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Ergonomical evaluation & dynamic performance of pedal operated coconut dehusker

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Abstract
The generally coconuts are dehusker manually using either a machine or a spike. These methods are requires skilled labors and training to use safety, comfort and convenience of the operator. The working position, pedals and instruments should be conveniently and logically located. Equipment that is usable and safe by solving these difficulties, dynamic performance. In our design a closed coil spring is use to increase the force of dehusking. It is simple in design with pedal operated. No need any motor to operate only manual work is needed. This mechanism is used of spring type. We joined the parts of the device by welding and pin joints.

Keywords: Spike, pedals dynamic, spring, performance, ergonomic

Introduction
Ergonomics are the study of the interaction between people & machines and the factors that affect the interaction. Its purpose is to improve the performance of systems by improving human machine interaction. This can be done by 'designing-in' a better interface or by 'designing-out' factors in the work environment, in the task or in the organization of work that degrade human–machine performance.
The design is of the modern agricultural operation including human factors. These factors allow to the operator performene's many method and priniple task with the efficiency, safety and minimum fatigue. The general ergonomics human factor including such as items includes riding comfort, visibility, location and arrangement of controls, ease of operating control, design and thermal comfort and sound (noise) etc.

Introduction of pedal operated of coconut dehusker machine
Coconuts are their known great versatility, as evidenced by many traditional method uses, ranging from food to cosmetics. The coconuts are distinct from other fruits for their large quantity of water (also called 'juice') and when immature, they are known as tender-nuts or jelly-nuts and may beharvested for their potable coconut water. When mature, they can be used as seed nuts or processed to give oil from the kernel, charcoal from the hard shell, and coir from the fibroushusk. The coconut de husking is post harvesting operation which is necessary step towards making the coconut ready for the further utilization. The coconut de husking process is complicated and studies are still in the initial stage in all coconut cultivation countries all over the world.
The coconut also has cultural and religious significance in certain societies particularly in India farm mechanization increases the effective utilization of machines to increase the productivity of land and labour. Besides it helps in reducing the drudgery, time and cost of cultivation in farm operations.
In farm mechanization, the operations are divided into three
i) Pre-harvesting operation
ii) Harvesting operation
iii) Post-harvesting operation.

Coconut (cocosnucifera) is one of the world's most useful and important perennial plants. The coconut fruit is made up of an outer exocarp, a thick fibrous fruit coat known as husk; underneath is the hard-protective endocarp or shell. The coconut palm is widely cultivated in the tropics. India is the world's third largest producer of coconuts after the Philippines and Indonesia. Other producers are Thailand, Malaysia, Papua New Guinea and the Pacific Islands.

With coconut plantations extending over more than a million hectares, India produces about 5500 million nuts a year. Copra produced in the country is about 0.35 million tons and India accounts for about 50% of the world trade in coir. Coconut plantations are mostly concentrated in the coastal and deltaic regions of south India. In India, the crop is produced mainly by small and marginal farmers who number about 5 million. The average size of holding is as small as 0.25 hectares. With agricultural labour problems worsening and water resources dwindling, more and more plantation acreage is being converted from arca to coconut since the latter is easier to grow and more remunerative. Almost all the parts of coconut are useful. The meat of immature coconut fruit can be made into ice cream while that of a mature coconut fruit can be eaten fresh. It is used for making shredded coconut and livestock feed. Coconut milk is a refreshing and nutritious drink while its oil is use for cooking and making margarine. Coconut oil is also very important in soap production.

This causes wastage of time that never comes back. We are trying to overcome this problem by making acoconut de-husking and cutting machine which is more efficient than existing machines.

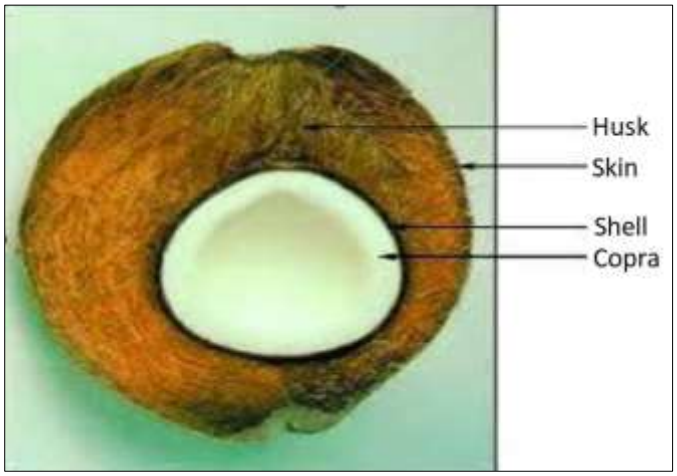

Fig 1: Cross section of coconut

Coconut is one of the world's most useful and important perennial plants. A coconut can be divided into three parts:

1. Exocarp-outer covering
2. Thick fibrous fruit coat- husk
3. Endocarp-inner shell

Material and methods

The chapter describes the materials used and the methodology adopted in conducting this study. The procedures are calibration for machine operated with manually and the ergonomic evaluation of the selected models of manual coconut dehuskers.

The experiment was conducted to ergonomically body movement size of force and Physiological –noise, light, temperature etc. And second is evaluation of machine design pedal operated coconuts dehusker and performance evaluation of coconuts dehusker in this chapter.

Selection of subjects

The subjects are the ergonomical evaluation of manual coconut dehusker selected from the farm workers of the field and based on their experimental in operating the manual coconut dehuskers. Ten male and five female of its machine according to the age group 25 to 40 years and medically fit. The anthropometric data, with reference to the dimensions of the positions in functional components of coconut dehuskers are clarify, identified of fifteen different body dimensions (strength measurements were selected for the study). The stature, weight, acromion height, grip diameter, hand length, palm length, fore-arm hand length, grip strength, leg push, muscle strength of the selected male and female were measured in the laboratory.

The anthropometric dimensions (data) of measured using the following equipments.

- Integrated Composite Anthropometer
- Electronic push pull dynamometer
- Back-Legs-Chest dynamometer
- Digital hand dynamometer
- Finger goniometer
- Grip diameter cone

Ergonomic evaluation of the selected coconut dehusking devices

Ergonomic evaluation of the selected coconut dehusking devices was conducted, for assessing their performance. The study was conducted at the Ergonomics Laboratory of KCAET, Tavanur, with coconuts having an average weight of 500 g. The subjects were given prior and complete information about the experimental requirements, so as to enlist their full cooperation. A thorough training was given to the subjects for a week to get them familiarized with the coconut dehusking device, even though they already had experience in coconut dehusking using the implement. The work was started after attaining a complete experience on each device. The subjects were rested for 30 minutes before starting the trial. The electrodes contained in the chest belt transmitter of heart rate monitor were wetted with water and fastened on the chest of the subject. Each trial started with taking five minutes' data for physiological responses of the subjects while resting on a bed. Heart rate during the dehusking was measured by the heart rate monitor. Each trial was replicated three times for each subject. The same procedure was repeated for testing the two selected dehuskers models for the eight subjects.

Energy cost of operation

Each of the subjects were made to work on both the selected coconut dehusking tools for about 25 minutes. The corresponding heart rates were measured. From the values of heart rate (HR) observed during the trials, the corresponding values of oxygen consumption rate (VO_2) of the subjects for the selected coconut dehusking tools were obtained from the calibration chart of the subjects. The energy cost of operation of the selected coconut dehusking tools was computed, by multiplying the oxygen consumed by the subject during the trial period with the calorific value of oxygen (20.88 kJ/L) for all subjects. Sufficient rest period was given to the subject between trials using the different models. The values of heart rate, oxygen consumption and the energy expenditure for all the subjects were measured using this method.

Workload classification

Workload can be classified based on the energy expenditure and oxygen consumption during the operation. Workload can

be categorized as light, moderate, heavy and unduly heavy as per this classification.

Subjective rating

Overall Discomfort rating

A ten point Rated Perceived Exertion (RPE) scale was used by the subjects to denote the level of discomfort experienced during operation of the implement. Intensity of discomfort increased from 1 to 10, 1 being rating for least discomfort and 10 the most discomfort. A moveable pointer was provided to indicate the rating. At the end of each trial, the RPE scale was shown to the subjects to identify the level of perceived exertion while using the selected coconut dehuskers.

The subject was asked to select a number that corresponds to how hard the subject perceives himself or herself to be working. This feeling should reflect how heavy and strenuous the exercise feels, combining all sensations and feelings of physical stress, effort, and fatigue, heart rate, breathing rate and perspiration, by the subject.

Body part discomfort score

A body mapping technique was used to have meaningful rating of the discomfort perceived by the subject during operation. The subject was shown the image (fig. 3.4) that divides the human body into 27 regions where discomfort due to physical activities are felt. The subject was asked to mention all body parts with discomfort, starting with the worst, the second worst and so on until all parts had been mentioned. The maximum number of intensity levels of pain experienced for the operation were categorized. A rating was assigned to these categories in an arithmetic order. The intensity levels of pain experienced for the dehusking operation was divided into four categories; for the first category (body parts experiencing maximum pain) rating was maximum as four, for second category (body parts experiencing next maximum pain) rating was allotted as 3.5, for the third category it was 1.5 and for the last category (body parts experiencing least pain) rating was allotted as 1. The pain experienced by different subjects might vary in different body parts. The body part discomfort score of each subject was the rating multiplied by the number of body parts corresponding to each category. The total body part score for a subject was the sum of all individual scores of the body parts assigned by the subject. The body parts discomfort score of all the subjects was added and averaged to get the discomfort mean score. The procedure was followed for both the coconut dehuskers.

Pedal operated dehusking machine

This was a tool mounted on a platform, and standing upright when placed on the floor. Coconut was fed by hand and impaled on the stationary tool. The depressing of its foot lever each time caused the separation of one sector of the husk. Repetition of these operations three or four times caused complete removal of the husk. Re-setting of its movable blade on to the stationary blade, to keep them in the upright position, was achieved with the aid of a torsion spring of high spring constant. Slipping of the foot from the pedal when depressing would be causing quick return of the pedal and any part of the leg or body coming in the way of its path was not that advantageous, as this action destabilized the bound to get an impact, which may sometimes be inflicting injury. These disadvantages might have prevented the acceptance of this tool.

Plate 1: Pedal operated coconut dehusker

Working

Coconut is a main crop of kokan region and dehusking of coconut is very necessary step in making coconut ready for further utilization. Coconut dehusking involves removing of the husk from the coconut. Traditional dehusking is time consuming and difficult process. To overcome this limitation, to improve the automation and to provide safety for the operator, a new design dehusking machine is introduced and fabricated. Normally used manual coconut dehusker is modified with closed coil spring, which is connected to the pedal. Then it is operated manual without any motors and skilled labours. When we applied the load on the pedal the spring which is connected to the pedal gives the maximum force to the husker to husk the coconut. The components that are used in this coconut dehusker are manual husker, closed coil spring, foot pedal. The coconut to which we want to husk is placed on the top of the knife edged pedal operated coconut dehusker. Then the load is applied to the pedal, which is connected with the coconut dehusker. Then the lever, which is connected to the pedal, get pulled with that force. The knife-edge coconut dehusker is opened with that force. After husking of coconut the knife-edge gets closed with the force which is generated by the spring.

Plate 2: Coconut before dehusking

Plate 3: Dehusked coconut

Result and discussion

Assessment of the results study from the ergonomic evaluation of pedal operated coconut dehusker.

Selection of subjects

Ten male and five female subjects, medically fit and age group of twenty five to thirty five years, were selected from the farm workers of the college. All the subjects had more than five years of experience in operation of the manual coconut dehusker.

Analysis of anthropometric data and strength parameters

Table 1: (Analysis of anthropometric data & strength male parameter)

Sr. No.	Parameters		Male (1-10)									
			1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
1	Stature (cm)		170	166	170	169	167	161	164	161	160	170
2	Weight (kg)		65	63	64.9	61	63.5	61	62	61	60.8	65.5
3	Acromion height (cm)		105	92	99	104	92	92	90.5	92	98	108
4	Grip diameter (cm)		12	10	10	12	10.2	09	11	09	09	12
5	Hand length (cm)		77.5	75	78.5	74	75	70	73.5	70	70.5	78
6	Palm length (cm)		19.5	18	20	20	18	18	19.5	18	20	20
7	Palm width (cm)		9	10	10	11	10	10	9	10	10	11
8	Forearm hand length (cm)		45	45	46	46	46	46	43	42.5	44	46
9	Grip strength (kg_f)	Right	29	27	28	45	28	27	15	27	28	30
		Left	27	25	27	42	26	25	13	25	27	29
10	Hand pull (both)(kg_f)		34	27	25	20	30	27	35	27	26	20
11	Leg push (k_f)	Right	48	48	48	48	46	42	46	42	42	49
		Left	47	46	48	46	42	48	45	48	40	46
12	Muscle strength (kg_f)		138	134	132	149	127	128	130	128	131	148

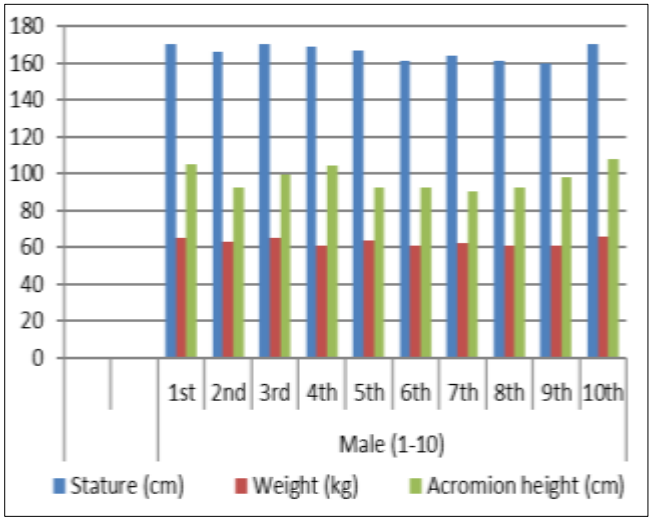

Fig 2: Relation between stature, weight and acromion

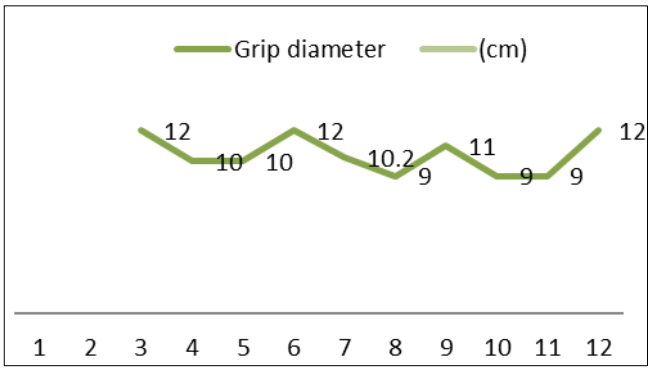

Fig 3: Grip diameter (cm)

Calibration of subjects

All the selected subjects (both male and female) were calibrated in laboratory. Sanders and McCormick (1993) suggested the calibration of each person to determine the relationship between heart rate and oxygen consumption.

Basal Metabolic Rate

The basal metabolic rate of the subject was measured by the following procedure. Sample calculations of both male and female are subject shown below.

I-Computation of BMR (for male)

Average age of male (years) = 30
Average weight of male (kg) = 56.4
Average height of male (cm) = 165.8
Room temperature (T_2), K = 303
Room pressure (P_2), bars = 0.99
Oxygen consumption for a period of 6 min (V_2), cc = 1300
Standard temperature (T_1), K = 273
Standard pressure (P_1), bars = 1.032

Oxygen consumed under standard

Temperature and pressure (L) = $\frac{P_2V_2}{T_2} \times \frac{T_2}{P_1}$

$= \frac{0.99 \times 1.300}{303} \times \frac{273}{1.032}$

=1.1236

Energy produced in 6 min, kcal = 1.1236× 4.832

= 5.429Kcal

Energy per day, kcal = 5.429 x 60 x 24 /6

Basal metabolic rate, kcal /day = 1302.96

Conclusion

Step-I concluding remarks

This is a comprehensive topic of the objects which discusses work in the area of ergonomics evaluation and dynamic performance of coconut dehusker. The research also point of the prevalence male and female are people with working posture. This i one of the first attempts to quantitatively evaluate the level of grip strength of worker acquire due to the occupational stress.

And it was observed that, there was a significant association of the perceived exertion age and greater experience.

Step-II testing the pedal operated coconut dehusker

After testing the pedal operated coconut dehusker result were calculated in chapter IV and from these result final conclusion were drown are as follows:

a) Based on the overall objectives of the project, a pedal operated coconut dehusker, had been successfully developed and constructed using locally available materials.
b) The machine is simple in operation, less bulky with good ergonomic considerations for its comfortable use in a standing posture by either male or female operator.
c) This is justified by the portability and low height of as well as the low energy requirement.
d) The machine overall performance is favourable with more dehusking capacity, more dehusking efficiency and less coconut damage.
e) The machine developed required a low cost.
f) A very reduced human effort was required for dehusking coconuts
g) The pedal operated coconut dehusker has a better output capacity, reasonable dehusking efficiency.
h) This pedal operated coconut dehusker can be used for household use and consumption.
i) Pedal operated coconut dehuskercan be used for dehusking both wet and dry coconuts
j) By implication, machine performance efficiency does not give a true reflection of how effective a system work until the machine capacity is determined.

The section of this chapter of the study fulfill objective in which the related to “ergonomical evaluation & dynamic performance of pedal operated coconut dehusker” and to validated the ergonomically design.

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