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ERGONOMIC INVESTIGATION IN TERM OF OXYGEN CONSUMPTION (OCR), HEART RATE (HR) AND ENERGY EXPENDITURE FOR MAIZE SHELLING METHODS

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ABSTRACT

Maize is the third most important cereal in India and Production 23 Mn MT in 2009-10 (Department of Agriculture & Coopration, India). Rajasthan has the largest area 10.62 lakh hectares under cultivation among all states with total production of 2.1 Mn MT (2010). Agriculture is generally recognized as the nation's most hazardous industry and Shelling or threshing is the most tedious job. Four method of maize shelling namely shelling cob grain by hand, octagonal maize sheller, hand operated maize sheller and beating by stick method were ergonomically study. The Ten male agricultural subjects of 25-35 yr age group were randomly selected for the study. The mean OCR, and HR for octagonal maize sheller was lowest among all method of maize shelling and highest for beating by stick method. The energy expenditure rate was highest for beating by stick method (3.84 kcal/min) and lowest for octagonal maize sheller (1.52 kcal/min). Energy expenditure rate for shelling cob grain by hand and octagonal maize shelling operation could be scaled in “Very light” category of work load. Whereas the hand operated maize sheller and beating by stick method could be scaled as in “Light” category of work load.

KEYWORDS: Energy Expenditure Rate, Ergonomic, Heart Rate, Maize Shelling, Oxygen Consumption Rate

INTRODUCTION

Aagriculture is generally recognized as the nation's most hazardous industry and displays high rates of musculoskeletal disorders with evidence to suggest that ergonomic risk factors are involved. Threshing or shelling is the most tedious and time consuming job if do indigenously (James M. Meyers). Maze is cultivated mainly for food, fodder, feed and Industrial use. Rajasthan has the largest area 10.62 lakh hectares under cultivation among all states with total production of 2.1 Mn MT (2010)

Traditionally maize is threshed by shelling cob grain by hand and beating the cob by stick. At present maize shelling has been improved by the use of tubular maize sheller and hand operated sheller. A tubular maize sheller is getting popularity among the small and marginal growing farmer. Human energy is predominantly used in Indian agricultural especially in maize farming starting form seed bead preparation to threshing. Farm implement and machinery hitherto have not been ergonomically developed. Hence there is an urgent need to study the ergonomic aspect to quantity the drudgery involves in manually maize shelling operations viz. shelling cob grain by hand, octagonal maize sheller, hand operated maize sheller and beating by stick method.

MATERIAL AND METHODS

Anthropometric Characteristics A healthy age group ranging 25-35 yr free from respiratory or any other health

problem was selected for maize shelling operations. Ten male agricultural subjects of this age group were randomly selected for the study. Anthropometric parameter of the subjects were measured using a scale, weighing balance, measuring tape and Anthropometer that posture provide standard measuring posture.

Manual Maize Shelling Operations: Four method of maize shelling namely shelling cob grain by hand, octagonal maize sheller, hand operated maize sheller and beating by stick method were carried for removing maize kernel from the cob. In shelling cob grain by hand agricultural worker remove the grain from cob by using his thumb first make a line, after that they rub the cob by another shelled cob to remove the grain, due to rubbing action grains were detached from the cobs. The operations were done in sitting posture. The octagonal maize sheller of 70 mm long, 60 mm diameter and weight of 140 g was made up mild steel of 1.00 mm thickness. Four tapered fins are provided for shelling. The tapered ends provided two variable opening 40 mm at one end and 28 mm at other end shelling. Shelling was done by holding the sheller in one hand and gradually inserting the cob into the sheller by the other hand with clockwise and anti clockwise twist. The work was carried out in sitting posture.

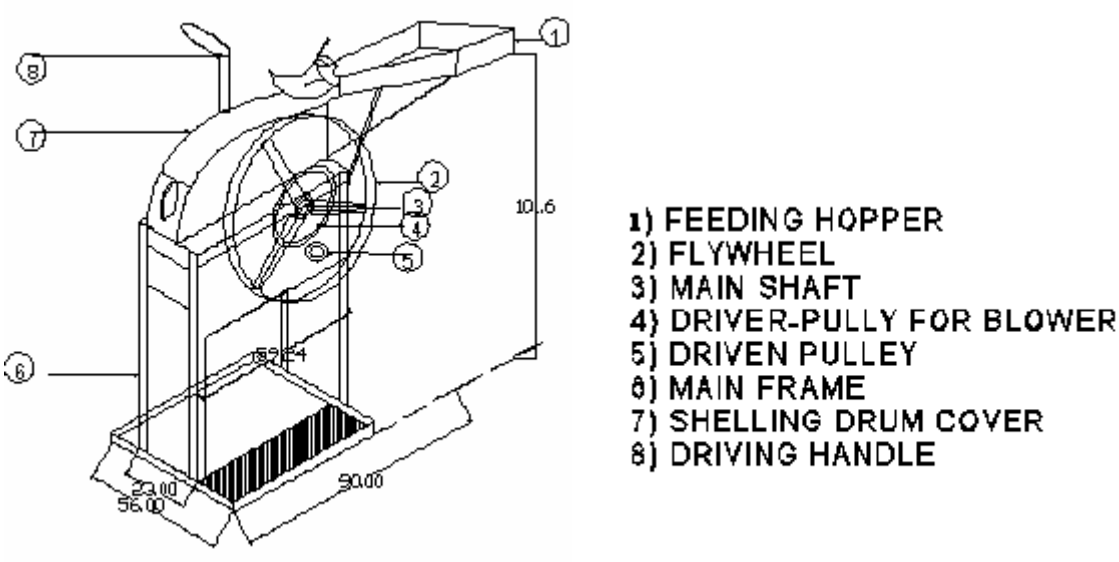

Figure 1: Schematic Diagram of Hand Operated Maize Sheller

The hand operated maize sheller consisted disc with a peg projections forming a conical passage. The disc was rotated by a handle attached to a flywheel. When the cob was pushed from the feed hopper, it was pulled by the rotating disc and allow to pass through the conical passage shelling was completed. The shelled corn was dropped and the wind blast from fan separates it from husk and sand. A Schematic diagram of hand operated maize sheller is presented in Figure 1. The clean corn was delivered to the outlet. Common traditional shelling method is to beat the maize cob with wooden stick. A group of four agricultural workers were asked to beat the heap of maize cob by wooden stick. The grains are detached from the cob due to impact force. This method is mostly used for gain purpose as the broken grain percentage is higher in this method.

Physiological Cost Estimations

The trials were conducted between 8.00AM and 1.00 PM during the month of December at Udaipur. The mean dry bulb temperature, wet bulb temperature, relative humidity and wind velocity varied between 8.4 to 23.5^{0}C, 7.6 to 16.6^{0}C, 35 to 85 per cent and 1.6 to 3.2 km/h respectively during the period of experiments. The K4 b^2 is an electrical

medical device which measure and analyzed oxygen consumption rate and heart rate without any disturbance of the worker during field activity. It is fixed to the worker during the test by an anatomic harness. Before start of the operation worker was allowed to take rest for 5 min and there resting OCR and HR was recorded. After that worker was asked to perform shelling cob grain by hand for 15 min working and the observations recorded for 15 minute working and 15 minute resting. The energy expenditure rate was calculated by 1 litre of oxygen = 2.88 kj (Nag 1989) and kj was converted in kcal.

RESULT AND DISCUSSIONS

The present study deals with the evaluation of different manually operated maize shellers from ergonomical considerations. Ten male agricultural subjects of the age group were randomly selected for the study. Total 19 body dimensions were found involved in maize shelling operations. The stature of male subjects were ranged from 160.0 cm to 176.0 cm. and weights of subjects ranged from 45.50 Kg to 63.20 Kg. In maize shelling operation, the man and machine interaction is through hand. Hand lengths of subjects were ranged from 17.10 cm to 20.05 cm. The arm reach from wall and vertical grip reach in sitting posture of subjects were ranged between 79.18 cm to 88.65 cm and 108.0 cm to 124.50 cm, respectively.

The experiments were carried out to assess the physiological cost of the subjects for different maize shelling operations by shelling cob grain by hand (traditional method), octagonal maize sheller (MS), hand operated maize sheller and beating method (by stick). The mean working OCR and ΔOCR were highest for beating by stick method (0.773 lit/min, 0.540 l/min) followed by hand operated maize sheller (0.677 l/min, 0.432 l/min), shelling cob grain by hand (0.317 l/min, 0.006 l/min) and lowest for octagonal maize sheller (0.306 l/min, 0.056).

Shelling cob grain by hand and octagonal maize sheller are being used for shelling of cob for seed purpose. The OCR for hand operated maize sheller was 14 per cent lower than that of beating by stick method. For grain purpose, it was observed that 25 percent of oxygen consumption (Δ OCR) was saved using the hand operated maize sheller over beating by stick method. Because of beating by stick method required more physiological effort as compared to hand operated maize sheller. According to classification suggested by Christensen(1953), mean working oxygen consumption rate for shelling cob grain by hand and octagonal maize shelling operation could be scaled in “Very light” category of work load. Whereas the hand operated maize sheller and beating by stick method could be scaled as in “Light” category of work load.

The lowest mean working HR and Δ HR were observed 88.85 beats/min and 7.83 beats/min for octagonal maize sheller and highest was 129.14 beats/min and 41.65 beats/min for beating by stick method, followed by 120 beats/min and 41.01beats/min for hand operated maize sheller and 90.57 beats/min and 7.81 beats/min for shelling cob grain by hand, respectively. According to classification suggested by Christensen (1953), mean working heart rate for shelling cob grain by hand and octagonal maize shelling operation could be scaled in “light” category, hand operated maize sheller is moderately heavy and beating by stick method could be scaled as in “heavy” category.

Since oxygen consumption rate (O_2) is a better parameter than heart rate, the energy expenditure rate is calculated using O_2 value of the subjects. The energy expenditure rate was highest for beating by stick method (3.84 kcal/min) followed by hand operated maize sheller (3.37 kcal/min), shelling cob grain by hand (1.57 kcal/min) and octagonal maize sheller (1.52 kcal/min). The energy expenditure rate for shelling cob grain by hand and octagonal maize sheller was almost same which means that work load for both the methods is nearly same. The EER for hand operated maize sheller was 12.23

per cent lower than EER for beating by stick method for grain purpose. According to classification suggested by Christensen (1953), energy expenditure rate for shelling cob grain by hand and octagonal maize shelling operation could be scaled in “Very light” category of work load. Whereas the hand operated maize sheller and beating by stick method could be scaled as in “Light” category of work load.

CONCLUSIONS

The mean OCR, HR and for octagonal maize sheller was lowest among all method of maize shelling and highest for beating by stick method. The energy expenditure rate was highest for beating by stick method (3.84 kcal/min) and lowest for octagonal maize sheller (1.52 kcal/min). Energy expenditure rate for shelling cob grain by hand and octagonal maize shelling operation could be scaled in “Very light” category of work load. Whereas the hand operated maize sheller and beating by stick method could be scaled as in “Light” category of work load. For maize shelling operations octagonal maize sheller and hand operated maize shelling are superior than shelling cob grain by hand and beating by stick method.

ABBREVIATION: Mn MT-Million Metric Ton, HR- Heart Rate, OCR- Oxygen Consumption Rate

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