The Pharma Innovation Journal 2020; SP-9(8): 44-49

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2020; SP-9(8): 44-49

www.thepharmajournal.com
Received: 05-06-2020
Accepted: 09-07-2020

Naveendra Kumar Patel
Ph.D., Scholar, Department of Farm Machinery and Power Engineering, Shuats, Prayagraj, Uttar Pradesh, India

Dr. RC Ram
Assistant Professor, Department of Farm Machinery and Power Engineering, Shuats, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Naveendra Kumar Patel
Ph.D., Scholar, Department of Farm Machinery and Power Engineering, Shuats, Prayagraj, Uttar Pradesh, India

Ergonomic evaluation of hand operated linseed thresher

Naveendra Kumar Patel and Dr. RC Ram

Abstract
Ergonomics is the scientific study of relationship between human and his/her working environment. A study was conducted on the ergonomic evaluation of hand operated linseed thresher. Anthropometric data of age group operators of (20-23, 24-27, 28-31 and 32-35 years) were determined. Heart rate, oxygen consumption rate, energy expenditure rate and body part discomfort score of age groups were determined during working on linseed thresher at different weight sample of linseed. Anthropometric data of stature, arm length, standing eye height, knee height, elbow height and body mass index were determined for different age groups. Heart rate, oxygen consumption rate, energy expenditure rate and body part discomfort score were increasing when age groups increased at weight sample (1.0, 1.5 & 2.0 kg). Heart rate, oxygen consumption rate, energy expenditure rate and body part discomfort score of 20-23 yrs age groups were found minimum and varied from 90-106 b/min, 0.34-0.52 l/min, 7.08-11.03 kJ/min and 20.16-25.58 respectively on working. Heart rate, oxygen consumption rate, energy expenditure rate and body part discomfort score of 32-35yrs age groups were found maximum and varied from 120-135 b/min, 0.68-0.84 l/min, 14.23-17.67 kJ/min and 44.82-58.07 respectively during working operators on linseed thresher at different weight samples.

Keywords: Linseed crop, hand operated linseed thresher, Heart rate, Energy expenditure, Oxygen consumption and Body part discomfort score

1. Introduction
Linseed (*Linum usitatissimum* L.) is considered as one of the most important economic yarn crops. The major linseed production countries are Kazakhstan, Russia, Canada, China, India, and USA. The area harvested under the crop India is estimate to be 0.30 million hectare. India's production quantity of linseed was recorded as 0.184 million tons during 2017. India is 5th rank among the linseed producing countries during 2017. In India, the major linseed growing states are Madhya Pradesh, Maharashtra, Uttar Pradesh, Bihar, Rajasthan, Orissa, Karnataka, and West Bengal. Madhya Pradesh and Uttar Pradesh together contribute to the national linseed production to the extent of about 70 percent (www.factfish linseed production). Agriculture has an important place in Indian economy and the main work force in it is human power. Table 1. gives the population dynamics of Indian agricultural worker and it was estimated that by 2050, the population of agricultural worker will be about 202 million of which 121 will be the female workers and 81 male workers.

Table 1: Population dynamics of Indian agricultural workers for 2050 (No. in millions)

S. No.	Item	2012	2020	2030	2040	2050
1	Total population	1222	1323	1432	1520	1612
2	Total No. of workers	504	566	641	711	787
3	Total No. of workers as % of population	41.2	42.8	44.8	46.8	48.8
4	No. of agricultural workers	240	230	222	211	202
5	% of agricultural workers to total workers	47.6	40.6	34.6	29.7	25.7
6 (a)	No. male agricultural workers	132	115	100	84	81
(b)	No. of female agricultural workers	108	115	122	127	121
(c)	% of females in agricultural work force	45	50	55	60	60

Source: vision 2050 Document of Central Institute of Agricultural Engineering, Bhopal

Agricultural operations are very labor intensive in India. Farming operation includes working with biological and mechanical systems and farmer has to work in adverse climatic conditions, poor infrastructure, limited implements and machines in ergonomically unsuitable postures.

The word ERGONOMICS is derived from two GREEK words: ERGO (means work) and NOMOS (means rules of laws). Ergonomics is the scientific study of relationship between man-machine and working environment. The ergonomics is the scientific discipline mainly concerned with understanding of the interaction of humans, and the scientific design profession that applies theory, principles, data and methods to design and improve the work system involving machine or job with human as an integral system.

Selection of subject (workers) plays an important role whenever we are conducting an ergonomic study. The subjects are required to be medically fit and represent real user population in operation of the selected machinery. The selection is made on the basis of gender, age, height and weight. In India, generally male subjects are selected for conducting ergonomic studies on agricultural machinery.

The aim of the study was the determination of anthropometric parameters of the operators and also to evaluate the physiological and postural discomfort parameters of different ages of operators at different weight sample of linseed thresher.

Keeping in view the above facts, this study was undertaken with the following objectives:

1. To determine the anthropometric parameters of the operators.
2. To evaluate the physiological and postural parameters of age groups operators on linseed thresher.

2. Materials and Methods

The ergonomic evaluation of hand operated linseed thresher was conducted with male agricultural workers of the farm of SHUATS, PRAYAGRAJ, (U.P), and INDIA. Hand operated linseed thresher is equipped with hand operated which is used for rotating threshing cylinder. In this machine the handling of the threshing cylinder is done manually but holding of the linseed crop over the threshing cylinder done manually. Hand operated linseed thresher is fabricate in the farm machinery workshop. The detail specification of the thresher is given Table 2.

Table 2: Specification of linseed thresher

S. No.	Particulars	Specifications
1	Overall dimensions L×W×H (mm)	500×300×1000
2	Power transmission unit	Hand operated, Chain
I	Drive type	Chain and sprocket
A	No. of Chain & No. of sprocket	1 & 3
B	Sprocket dia. (mm)	70
C	No. of teeth on sprocket	18
II	Blower dia. (mm)	280
3	Crop feeding device	Chute type
I	Method of feeding	Manual, Hold on method
II	Height above ground, (mm)	920
III	Size of opening, (mm)	460 × 390
4	Threshing cylinder	Nylon roller
I	Size of nylon roller, (mm)	300×130
5	Size of open type concave (mm)	380 × 280
6	Blower	Blade type

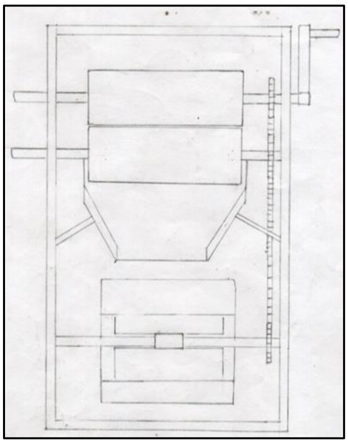


Fig 1: Front view of linseed thresher

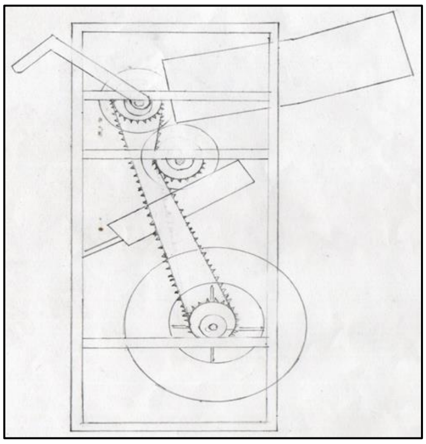


Fig 2: Side view of linseed thresher

Fig 3: Front view of linseed thresher

Fig 4: Side view of linseed thresher

Hand operated linseed thresher is the testing of the agricultural farm. Linseed thresher was evaluated on the basis of physiological and psychological ergonomics parameters viz. heart, Oxygen consumption rate, energy expenditure rate and body part discomfort score for estimation fatigue.

2.1 Selection of age subject operators
Sixteen male agricultural workers from SHUATS, Prayagraj in India were selected age subject for study. Selection of subject plays an important role whenever we are conducting an ergonomic study. In India, generally male subjects are selected for conducting ergonomic studies on agricultural machinery. For this study, different age subjects were selected from the available workforce of different age varied from 20-35yrs as given in table 3. In order to record various data we firstly need the basic measuring instruments for recording the height, weight and anthropometric related data. The instruments, equipments and subjects required in the reading session are as follows:

1. Integrated composite anthropometer-(for measuring multiple body dimension)
2. Measuring tape- (for various body dimensions)
3. Heart rate monitor- (for measuring heart rate)
4. Weighing scale- (for measuring human body weight)

Table 3: Detail of selected different age subjects

S.I. No.	Age group (years)	Height (cm)	Weight (kg)	BMI
1	20 – 23	166	65	23.59
2	24 – 27	170	62	21.45
3	28 –31	172	73	24.68
4	32 – 35	164	70	26.02

The first step is to find the weight and height of the subjects and find out the body mass index of each them. Their health was determined by finding the body mass index is formula given

$$BMI = Weight\ (kg) / [Height\ (m)]^2$$

Determination of variables
- Independent Variable

a. Different age groups = 20 - 23, 24 - 27, 28 - 31 and 32 – 35 yrs
b. Weight sample of linseed = 2.5, 3.5 and 5.0 kg (three replications R_1, R_2 & R_3)

- Dependent Variable

1. Heart rate (b/min)
2. Oxygen consumption (l/min)
3. Energy expenditure rate (kJ/min)
4. Body part discomfort score

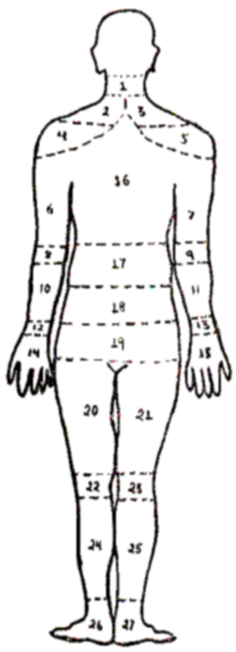
2.2.2 Oxygen consumption (l/min)
The OCR of subject on their measured heart rate was estimated based on general equation as given by Singh *et al.* (2008) [18].

$$OCR = 0.0114 \times HR – 0.68$$

2.2.3 Energy expenditure rate (kJ/min)
The EER was computed by using the following equation given by Nag *et al.* (1980) [16].

$$EER = 20.86 \times OCR\ (kJ/min)$$

2.2.4 Body part discomfort score
To measure localized discomfort, Corlett and Bishop (1976) technique was used. In this method, the body of subject is divided into 27 regions. Each body region was numbered differently to avoid a subject marking on body region only. The subject was asked to mention to all body parts with discomfort, staring with the most painful, the next painful in descending order till no further areas are referred. The number of different groups of body parts which are identified from extreme discomfort to no discomfort represented the number of intensity levels of pain experienced by the operator. If the maximum number of intensity levels of pain experienced for the experiment was five categories, first category (body parts experiencing maximum pain) was given rating of 5 and for second category (body parts experiencing next maximum pain) rating was given as 4 and so on, for the fifth category (body parts experiencing least pain) rating was allotted as one. The number of categories of pain experienced by different subjects might vary.
For example, if one subject has experienced 5 categories, first category (body parts experiencing maximum) rating was allotted as 5 and for second category (body parts experiencing next maximum pain) rating was allotted as 3.75 and so on for the fifth category (body parts experiencing least pain) rating was allotted as 1.25.
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 subjects. The body part discomfort score of all the subjects was added and averaged to get mean score. The same procedure was repeated for all the experiments the overall BPDS would be the average value of all the subjects.



1: Neck
2: Clavicle left
3: Clavicle right
4: Left shoulder
5: Right shoulder
6: Left arm
7: Right arm
8. Left elbow
9: Right elbow
10: Left forearm
11: Right forearm
12: Left wrist
13: Right wrist
14: Left palm
15: Right palm
16: Upper back
17: Mid back
18: Lower back
19: Buttocks
20: Lift thigh
21: Right thigh
22: Left knee
23: Right knee
24: Left leg
25: Right leg
26: Left foot
27: Right foot

Fig 5: Region for evaluating body part discomfort score

3. Results and Discussion

3.1 Anthropometric data of selected age subjects

Anthropometric data of selected subjects were measuring to the integrated composite anthropometer and measuring tape in complete resting condition. Measuring tape was used to all body dimension record the anthropometric data. All the measurement using the tape was taken when the subjects were in a relaxed mode. Four subjects were selected from agricultural engineering farms of different age groups. It is presented in Table 4.

Table 4: Anthropometric data of age (year) subjects for male workers

S.I No.	Anthropometric data	Dimension (cm)			
		20 - 23	24 - 27	28 – 31	32 – 35
1	Stature	166 ± 3.16	170 ± 3.16	172 ± 3.16	164 ± 3.16
2	Arm length	66 ± 2.55	64 ± 2.55	59 ± 2.55	63 ± 2.55
3	Arm span	164 ± 2.12	159 ± 2.12	164 ± 2.12	161 ± 2.12
4	Standing eye height	159 ± 2.06	158 ± 2.06	154 ± 2.06	155 ± 2.06
5	Sitting height	85 ± 1.3	82 ± 1.3	85 ± 1.3	83 ± 1.3
6	Sitting eye height	75 ± 1.22	72 ± 1.22	75 ± 1.22	74 ± 1.22
7	Popliteal height	42 ± 0.71	43 ± 0.71	43 ± 0.71	44 ± 0.71
8	Knee height	51 ± 1.12	52 ± 1.12	50 ± 1.12	49 ± 1.12
9	Pelvic height	90 ± 1.48	93 ± 1.48	89 ± 1.48	91 ± 1.48
10	Elbow height	109 ± 1.87	106 ± 1.87	104 ± 1.87	105 ± 1.87
11	Shoulder height	136 ± 1.3	139 ± 1.3	138 ± 1.3	136 ± 1.3

Body part dimension ± SD

3.2 Heart rate

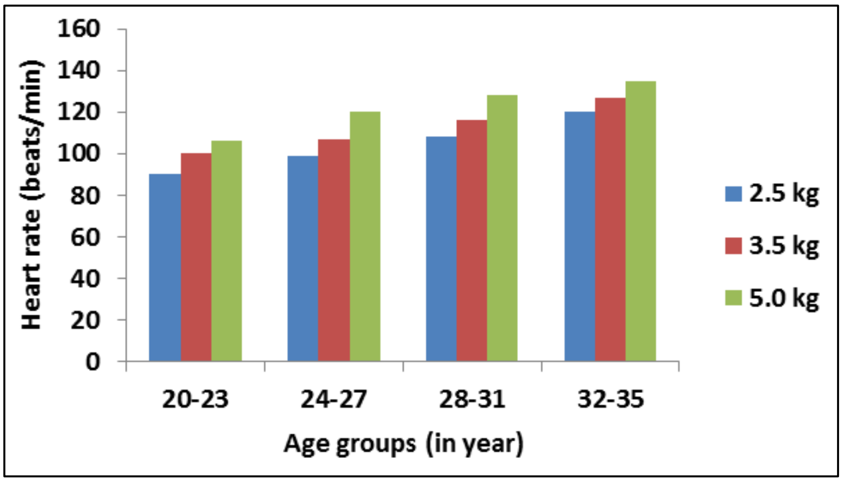


Fig 6: Relationship between age groups and heart rate of workers during working on linseed thresher at different weight sample of linseed

Heart rate of different age groups operators (20-35 yrs) varied from 90 to 135 bpm during operators of linseed thresher at different weight sample (2.5, 3.5 & 5.0 kg). Lowest heart rate was found 90 bpm for the age groups (20-23year) at the lowest level of weight sample and highest heart rate was 135 bpm for the age groups (32-35year) at the higher level of weight sample. The main reason for increased heart rate with age groups found to be irregular design of thresher. The results were found to similar with Tiwari *et al*, (2005).

3.3 Oxygen consumption rate (OCR)

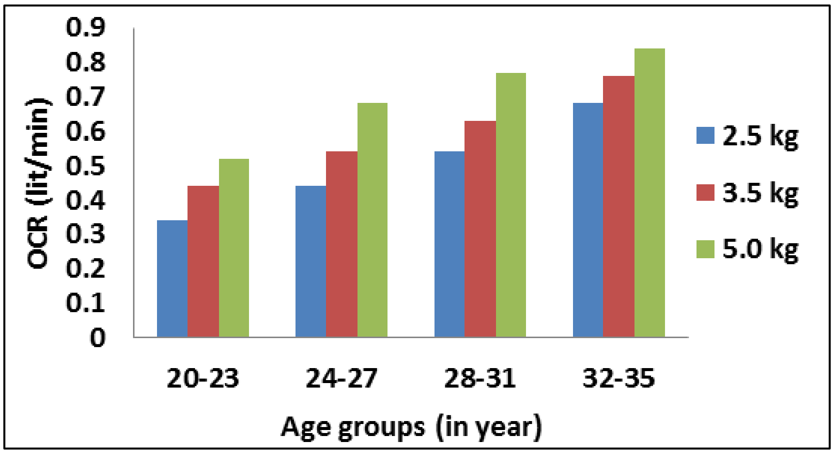


Fig 7: Relationship between age groups and OCR of workers during working on linseed thresher at different weight sample of linseed

Oxygen consumption rate of different age groups operators (20-35 yrs) varied from 0.34 to 0.84 lit/min during operators of linseed thresher at different weight sample (2.5, 3.5 & 5.0 kg). Lowest OCR was found 0.34 lit/min for the age groups (20-23year) at the lowest level of weight sample and highest OCR was 0.84 lit/min for the age groups (32-35year) at the higher level of weight sample. The main reason for increased OCR with age groups found to be irregular design of thresher. The result was found by similar to Singh *et al.*, (2008) [18].

3.4 Energy expenditure rate (EER)

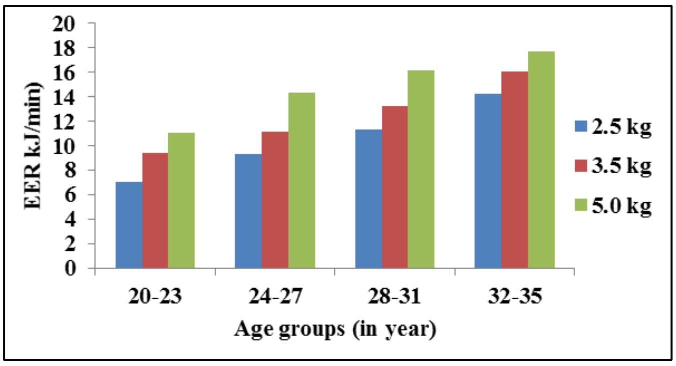


Fig 8: Relationship between age groups and EER of workers during working on linseed thresher at different weight sample of linseed

Energy expenditure rate of different age groups operators (20-35 yrs) varied from 7.08 to 17.67 kJ/min during operators of linseed thresher at different weight sample (2.5, 3.5 & 5.0 kg). Lowest EER was found 7.08 kJ/min for the age groups (20-23year) at the lowest level of weight sample and highest EER was 17.67 kJ/min for the age groups (32-35year) at the higher level of weight sample. The main reason for increased EER with age groups found to be irregular design of thresher. The results were found by similar to Nag *et al*. (1979).

3.5 Body part discomfort score (BPDS)

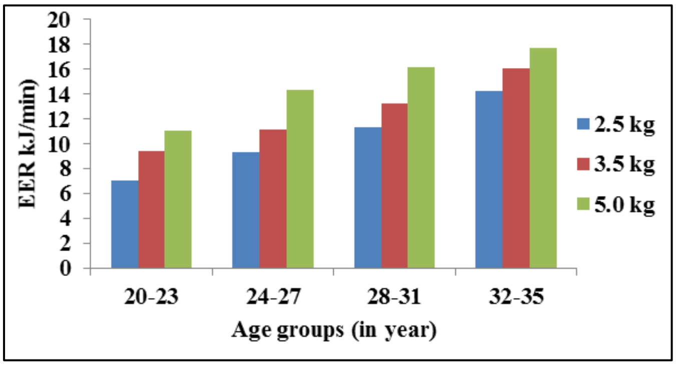


Fig 9: Relationship between age groups and EER of workers during working on linseed thresher at different weight sample of linseed

Energy expenditure rate of different age groups operators (20-35 yrs) varied from 7.08 to 17.67 kJ/min during operators of linseed thresher at different weight sample (2.5, 3.5 & 5.0 kg). Lowest EER was found 7.08 kJ/min for the age groups (20-23year) at the lowest level of weight sample and highest EER was 17.67 kJ/min for the age groups (32-35year) at the higher level of weight sample. The main reason for increased EER with age groups found to be irregular design of thresher. The results were found by similar to Nag *et al*. (1979).

3.5 Body part discomfort score (BPDS)

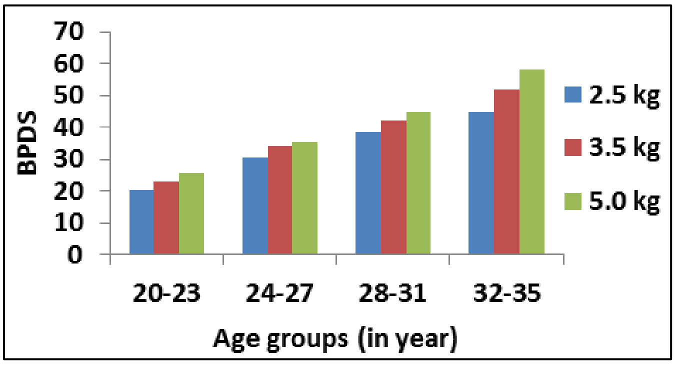


Fig 10: Relationship between age groups and BPDS of workers during working on linseed thresher at different weight sample of linseed

BPDS of different age groups operators (20-35 yrs) varied from 20.16 to 58.07 during operators of linseed thresher at different weight sample (2.5, 3.5 & 5.0 kg). Lowest BPDS was found 20.16 for the age groups (20-23year) at the lowest level of weight sample and highest BPDS was 58.07 for the age groups (32-35year) at the higher level of weight sample. The main reason for increased BPDS with age groups found to improve it in all design of thresher. The results were found to similar with Kumar *et al*, (2002).

4. Conclusions

Following conclusions were drawn from the study:

1. Anthropometric data of age (year) subjects for male workers *viz.* stature, arm length, arm span, standing eye height, sitting eye height, popliteal height, knee height, pelvic height, elbow height and shoulder height were found out using ICA and measuring tape.
2. With increasing age groups of subjects, heart rate also increased when during working on linseed thresher at different weight sample.
3. With increasing age groups of subjects, oxygen consumption also increased when during working on linseed thresher at different weight sample.
4. With increasing age groups of subjects, energy expenditure also increased when during working on linseed thresher at different weight sample.
5. With increasing age groups of subjects, body part discomfort score also increased when during working on linseed thresher at different weight sample.

5. References

1. Astrand PO, Rodahl K. A textbook of work physiology. Mc Graw Hill, New York, 1986.
2. Bimala Rana K, Gandhi S, Dilbaghi M. Ergonomic evaluation of farm women picking cotton, A paper presented in the International Congress on Humanizing Work and Work environment held at IIT, Mumbai, December, 2001, 11-14.
3. Bobbert AC. Physiological comparison of three ergometry. Journal of Applied Physiology. 1960; 15(6):1007-1014.
4. Bonjer FH. Relationship between working time, Physical working capacity and allowable calorie expenditure. (Quoted in the fundamental of exercise testing by Lange Andssen et al, Geneva W.H.O-1971), 1968, 115.

5. Brouha L. Physiology in Industry. Pergamon Press, New York, 1960, 3.
6. Baruah TS, Mondal A, Gharami, Adak D. The Tai-Phake of Assam, India – A Morphometric Study and Population Comparison with Neighbouring Groups. Coll. Antropology. 2006; 30(3):579-583.
7. Barroso MP, Arezes PM, Costa LG, Miguel AS. Anthropometric study of Portuguese workers. International Journal of Industrial. Ergonomics. 2005; 35(5):401-410.
8. Corlett EN, Bishop RP. A technique for assessing postural discomfort Ergonomics. 1976; 19:175-18.
9. Chandra A, P Chandna, S Deswal. Analysis of Hand Anthropometric Dimensions of Male Industrial Workers of Haryana State. International Journal of Engineering (IJE). 2011; 5(3):242-256.
10. Deupree RH, Simon JR. Reaction time and movement time as a function of age stimulus duration and task difficulty. Ergonomics. 1963; 6(4):403-411.
11. Dewangan KN, Prasanna Kumar GV, Suja L, Choudhury MD. Anthropometric dimensions of farm youth of the north eastern region of India. International Journal of Industrial Ergonomics. 2005; 35(11):979-989.
12. Ghugare BD, Adhaoo SH, Gite LP, Panday AC, Patel SL. Ergonomics evaluation of a lever operated knapsack sprayer. Applied Ergonomics. 1991; 22:241-50.
13. Gite LP, Yadav BG. Anthropometric survey for agricultural machinery design. Applied Ergonomics. 1989; 20(3):191-196.
14. Kathirvel K, Vidhu KP, Manian R, Senthilkumar T. Ergonomic evaluation of cono weeder for paddy, A paper presented at 37th ISAE convention held at Udaipur, 2002.
15. Khogare DT, Borkar S. Anthropometric data of agricultural workers for suggesting demensions of manually operated weeder. Asian Journal of Home Science. 2011; 6(1):57.
16. Nag PK, Dtta P. Effectiveness of some simple agricultural weeders with reference to physiological responses. Journal of Human Ergology. 1980; 8:13-21.
17. Rahi AMA. Ergonomical studies on agricultural workers for selected farm operation. Unpublished M.E. Thesis, CTAE, MPUAT, Udaipur, 2003.
18. Singh SP, Gite LP, Majumder J, Agarwal N. Aerobic capacity of farm women using sub-maximal exercise technique on tread mill. Agricultural Engineering International: the CIGR E Journal.10: Manuscript MES 08001, 2008.
19. Tewari VK, R Ailavadi, KN Dewangan, S Sharangi. Rationalized database of Indian agricultural workers for equipment design. Agricultural Engineering International. The CIGR Ejournal. Manuscript MES 05 004. Vol. IX. August, 2007.