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ERGONOMICAL EVALUATION ANALYSIS OF PEDAL OPERATED COCONUT DEHUSKER.

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Abstract

Agricultural operation's design takes into account human factors, traditional uses of coconuts, from food to cosmetics, attest to their well-known tremendous adaptability. Farm mechanization promotes the efficient use of machines to increase labour and land production. Additionally, it aids in cutting down on the laboriousness, expense, and duration of farming activities. In the tropics, the coconut palm is commonly grown. After the Philippines and Indonesia, India is the third-largest producer of coconuts worldwide. Thailand, Malaysia, Papua New Guinea, and the Pacific Islands are additional producers. India produces over 5500 million coconuts every year, with plantations covering more than a million hectares. About 0.35 million tones of copra are produced in the nation and India is responsible for 50% of global coir trade.

Keyword: *ergonomics, human, comfort, mechanization, harvesting operation, coconut etc.*

➢ INTRODUCTION

The current agricultural operation's design takes into account human factors. These elements enable the operator to carry out numerous basic and fundamental tasks safely, effectively, and with the least amount of weariness. The overall human aspect of ergonomics encompasses things like riding comfort, visibility, the placement and arrangement of controls, ease of control, design, thermal comfort, and sound (noise), among other things.

❖ Introduction of pedal operated of coconut dehisce machine

Numerous traditional uses of coconuts, from food to cosmetics, attest to their well-known tremendous adaptability. When young, the coconuts are known as tender-nuts or jelly-nuts and can be collected for their consumable coconut water. The coconuts are distinguished from other fruits by their huge quantity of water (also known as "juice"). When fully developed, they can be processed to produce oil from the kernel, charcoal from the hard shell, and coir from the fibrous husk, or they can be utilised as seed nuts. The dehusking of coconuts is a post-harvest procedure that is essential to preparing the coconut for subsequent use. The dehusking of coconuts is a difficult procedure, and research is still in their early stages in all nations that cultivate coconuts.

In some countries, particularly in India, the coconut also has cultural and religious importance. Farm mechanization promotes the efficient use of machines to increase labour and land production. Additionally, it aids in cutting down on the laboriousness, expense, and duration of farming activities. Three categories of operations are used in agricultural mechanization.

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In farm mechanization, the operations are divided into three

i) Pre-harvesting operation

ii) Harvesting operation

iii) Post-harvesting operation.

One of the most important and beneficial perennial plants in the world is the coconut plant (cocosnucifera). The coconut fruit is composed of a hard, protective endocarp or shell underlying a thick, fibrous fruit coat known as the exocarp. In the tropics, the coconut palm is commonly grown. After the Philippines and Indonesia, India is the third-largest producer of coconuts worldwide. Thailand, Malaysia, Papua New Guinea, and the Pacific Islands are additional producers. India produces over 5500 million coconuts every year, with plantations covering more than a million hectares. About 0.35 million tones of copra are produced in the nation, and India is responsible for 50% of global coir trade. In south India, coconut plantations are typically found along the coast and in the delta. The majority of the crop in India is grown by the country's 5 million or more small and marginal farmers. The typical holding is only 0.25 hectares in size. The conversion of more and more plantation area from arca to coconut is occurring as a result of the rising agricultural manpower shortage and the diminishing availability of water. Coconut is easier to grow and pays better than arca. Almost all of a coconut's parts are beneficial. While the meat of a mature coconut fruit can be consumed fresh, the meat of an immature coconut fruit can be turned into ice cream. It is employed in the production of animal feed and coconut flakes. While coconut oil is used in cooking and margarine-making, coconut milk is a cooling and wholesome beverage. In addition, coconut oil is crucial for the creation of soap.

❖ **A brief history of ergonomics**

The design and operational issues raised by technical advancements over the past century gave rise to ergonomics. The historical processes that gave rise to other disciplines like industrial engineering and occupational medicine also contributed to the development of this field..

Scientific management and work study

Ergonomics has its roots in scientific management, which was created through work study. It was created at the start of the 20th century and was founded on the understanding that productivity could be increased by rethinking the way work was done as opposed to just employing better machines.

The Principles of Scientific Management

Scientific management was a response to the Indian-inherited management techniques that were then the norm. Owners of factories provided the facilities, the electricity, the raw materials, etc., and paid foremen to organize the work. The essential industrial tasks were left to these foremen to organize as best they could, acting rather like subcontractors. Management was primarily interested in production and had a single, broad definition of "productivity," disdaining the work itself. Employee suggestions for improvements were rewarded, and the success of the business depended on finding a "good man" to organize the workforce. Time and motion studies and human engineering had their roots in work study and scientific management.

Companies used a new breed of professionals to research task design and human-machine interaction. Working practices were no longer considered to be at the employee's option, dictated by tradition or technology, but rather were seen as something that could be purchased and

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controlled by management. For the adoption of mass assembly and production line techniques, this shift in perspective was a prerequisite.

There are various ways that time and motion studies (methods engineering) can be critiqued, including the fact that it primarily considers the most obvious aspects of task performance, makes unfounded assumptions about people, and amounts to little more than common sense. Many contend that Taylorism was successful in "de-skilling" artisans and producing boring, repetitive employment. This may be the case, but an argument might be made that it also made industrial jobs more accessible to unskilled workers and mass-produced goods more reasonably priced. For management, taylorism had numerous benefits:

1. Greater flexibility in assigning operators to quickly learned jobs was made possible.
2. The need for competent labour decreased. There were no skill shortages, and pay and training expenses were easier to control.
3. The introduction of timed work made it possible to more precisely quantify production timelines. There is room for improvement in output forecasting.
4. There was always a finished product if everyone worked at the same rate.

Human relations and occupational psychology

In the 1920s and 1930s, occupational psychology began to take shape. The core of Taylorism had been to view the worker as an isolated individual whose production was influenced by both financial incentives and physical variables like weariness or bad job design. A job would be rebuilt to make it as easy to understand and perform as possible. To encourage employees to create more than the required amount, a bonus program would be implemented together with a production standard and pay rate. The idea was that "rational economic men" would increase their output in order to increase their bonus. The social setting in which labour was performed was disregarded. Taylorism had benefits, but it also created problems for management.

Continuous salary increases were required to keep up with productivity's rising levels. New approaches were taken to prevent this. Every time consistent gains in output were made, new, higher production standards were implemented, and bonuses were only given when the new benchmark was surpassed. Workers responded by limiting their production to stop the benchmark from being raised and applied social pressure to "rate-busters," which is not unusual.

➢ MATERIAL AND METHODS

The chapter provides a description of the study's materials and methods. The methods involve calibrating the manual coconut dehuskers for machine operation and evaluating their ergonomics. The experiment examined the relationship between ergonomic body movement size of force and physiological factors as noise, light, and temperature.

The farm workers in the field who were chosen for the ergonomical evaluation of manual coconut dehusker were chosen based on their experience using the machines. Its machine has ten male and five female employees who are between the ages of 25 and 40 and in good health. The anthropometric data identified fifteen various body dimensions (strength measurements were used for the study), with reference to the dimensions of the positions in functional components of coconut dehusker. The selected male and female were measured in the lab for stature, weight, acromion height, grasp diameter, hand length, palm length, forearm hand length, grip strength, leg push, and muscle strength.

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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

Integrated Composite Anthropometer

Integrated Composite Anthropometer (ICA), developed by IIT, Kharagpur,(*sources*) comprised of a base platform, an adjustable backrest plate, and an adjustable seat.

Selectively are place with respect to various measuring units, so as to facilitate measuring body dimensions, both in standing and sitting posture; and a linkage mechanism assembly adapted for strength measurement.

Back-Legs-Chest dynamometer

The back-legs-chest dynamometer was used to gauge the strength of the body's back, leg, and chest muscles. The instruments measured force in pounds and kilo-gram and had an adjustable chain to account for variations in height or the application point of forces. Before testing a different object, the gauge's pointer was made sure to be reset to zero.

Digital hand grip dynamometer

The hand grip dynamometer was used to measure the grip strength of male and female subjects, and the results were expressed in kilo-gram of force. The device has the handle in the ideal position. Each tool was designed to allow the user to comfortably grasp the dynamometer while exerting all of his or her physical strength to squeeze the handle. The indicator displayed the greatest effort in kgf. Before the grip strength of the measuring time, the pointer is reset.

Plate 3.4 Digital hand dynamomet

Finger goniometer

A goniometer is a device that either measures angles or enables exact angular positioning of objects. The Greek words gnia, which means angle, and matrons, which means measure, are the roots of the word goniometry. A goniometric stage, also known as a positioning goniometer, is a tool that precisely spins an object around a fixed axis in space. It is comparable to a linear stage, except the stage platform rotates in part on a fixed axis above the mounting surface of the

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platform rather than moving linearly with respect to its base. A partial worm wheel fixed to the underside of the stage platform meshes with a worm in the base to power positioning goniometers, which normally operate in this way. Depending on the automated positioning system, a motor may rotate the worm gear manually. A finger goniometer is used to calibrate degrees. This is used to calculate the joint flexion angle (postural angle). The anatomical fulcrum of the joint measurement and the goniometer's fulcrum were in line. The dial indication on the centre of the limb to be measured is where the goniometer's flat arm is attached. The goniometer's two arms were kept in place while the joint being measured was moved through its full range of motion. Directly from the dial's point parameter indicator, the range of motion was determined.

Plate 3.5 Finger goniometer

Grip diameter cone

The grip diameter cone was used to gauge the subjects' grip diameter. Each participant was instructed to hold the cone with their thumb and middle finger touching. The subject's grip diameter was measured by the equivalent diameter of the circles marked on the cone..

Weighing balance

Each subject's weight was determined using a platform balance (Model: A&D EM-150KAL). The digital readout panel displayed each subject's weight in kilo-gram. For a subject to take part in an ergonomic evaluation efficiently, they must be physically and mentally fit. By checking for normal health through a medical examination, the ten people who were ultimately chosen for the study had enough levels of medical fitness.

Calibration of subjects

Heart rate and oxygen uptake should be correlated for each participant in order to assess the physiological workload using heart rate. In the lab, both variables must be assessed simultaneously under a variety of sub-maximal stresses. Calibrating subjects is the name given to this method.

Polar heart rate monitor

Heart rate monitor is a compact portable instrument to monitor the heart beat rate. This can be used in the field directly.

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This heart rate monitor has three basic components.

- Chest belt transmitter
- Elastic strap
- Receiver unit

Chest belt transmitter

The belt transmitter includes two electrodes with a rectangular groove on the underside that take up the subject's heartbeat and transform it into electromagnetic signals. The electrodes were wetted with water to improve sensing.

Elastic strap

This was done so order to comfortably position the belt transmitter under the pectoral muscles (breasts). The belt transmitter should be comfortable to wear and snug enough to allow for normal breathing.

Receiver

With the aid of a battery that is placed within, this device received signals from the transmitter and displayed them on the screen. This receiver unit can be attached to a watch strap and was positioned within a one-meter radius.

Basal Metabolic Rate

The basal metabolic rate (BMR), which represented the amount of energy expended by a human while at rest, was measured as the first stage in the calibration process. In the post-absorptive stage, a subject's basal metabolic rate was assessed using both the Benedict Roth apparatus and a heart rate monitor.

Calibration procedure

The calibration of a chosen point of objects is done simultaneously using a treadmill and a Benedict-Roth recording spirometer. Water was used to moisten the electrodes in the heart rate monitor's chest belt transmitter before they were affixed to the individuals' chests. Before the test started, the participant was given a chance to rest for 30 minutes. After that, the Benedict-Roth Spirometer was calibrated.

Ergonomic evaluation of the selected coconut dehusking devices

For the purpose of evaluating their effectiveness, the chosen coconut dehusking equipment underwent an ergonomic examination. The research was done at Ergonomics Laboratory. To ensure full cooperation from the subjects, the requirements of the experiment were fully and beforehand explained to them. Despite the fact that the subjects had prior experience using the device to dehusk coconuts, a complete training session lasting a week was provided to familiarize them with it. After each gadget had a finished experience, the task was begun. Prior to the study, the subjects were given 30 minutes of rest.

Energy cost of operation

Each subject was required to use both of the chosen coconut dehusking implements for roughly 25 minutes. They measured the comparable heart rates. The subjects' respective oxygen consumption rates (VO2) for the chosen coconut dehusking tools were determined using the heart rate (HR) values observed during the trials and the calibration chart of the individuals.

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Maximum aerobic capacity

The subject's peak oxygen consumption is known as the maximum oxygen uptake, above which an increase in workload will not cause an increase in oxygen uptake. An international benchmark of cardio-respiratory fitness is the maximal aerobic capacity, often known as the maximum oxygen uptake capacity or VO2max (Gite and Singh, 2005). The information on the link between heart rate and oxygen consumption was used to estimate maximum oxygen consumption (VO2 max). The following relationship was used to determine each subject's maximum heart rate (Bridger, 2008).

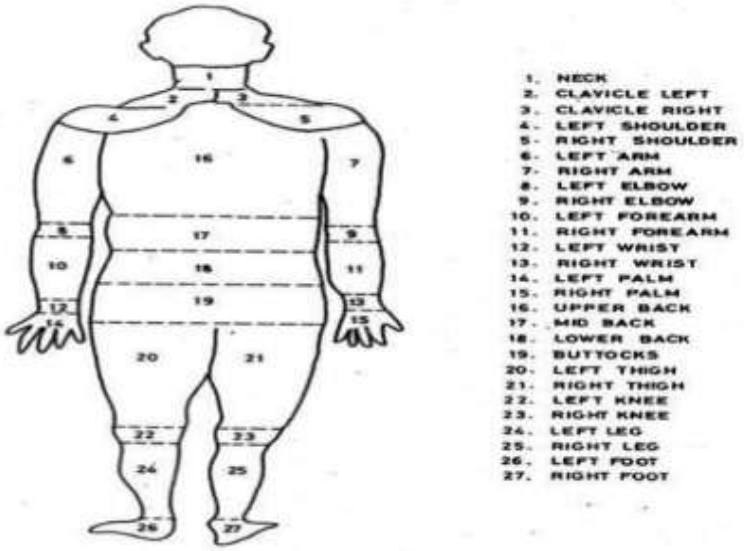
Maximum heart rate (beatsmin^{-1}) = 200 – (0.65 x Age in years)

The maximal aerobic capacity (VO2max) of an individual is determined by intersecting the computed maximum heart rate of the subjects with the plotted calibration chart line and the line of fit to the oxygen uptake. The VO2 max for each treatment was calculated and recorded in order to determine whether the operation of all the chosen coconut climbing equipment was within the acceptable workload (AWL).

Subjective rating

Overall Discomfort rating

The individuals' level of pain while using the device was recorded on a ten point Rated Perceived Exertion (RPE) scale. From 1 to 10, the intensity of discomfort was scaled, with 1 being the least discomfort and 10 the greatest. The rating was indicated by a movable pointer. The RPE scale was displayed to the subjects at the conclusion of each trial to determine their perception of exertion while using the chosen coconut dehuskers.



Regions for evaluating Body Part Discomfort Score

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➢ RESULT AND DISCUSSION

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

3.2 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.

3.3 Analysis of anthropometric data and strength parameters:

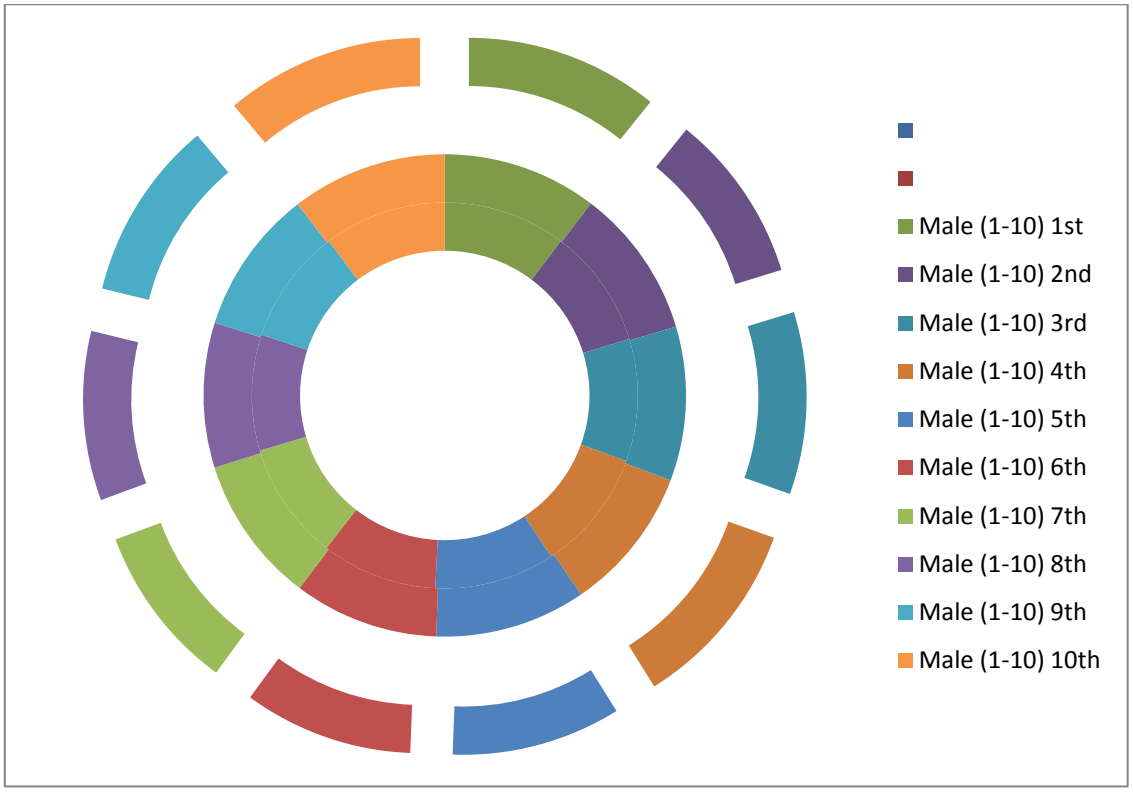

Fig.3.1 Relation between stature, weight and acromion

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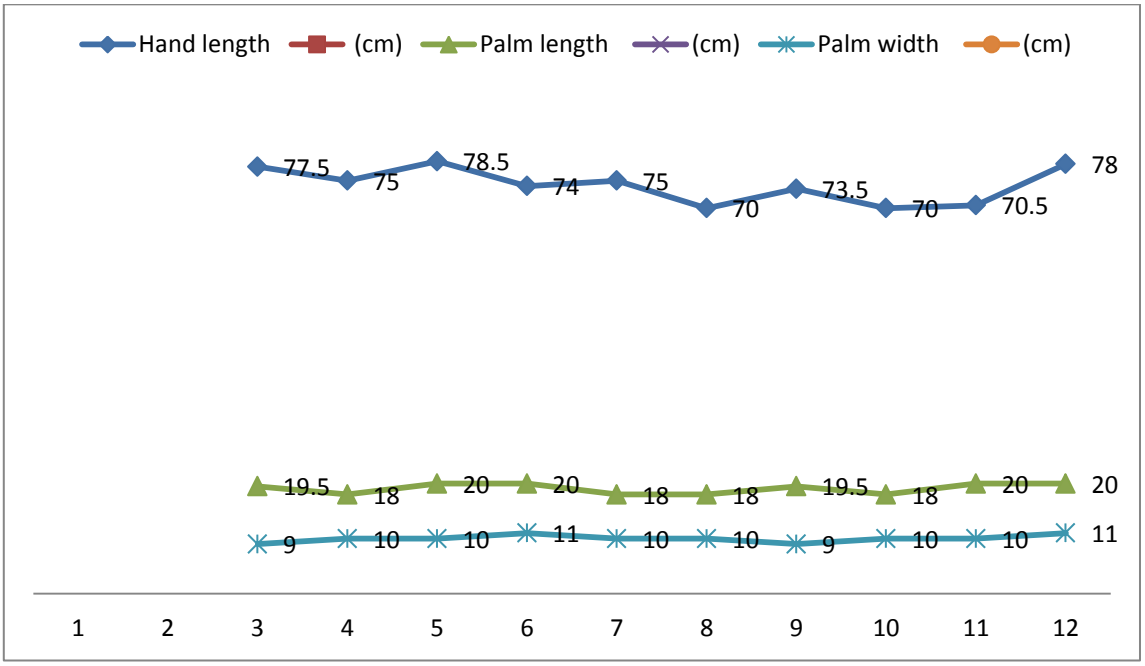

Fig.3.2 Relation between hand, palm length and width

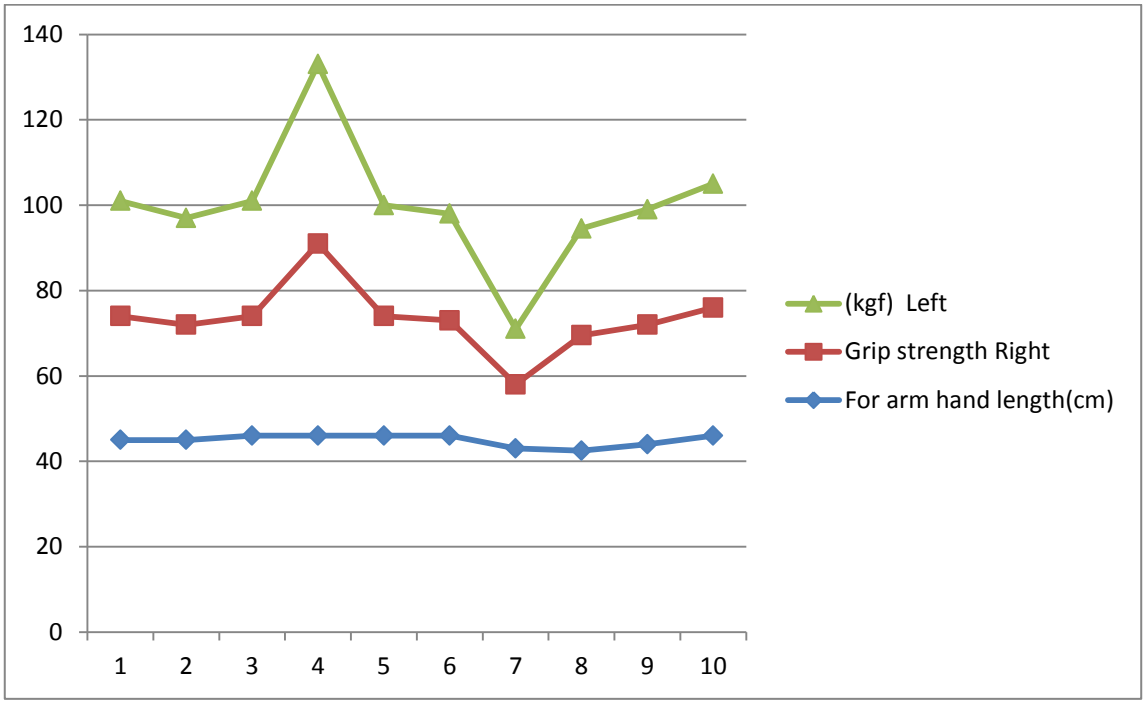

Fig.3.3 Arm hand (L) and grip strength (R&L)

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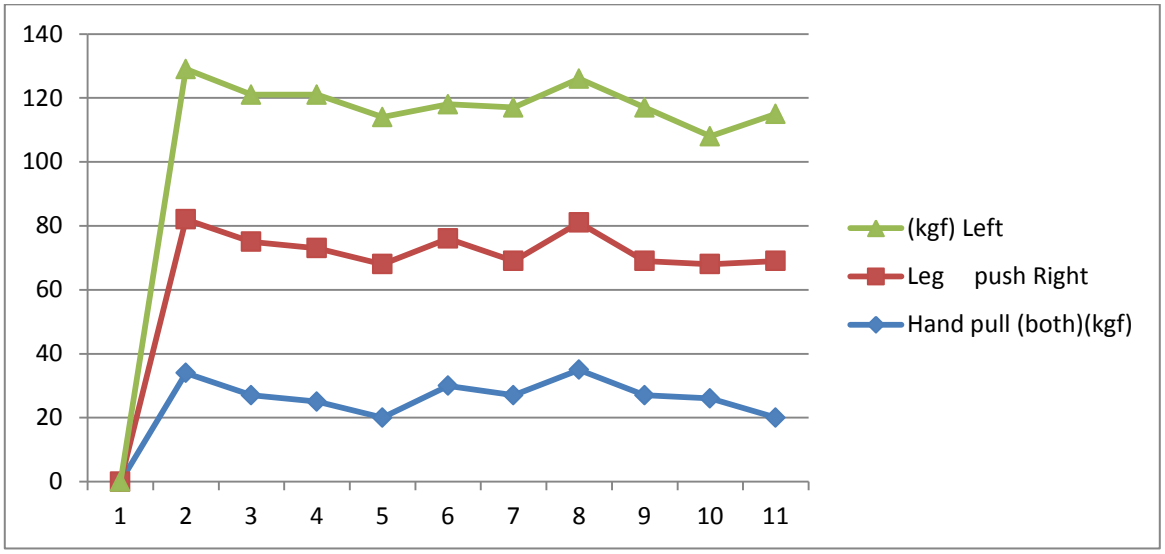

Fig.3.4 Relation between hand pull and leg push(R&L)

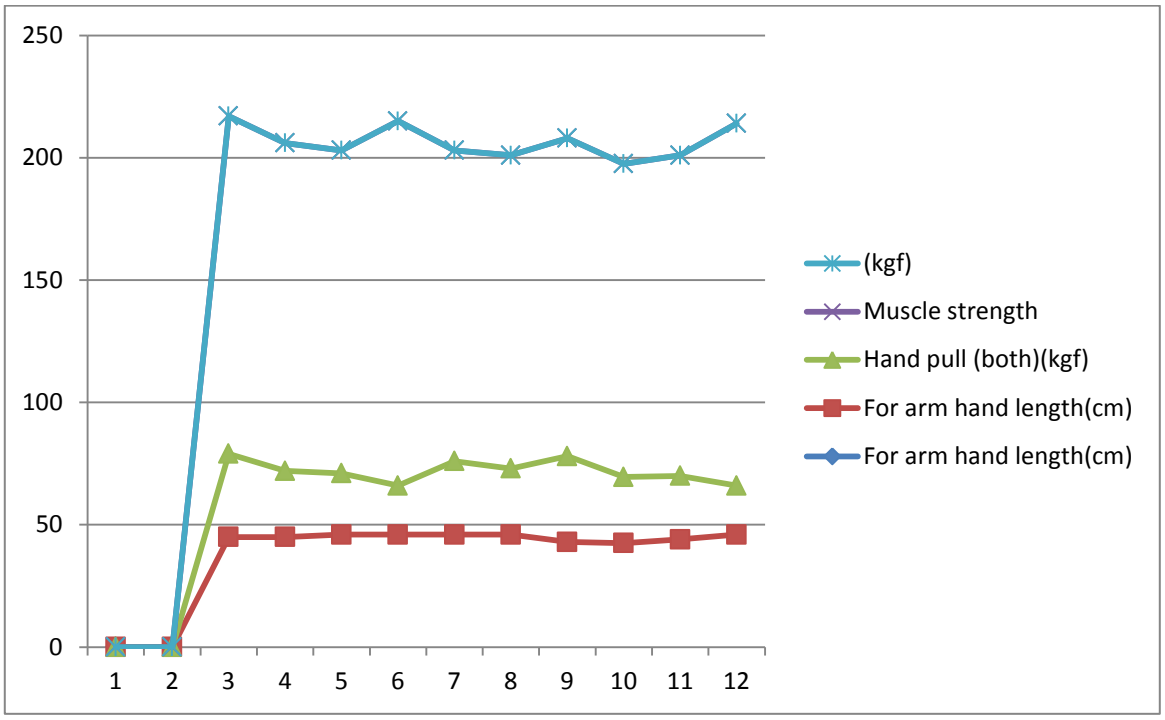

Fig.3.5 Relation between muscle strength with hand

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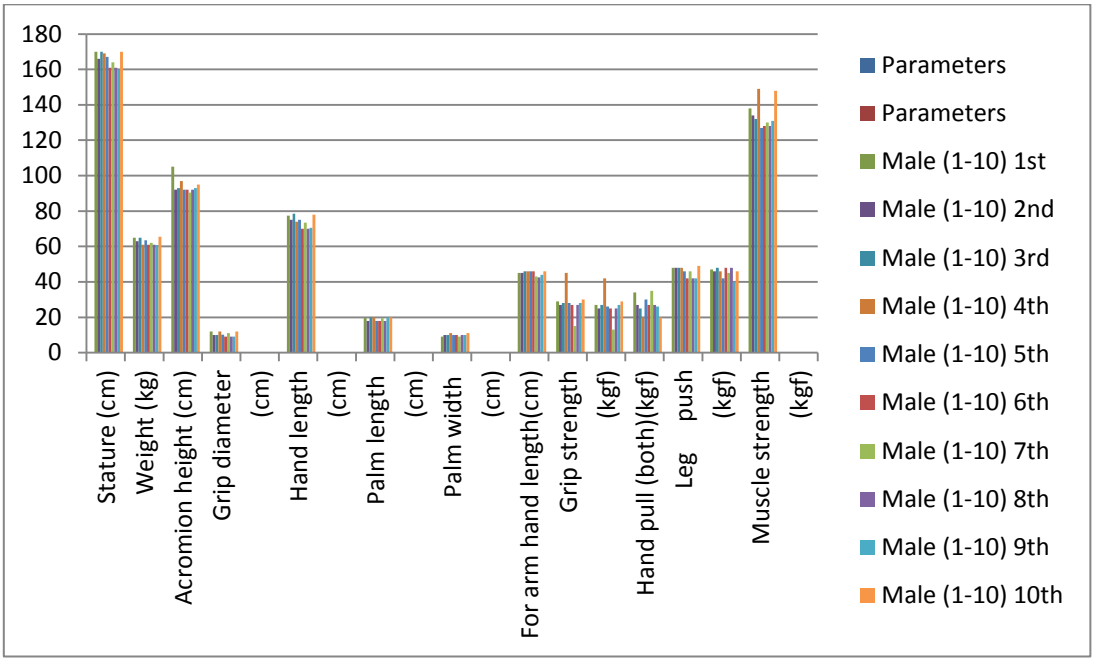
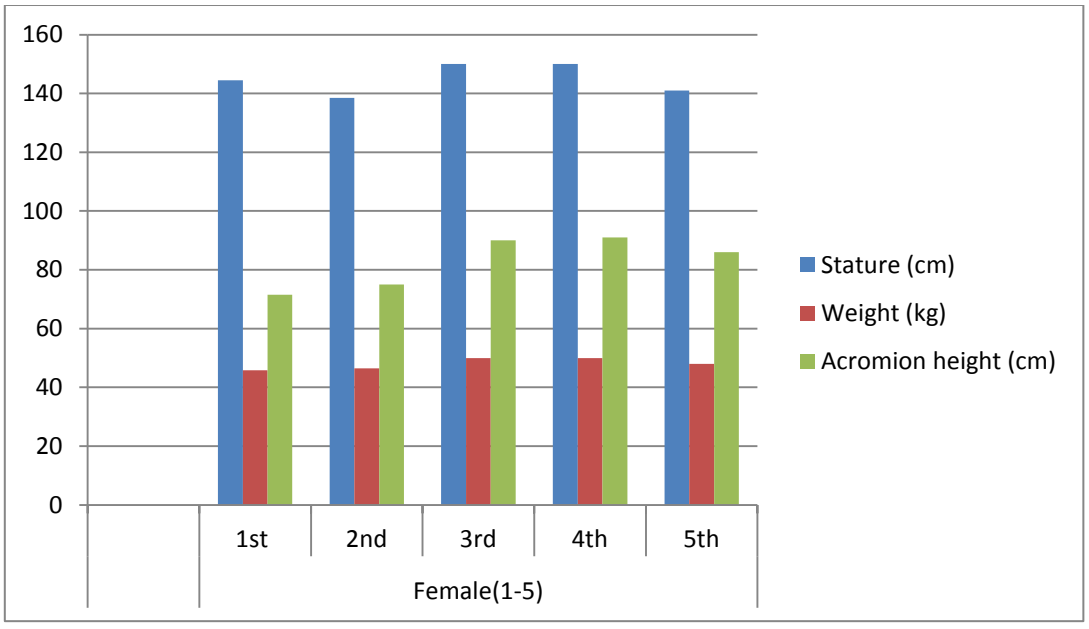


Fig.3.6 Analysis of anthropometric data & strength male parameter

❖ **Analysis of anthropometric data & strength of female parameter**



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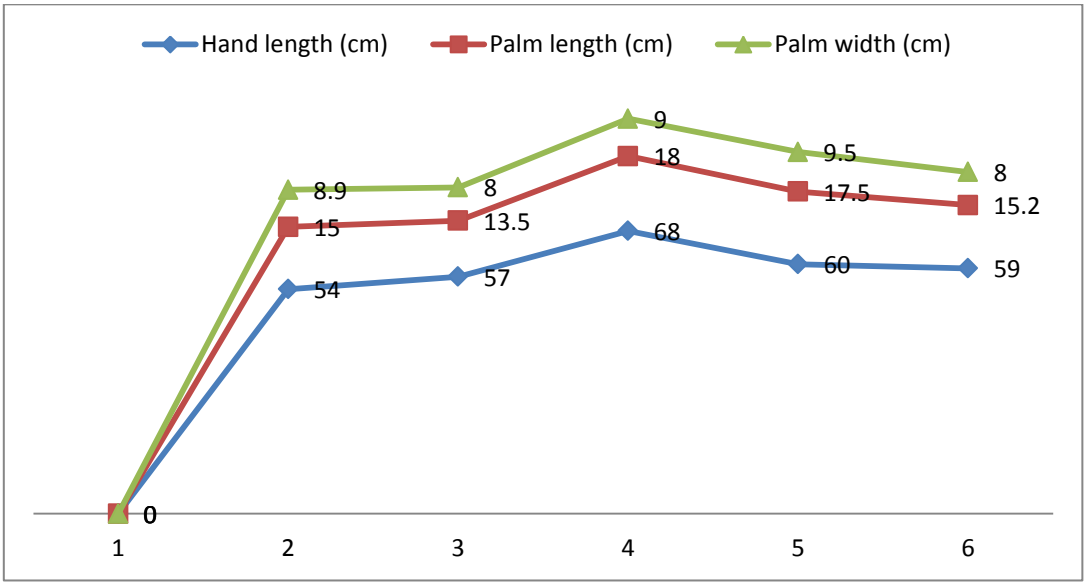

Fig.3.7 Relation between hand, palm length and width

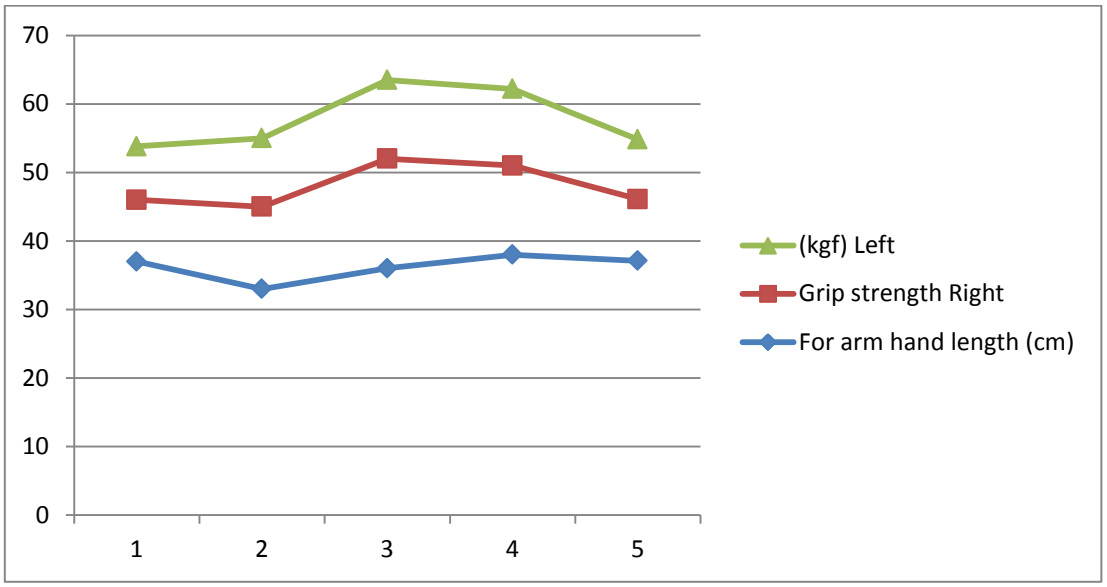

Fig.3.8 Arm hand (L) and grip strength (R&L)

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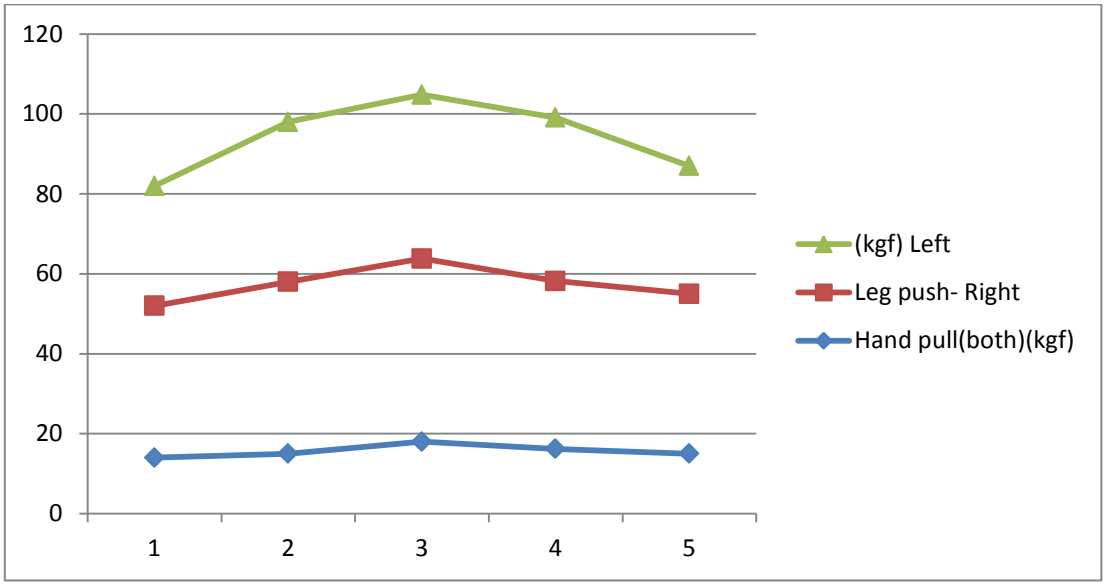

Fig.3.8 Relation between hand pull and leg push(R&L)

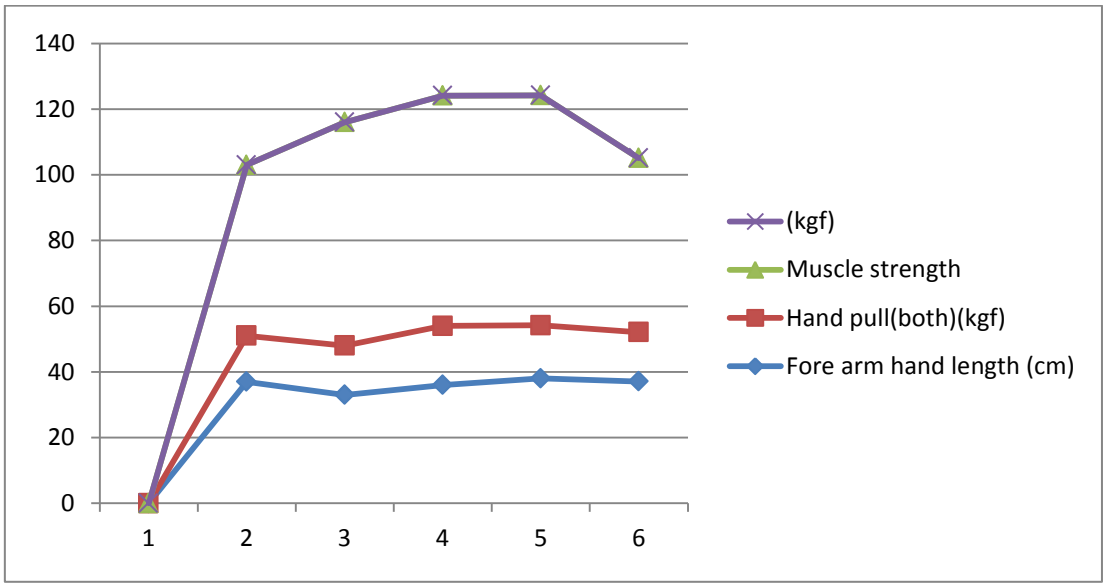

Fig.3.9 Relation between muscle strength with hand

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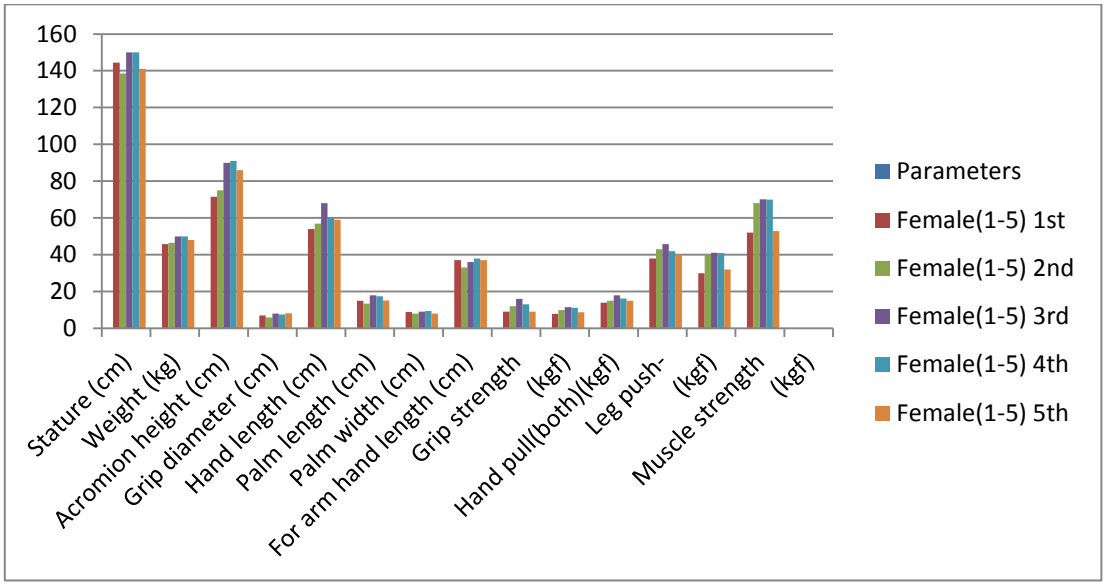

Fig.3.10 Analysis of anthropometric data & strength male parameter

Anthropometric data of selected male and female subjects was collect and tabulated. The measured data of men and women are given in table 4.2 respectively. The stature and weight of the male subjects ranged from 160 cm to 170 cm and 60 kg to 65 kg, while stature and weight of female subjects ranged from 138 cm to 145 cm and 45 to 50 kg respectively.

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.

➢ SUMMARY AND CONCLUSION

Step-I Concluding remarks

A thorough discussion of the objects' work in the fields of ergonomics evaluation and dynamic performance of coconut dehuskers is provided in this article. The study also shows how common working position is among both men and women. One of the earliest attempts to statistically assess the degree of grip strength that workers acquire as a result of workplace stress was made here. 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

The following final conclusions were drawn from the results of the testing of the pedal-operated coconut dehusker. In accordance with the project's overall goals, a pedal-operated coconut dehusker had been devised and built using resources that were readily available in the area. Either a male or female operator can use the machine comfortably while standing up due to its ease of use, slimmer design, and superior ergonomic considerations. You can use and consume this pedal-operated coconut dehusker at home. Implying that unless the machine's capacity is established, machine performance efficiency cannot accurately reflect how well a system operates.

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