

Ergonomic Evaluation of Castor Decortication by Women - Conventional Method versus Manual Decorticator

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Abstract: *The manual hand operated multipurpose decorticator developed by ANGRAU was tested for castor decortications to study the physiological work load and muscular stresses. Results revealed significant reduction in physiological work load and muscular stresses when decorticator was used compared to hand beating the castor pods. A 33 percent reduction in time was also observed when decorticator was used over manual method which was significant.*

Keywords: Castor Decorticator, Physiological Work Load, Muscular Stress

1. Introduction

Farming in India is labour intensive. Women in India take part not only in several field operations but also in post processing activities of crop production. Cleaning and grading of grains, shelling, decortication, dehulling, peeling, slicing, fibre extraction are some of the activities of women. Decortication involves breaking of shells and removal of seeds. In castor production, women mostly do manual decortication by beating on the pods using a stick. Low output and bodily discomfort due to the continuous sitting or squatting posture were reported by them. Improvement in the existing tools, equipment and methods of work has significant effects in minimizing human strain and fatigue and increasing farm productivity. Agriculture being a largest sector of India, extensive ergonomic research on farm methods and practices, tools and equipment may generate a great deal of knowledge for the betterment of health, safety and productivity of billions of agricultural workers. It is also important that based on the physiological demand of work, the activities may be categorized into light, moderate and heavy with reference to an individual's maximal working capacity. Data of this nature additionally facilitate to transform the tasks of resource poor farmers to a drudgery free and safe operations.

2. Review of Literature

A study was conducted to assess ergonomically the efficiency of improved post harvest technologies viz. tubular maize sheller, groundnut decorticator, groundnut stripper and hanging type cleaner grader. Ten farmwomen were selected to assess and compare the impact of improved technologies over conventional one. The physiological cost of work and energy expenditure in terms of heart rate were observed to be lower while performing selected activities with the improved technologies compared to the traditional one. The work output was also found higher with all of the improved technologies (Badiger et al. 2006)

Gitau et al. (2013) conducted a study on shelling of groundnut pods in Kenya. Two manually operated

decorticators were tested and modifications were done on one of the decorticators to optimize its technical performance. Results of performance tests showed that for WBS (Wooden beater sheller) at a feed rate of 30 kg/hr and 22.6 mm clearance, shelling efficiency increased with decrease in moisture content for all the groundnut varieties. The highest shelling efficiency was 55.3% for ICGV 99568, 39.2% for ICRISAT Groundnut Variety (ICGV) 90704 and 29% for ICGV 12991 at moisture content of 5.92% wb. With the modifications done on the WBS decorticator, the highest shelling efficiency of 87% was obtained at a clearance of 10 mm for ICGV 99568 which is the largest in size from the three varieties. It implies that farmers who shell for seeds can now obtain more seeds shelled with low breakage and therefore will get more income.

Kinyanjui, (2011) observed that while hand shelling of groundnuts keep the rate of kernel breakage low, it is labour intensive, energy requirement is high and leads to "sore thumb syndrome" when large quantities are handled. A hand/power operated castor bean sheller was developed and evaluated in Tamil Nadu, India. It consists of a feed hopper with regulator, a screw auger, shelling discs, flywheel and blower. The unit can be either operated manually without connecting the blower or operated by a 0.5 hp electric motor with blower. The unit was evaluated and compared with the performance of existing hand-operated and power-operated groundnut decorticators for shelling castor bean. The size and orientation of slots in the perforated sieve of groundnut decorticators were studied. When the slots were perpendicular to the direction of oscillation, the castor bean shelling efficiency was greater with minimum breakage to castor kernels. The output and shelling efficiency of power/hand operated castor bean shellers were 163.00 and 52.65 kg, 97.29% and 98.72% with a kernel breakage of 0.82% and 0.88%, respectively (Duraisamy and Manian, 1990).

3. Methodology

Castor decortications activity both in conventional method and using manual decorticator (ANGRAU model)

performed by 30 women as subjects and belonging to 21-40 years age group. Initially, they were subjected to physical fitness test on step stool and using Polar Vantage NV HRM with an interface to the computer, and heart rate as variable was observed. Subjects were asked to do step exercise on the stool (29x45x24 cm) on 4 counts rhythm for a period of five minutes or till exhaustion. Physical fitness was then calculated using the following formula. Later, heart rate at rest (5 min) and work was measured continuously for 30 minutes duration, using Polar heart rate monitor when the worker was performing the tasks as per split plot design of experiment. Recovery heart rate was measured every minute at the end of the work for the duration till the subject attained 1/10th of the resting heart rate. The Physiological work load, muscular stresses, production output and environmental conditions were compared between the two methods of castor decortications. The following formulae were used in the calculating variables (Varghese et.al, 1994).
PFI = Duration of exercise (sec) / sum of (1+2+3 recovery heart rate counts) x100. Working heart
 Where, Physiological Cost of work = TCCW/ total time 9 min)

Total Cardiac Cost of Work (TCCW) = CCW +CCR

Cardiac Cost of Work (CCW) = (AWHR – RHR) x duration of work

Cardiac Cost of Recovery (CCR) = (Rec.HR – RHR) x duration of recovery

RHR = Resting Heart Rate; AWHR = Average Working Heart Rate; and Rec. HR= Recovery Heart Rate.

Based on working heart rate, work load was categorized as Very heavy (136 to 150);

Heavy (121- 135);

Medium (106 -120);

Light (91-105) and

Below 90 was very light.

Muscular exertion was assessed using body mapping score procedure.

4. Results

4.1 Physical characteristics

Table1 gives the physical characteristics of the women selected as subjects for the study. As per mean values, the selected women were within the normal range type, in terms of Body Mass Index, body type and Vo2 max and not reported any health ailments. Hence they were considered as healthy subjects for the ergonomic study. Table 2, projects the distribution of the selected subjects as per body type and Physical fitness. It can be found that 70 per cent of the subjects were Mesomorph. About 56 per cent of women were categorized to be below average and poor as per the physical fitness and remaining (44%) were found to be in average and above.

Table 1: Physical characteristics of the subjects N= 30 farm women

Mean age (yrs)	Height (cms)	Weight (kgs)		Vo2 (ml/kg/min)	Body Mass Index
		Gross	Lean Body Mass		
41	151.6	52	43.9	29.2	22.6

Table 2: Distribution of the respondents according to body type and PFI

Body Type	20-45 yrs	
	No.	Percentage
Ectomorph	4	13.3
Mesomorph	21	70
Endomorph	5	16.7
PFI		
Poor	10	33.3
Low average	7	23.3
High average	3	10
Good	2	6.7
Very good	2	6.7
Excellent	6	20

Table 3: Work load of women in castor decortication using conventional and improved method

Physiological variables	Conventional method	Using Multipurpose Decorticator
Average Resting Heart Rate b.min-1	88.01	84.8
Average Working Heart Rate (AWHR) b.min-1	108.5	107.2
Average Peak Heart Rate b.min-1	117.9	117.7
Average TCCW (beats)	399.03	179.9
Average PCW b.min-1	13.74	9.67

Table 4: Productivity of women in castor decortication using conventional and improved methods

Output variables	Conventional method	Using Multipurpose Decorticator
Total time taken for the activity (min)	29.3	19.96
Quantity of pods per batch for decortication (kg)	2.5	2.5
Production per unit (kg/hour)	5	7.5
Environmental parameters		
Mean Temperature 0c	28	28

As per Table 3, work load of women in castor decortication activity was found to be at medium level both in conventional and while using decorticator as per AWHR. Whereas, high workloads were also observed due to peak heart rates leading to physical exhaustion to the workers. There is significant reduction in the TCCW and PCW when the decorticator was used. The reason could be observed due to the significant reduction in the time used for decortication between methods for the selected quantity of castor pods. There was 31.9 per cent decrease in the time taken for worker when decorticator was used. The productivity per unit time also was increased by 50 per cent. There is a significant difference in the total cardiac cost of work, physiological workload and time between the two methods as per ANOVA (Table 5). This indicated the merit of decorticator over conventional method in reducing physiological workload. Also the differences seen could partly be due to differences in subjects as all subjects were not at the same level of BMI or physical fitness. All the above results lead to infer that the use of a decorticator has got the potential to reduce the physiological load of the user to an accepted level.

Table 5: ANOVA for physiological workload while castor decortication - conventional method and multipurpose decorticator

Physiological Parameter	F-Values	
	between methods	between subjects
Average working heart rate (beats/min)	0.25	2.25*
Average peak heart rate (beats/min)	0.004	1.32
Average energy expenditure (kJ/min)	0.25	2.25*
Peak energy expenditure (kJ/min)	0.004	1.32
Average TCCW (beats)	84.6*	1.2
Average PCW (beats/min)	30.97*	2.87*
Average RPE	3.85	1.96*
Time (min)	88.32*	2.68*

*Results significant at 5% level

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4.2 Muscular stress

During the work, the postural change from frequent bending assumed while beating with sticks in the conventional method was decreased by 40 per cent. This was due to performance of work in standing position. Therefore, as per body map reduction in pain was perceived in neck, shoulder, upper and lower limbs. Therefore, use of multipurpose decorticator could positively reduce the musculoskeletal stresses.

5. Conclusions

In conclusion, the study revealed that the physiological cost of work decreased by 27 per cent when decorticator was used compared to conventional method of beating with sticks. Significant reduction in time was achieved with the use of decorticators as it saved 33 percent of time over manual method. While the technologies available for women specific operations in crop production need evaluation on ergonomic parameter, participatory intervention efforts need emphasis for extending the benefits of the technology extensively among farm women

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