45 years were selected at random and average age of the respondents engaged in wheat harvesting operation was counted as 32.50 years measuring body height of 156.50 cm and weight as 46.50 kg, respectively (Table 1).

Physiological stress of the wheat harvesters was determined on the basis of various parameters like average heart rate during work and rest, energy expenditure and physiological cost of work while performing the activity. Table 2 depicts that 19.50% of working efficiency increased by using serrated sickle as one farm woman harvested and bundled an average of 50 bundles each by using serrated sickle while only 39 bundles each of wheat was harvested and bundled through local sickle in given time frame of 6 h for wheat harvesting activity and 1.5 h for bundling activity. Physiological stress revealed that output recorded by serrated sickle was 87 m^2/h as compared to Local sickle by which 70 m^2/h area harvested. Mishra et al. (2013) also stated that improved sickle resulted in higher field capacity than simple sickle because of less pushing force required operating the sickle, which resulted in higher cutting speed and also found increased output with better harvesting efficiency and reduced drudgery by using

Table 1. Physical characteristics of selected respondents (N = 20).

Physical characteristic	Mean ± S.D.
Age (yrs)	32.50 ± 5.47
Height (cm)	156.50 ± 1.64
Weight (kg)	46.50 ± 2.63

Table 2. Evaluation of performance data of different parameters of the farm women while harvesting (N = 20).

Particular	Mean values ± S.D	
Type of implement used	Local sickle	Serrated sickle
Time (hrs.)	6	6
Numbers of bundle harvested	39 ± 2.50	50 ± 3.00
Average working heart rate (beats/min)	101 ± 4.99	110 ± 5.57
Average heart rate during rest (beats/min)	80 ± 3.55	86.50 ± 3.80
∆HR (beats/min)	21 ± 2.87	23.50 ± 3.52
Area covered/output (m^2/h)	70 ± 3.48	87 ± 3.92
Energy expenditure (kJ/s)	9.90 ± 0.57	12 ± 2.29
Cardiac cost (beats/m^2)	18 ± 2.81	14.50 ± 2.40
Reduction in drudgery (%)	-	19.00
Increase in efficiency (%)		19.50

Table 3. Correlation coefficient computed between different variables and energy expenditure (N = 20).

Particular	Energy expenditure (kJ/s)	
	Local sickle	Serrated sickle
Age (yrs)	-0.49*	-0.34
Height (cm)	-0.13	-0.19
Weight (kg)	0.22	-0.15
Time (min)	0.10	-0.13
Average working heart rate (beats/min)	0.94**	0.96**
∆HR (beats/min)	0.25	0.52*
Output (m^2/h)	0.07	0.17
Cardiac cost (beats/m^2)	0.15	0.46*

*Significant at P = 0.05, ** Significant at P = 0.01.

serrated sickle.

During harvesting with local sickle, the average ∆HR was 21 beats/min and energy expenditure 9.9 kJ/s while by serrated sickle, it was recorded as 23.50 beats/min and 12 kJ/s. The cardiac cost of worker was 18 beats/m^2 by local sickle while 14.50 beats/m^2 by serrated sickle. So the serrated sickle saves 19% cardiac cost of worker per unit of output and increases efficiency 19.50%. Dilbaghi et al. (2008) also found maximum output with improved sickle and reduction in total cardiac cost of worker with improved sickle over conventional sickle. The findings of the study are in conformity with Gite and Agarwal (2000) who revealed that drudgery reduction due to use of improved sickle was about 16.50% as compared to local sickle. They also revealed that improved sickle requires less effort for cutting and reduce the drudgery in harvesting. Singh (2012) also compared improved and local sickle for paddy harvesting and stated that potential demand of improved sickle is more than 2.27 million in the country. This clearly indicated the potentiality of improved sickle in the country.

Table 3 reveals that various physical measurements of respondents exhibited non significant negative correlation with energy expenditure similarly age of respondent showed significantly (P = 0.05) negative relationship (r = 0.49) with energy expenditure by harvesting with local

Table 4. Correlation coefficient computed amongst the variables of serrated sickle (N = 20).

Particular	Age (years)	Wt (kg)	Time (min)	Av. WHR (beat/min)	∆HR (beats/min)	Cardiac cost (beats/kg)	Output (m^2/h)
Age (years)	1.00						
Weight (kg)	0.38	1.00					
Time (min)	0.40	0.23	1.00				
Av. WHR (beats/min)	-0.26	-0.17	-0.11	1.00			
∆HR (beats/min)	0.19	0.59**	-0.17	0.45*	1.00		
Cardiac cost (beats/ m^2)	0.24	0.65**	0.39	0.52*	0.97**	1.00	
Output (m^2/h)	-0.40	-0.29	0.92**	0.23	0.19	-0.29	1.00

*Significant at P = 0.05, ** Significant at P = 0.01.

sickle and revealed that ageing effect working efficiency, while using serrated sickle physical parameters is not directly responsible to effect working efficiency as is shown non significantly negative correlation with energy expenditure. Energy expenditure was increasing at right angles as increase of average working heart rate during the spin of harvesting in both cases as it exhibited significantly (P = 0.01) positive correlation with local sickle (r = 0.94) and serrated sickle (r = 0.96). Heart rate difference between working and resting period of respondent [∆HR (r = 0.52)] and cardiac cost (r = 0.46) also showed positive correlation (P = 0.05) with energy expenditure and revealed that more energy was exhausted as rising of heart rate and cardiac cost also found more at same point in energy expenditure while using serrated sickle for wheat harvesting. Crouter et al. (2006) also stated that HR and physical activity (PA) can predict EE in individual subjects vary depending on age, height, weight and fitness of the subjects.

Correlation coefficient computed amongst variables of serrated sickle is demonstrated in Table 4. Perusal analysis of data recorded given the impression that the average weight of respondent showed significantly (P = 0.01) positive relationship with ∆HR (r = 0.59) and cardiac cost (r = 0.65) and exhibited the working capacity affected through fluctuation of weight of worker. Output of work (numbers of bundled harvested) was depended upon the duration of work as it confirmed positive correlation (P = 0.01) with time (r = 0.92). Cardiac cost also showed significant (P = 0.01) positive association with average heart rate difference between working and resting period (r = 0.97) during wheat harvesting with serrated sickle. Singh et al. (2010) have also reported positive relationship of Cardiac cost with average heart rate during maize shelling with tubular maize sheller.

Conclusion

Serrated sickle is women friendly tool because the assessment of technology increases the efficiency and reduces drudgery and it avoids bending and squatting posture. Serrated sickle provides safety to the workers due to its better construction and reduces musculo-skeletal disorders. It is necessary to maintain proper posture during performing these types of activities. Serrated Sickle saves about 19% cardiac cost of worker per unit of output over traditional practice. It does not require sharpening of cutting edge frequently.

This is a kind of women empowerment. It lessens the exertion and fatigue. Women feel comfortable; they earn money by reducing the labour. Their social life increases and they feel empowered in society. Hence, periodic training programmes should be organized to emphasize on educating workers regarding recognition of musculo-skeletal disorders and importance of rest pauses and maintaining proper posture while performing agricultural activities.

Conflict of Interest

The authors have not declared any conflict of interests.

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