

A DECISION SUPPORT SYSTEM FOR ERGONOMICS STUDIES

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Abstract

Agricultural ergonomics has been gaining much importance in recent years. Evaluation of developed machines in ergonomic point of view is of utmost importance for attaining safety and comfort of the operator. Analysis of different ergonomic parameters like physiological cost of operation, vibration and noise etc. and subsequent comparison with different international standards are time consuming and cumbersome. So any type of user interactive and automated calculation, analysis and subsequent comparison with standards can be helpful for scientific experiments of effective practical value.

Noise, Vibration and Harshness (NVH) software, though available in industrial field, are yet to be in operation for agricultural sector. A user interactive software, 'ergo-NVH-ag 1.0', was developed in Visual Basic 6.0 for parameters like noise and vibration analysis, physiological cost and BMI prediction. The developed software is equipped with noise and vibration databank of tractor and power tiller available in India.

The software calculates the energy expenditure rate, noise level and vibration emission on basic data input, compares them with standards and comes up with useful decision information on efficient human management for safer operation of tractor and power tillers.

Key words: NVH, ergonomic analysis, DSS, Noise, Vibration

SAFETY WITH PESTICIDE AND ISSUES IN USE OF PERSONAL PROTECTIVE EQUIPMENT FOR AGRICULTURAL PURPOSES

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Abstract

The pesticides are beneficial in terms of controlling crop damages due to insect and pest, disease etc but equally dangerous to health of human beings. Agriculture in India employs about 242 million workers, which is about 52% of the working population and exposed to chemical hazards. The exposure to chemical and other occupational hazards are well defined with strict regulations under industrial laws for organized sector. However, protective measures and safety guidelines are almost non-existent in agriculture.

Studies have reported that operators often do not wear proper clothes, shoes and other protective equipment while performing the spraying operation. According to the survey conducted on agricultural accidents occurred during 2004-05 in nine districts of Madhya Pradesh, it was found that accident incidence rate while spraying was reported as 45/100,000 workers/year. Apart from this the flow of dangerous chemicals in operator's blood through skin contact and breathing go unnoticed. The long term exposure or repeated exposure leads to many chronic diseases, which often not realized by operators. Use of personal protective equipment (PPE) is recommended for use during spraying operation, which is seldom utilized by operators. Therefore, 16 commercially available PPEs (respiratory mask – 7, hand gloves –5 and eye protectors-4) were collected and tested as per BIS standards for their suitability. It has been reported that PPEs are often not utilized due to higher degree of discomfort felt by operators. Therefore, eleven subjects were asked to evaluate the associated discomfort with the selected PPEs. Cartridge type respiratory masks suitable for chemical safety was rated highly uncomfortable (ODR 6.4-7.6) by all operators.

Weight experienced on the face and breathing resistance were found to be the major factor associated with respirator masks causing discomfort to operator, while perspiration was found to be the major factor in case of hand gloves. Eye protectors made of transparent plastics were found to be more comfortable and having better visibility as compared to eye protector made of opaque hard plastic frame with glass ocular. The design refinements are needed to reduce weight experienced by operator in respirator and for better absorption of sweat in hand gloves.

Keywords: safety, pesticide personal protective equipment, agricultural purposes

AN ERGONOMIC EVALUATION OF SPADING ACTIVITY AMONG THE CHILD LABOURS IN AGRICULTURAL SECTOR IN WEST BENGAL, INDIA

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Abstract

Agriculture is an industry with tremendous opportunities for the application of ergonomics principles. Majority of child labour is mainly found in agricultural sector in India. During different sort of agricultural activities in potato cultivation, the child agricultural workers faced lot of problems (feeling discomfort and pain) during and after the work due to awkward posture for prolonged period in the agricultural field, which may lead to musculoskeletal disorder in near future.

Spading activity is mainly considered as one of the most strenuous activity in agricultural sector. During this activity, the male and female child labours perform considerable amount of manual and rigorous tasks in the agricultural field in an awkward and constant forward bending, twisting posture for prolonged period of time which mainly responsible for discomfort feeling in different parts of the body especially at lower back and knee regions of the body. Even the posture adopted during spading activity was found to be most hazardous and require correction as soon as possible as revealed by OWAS method.

From this study it can also be concluded that male and female child labours in agricultural sector perform considered amount of high intensive, continuous, repetitive job, which may lead to discomfort feeling (pain) at the upper extremities (wrist, hands and shoulder) and may cause CTD in near future.

This study shows also that the heart rates of male and female child labours in agricultural sector were at very high level, i.e. 170 and 175 beats/min respectively, indicated enhanced cardiac load during spading.

Keywords: Child labour, Agriculture, Posture, OWAS, Cardiac load.

**OCCUPATIONAL HEALTH HAZARDS AND USE OF WOMEN FRIENDLY
TECHNOLOGY IN AGRICULTURE**

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Abstract

The study was undertaken on a sample of 150 farm women from rural areas of Haryana to assess the occupational health hazards and the usage pattern of women friendly technologies in agriculture on four major crops viz. wheat, cotton, paddy and maize. Weeding, harvesting and threshing were the most common activities performed by farm women.

An average woman spent maximum time on harvesting of various crops viz., wheat (11.18 hrs/day) followed by cotton picking (11.15 hrs/day), paddy (10.42 hrs/day) and maize (7.50 hrs/day). However, on annual basis weeding of wheat took more time (59.3 man days) than harvesting (45.4 man days). Picking of cotton took 58.5 man days followed by weeding (35.9 man days). Harvesting of wheat & maize reported maximum physical stress on the farm women getting maximum mean score 4.38 and 4.67 respectively followed by cotton picking and weeding. Farm women faced maximum health hazards due to physical factors with a mean score ranging from 4.38-4.67/5.00 as they observed fatigue and pain in body parts.

Using unnatural body posture for longer duration and use of traditional tools were the main reasons. Hence, the women friendly technologies to perform these activities were found out. Results reveal that though the awareness was more for improved sickle, pick bag, capron, wheel hand hoe/weeder, tubular maize sheller but their usage was lesser. Thus, there is a need to improve the women's access to appropriate technologies which would reduce the related occupational health hazards, thereby, leading to enhanced productivity and preserving the health of women.

Keywords: Occupational health hazards, women friendly technologies

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PEDAL POWER FOR OCCUPATIONAL ACTIVITIES: OPTIMAL POWER OUTPUT AND PEDALLING RATEP. S. Tiwari[‡], L. P. Gite^{*}, M. M. Pandey^{**} and A. K. Shrivastava^{***}^{*}Central Institute of Agricultural Engineering, Nabibagh, Berasia Road, Bhopal-462038 (MP)^{**}Indian Council of Agricultural Research, Krishi Anusandhan Bhavan-II, Pusa, New Delhi-110012^{***}College of Agricultural Engineering, JNKVV, Adhartal, Jabalpur-482004 (MP), INDIA
Email: pstiwari60@yahoo.com; pst@ciae.res.in**Abstract**

Until about two and half centuries ago, muscle-power had been the prime source of energy for performing all the physical activities on our earth. Pedal power enables a person to drive devices at the same rate as that achieved by hand cranking, but with far less effort and fatigue. The use of pedal power for occupational work such as stationary farm operations has got scant attention in the past. Keeping these points into consideration a study was planned to optimise power output and pedalling rate for pedal work during stationary farm operations.

Physiological and psychophysical responses of 12 agricultural workers were studied on a computerised bicycle ergometer at five levels of power output (30 to 90 W) and seven levels of pedalling rates (30 to 90 rpm).

Statistical analysis of data indicated that physiological and psychophysical responses were significantly affected with power output as well as pedalling rate. Increase in physiological responses (heart rate and oxygen consumption rate) over rest were significantly higher when pedalling frequency was 30 rpm and above 50 rpm. There was no significant difference between physiological responses at 40 and 50 rpm. Physiological responses increased linearly with power output and were significantly different from each other. The delta values of physiological responses at 60 W power output and 50 rpm pedalling rate ($\Delta HR = 40.5$ beats/min and $\Delta VO_2 = 0.56$ l/min) were within acceptable limits for continuous pedalling work.

It can be concluded that for daylong pedalling work the power output should be limited to 60 W and pedalling rate should be 50 rpm.

Keywords: Pedal work, power output, pedalling rate, physiological responses

**EVALUATION OF RIDE AND HAND-ARM VIBRATIONS
TRANSMITTED TO TRACTOR OPERATOR¹**

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Abstract

The occupational hazards of tractor driving include disorders of the spinal column and stomach. These ailments are caused by vibration. Besides, these also result in a lowering work output and quality. In view of the deterioration in health and working efficiency attributed, at least in part, to the ride and hand-arm vibration, it is highly desirable for the seat and steering wheel to attenuate tractor vibration as much as possible. Ride and hand-arm vibration levels were measured by OR 36 - 8 channels sound and vibration measuring and analysing instrument (OROS, France make) on 35 hp tractor.

The tests were conducted on two different surfaces, namely, a tar-macadam road and a farm road during the transport mode of the tractor alone. The ride vibration levels at man-seat interface were measured at three different forward speeds of travel during transport mode on tar road at 4.7, 9.4 and 13.7 km/h and on farm road at 4.8, 7.1 and 8.6 km/h speeds. The hand-arm vibration levels were measured at two different forward speeds of travel during transport mode on tar road at 10.5 and 17.2 km/h speed and on farm road at 4.8 and 10.6 km/h speeds. Proper selection of frequency weightings were applied as applicable for input X, Y, Z and overall directions. The measured ride vibration levels under different operating conditions were compared with the values specified under ISO 2631/1, 1985 and given in the frequency bands of 4 to 8 Hz for vertical (a_z) axis and 1 to 2 Hz for longitudinal (a_x) and lateral (a_y) axes in relation to working efficiency and health and safety of the operator.

The results indicated that the ride vibration levels were within the 8 h exposure limit (ISO 2631/1, 1985) under most of the operating conditions. However, the 8 h fatigue decreased proficiency (fdp) limit was exceeded at higher forward speeds of travel under different operating condition in low frequency range at 4-5 Hz in vertical axis. It was concluded that ride vibration levels exceeded the 8 h fdp limit in the most human sensitive frequency ranges (below 8 Hz). The study indicated that ISO 5349 (1986) weighted r.m.s. acceleration levels in all the axes were higher on farm road as compared to tar road at different forward speeds of travel. The hand-arm vibration levels in x and y axes are within the 2 h, 4h and 8 h ISO 5349 limits at different forward speeds of travel except at 32 Hz frequency at 17.2 km/h speed on tar road in x axis. It exceeded the 2 h, 4 h and 8 h ISO 5349 limits at 63 Hz frequency in z axis under different operating conditions.

It highlighted the need to reduce vibration at 63 Hz frequency transmitted to the steering wheel of the tractor.

Keywords: ride vibration, hand-arm vibration, tractor

ERGONOMIC EVALUATION OF PADDY DRUM SEEDER

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Abstract

Upland rice is generally grown by transplanting method. Raising of nursery and manual transplanting are both labour extensive and causes drudgery to the workers. Direct seeding of sprouted rice seeds in well puddled soil reduces time and money of the farmers and drudgery to the workers. A CIAE designed 4-row direct paddy seeder was selected for ergonomic evaluation at farmer's field. Randomized block design was followed for the experiment.

Motivated 12 female and 9 male agricultural workers of north eastern region were selected for the study. All the workers operate the equipment for 1 hour. Resting and working heart rate and work related body parts discomfort during operation of direct paddy seeder was measured. Relationship between heart rate and oxygen uptake was determined in the controlled laboratory condition. Energy expenditure rate was determined by indirect method.

Results indicate that the resting and working heart rate of female workers were 81 ± 6 beats/min (Mean \pm SD) and 147 ± 12 beats/min, respectively. The energy expenditure of female subjects during working conditions was 24.35 ± 5.31 kJ/min. On the other hand the resting and working heart rate of male workers were 76 ± 12 beats/min and 137 ± 21 beats/min, respectively. The energy expenditure of male subjects during working conditions was 27.42 ± 6.07 kJ/min. The body parts discomfort score were vary from 0 to 2.11 (Borg CR-10 scale) among the female and male agricultural workers.

Key words: Direct paddy seeder, physiological cost, work related body parts discomfort scores, heart rate.

ERGONOMICAL EVALUATION OF PRE-GERMINATED PADDY SEEDERG C Satapathy¹ and S K Mohanty²

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nology, Bhubaneswar

Email: satapathygc@yahoo.co.in**Abstract**

Ergonomical evaluation of manual pregerminated paddy seeders were conducted at Central Farm, OUAT, with fifteen male subjects in the age group of 18 – 45 years. Their physiological parameters like Working heart rate (WHR), Work pulse (WP), Oxygen consumption rate (OCR), Relative cost of work load (RCWL), Energy expenditure rate (EER) and Overall discomfort rate (ODR) were measured during seeding operation.

Their mean value of age, weight, stature and VO₂ max were observed to be 31.3 + 8.46 yrs, 57.4 + 10.5 kg, 164.8 + 9.6 cm and 1.95 l/min + 0.09 respectively. The mean value of WHR was recorded to be 135.7 + 3.05 beats/min and 144.6 + 4.42 beats / min with 4 row and 6 row seeders. Both seeders can be operated above the LCP limit of 40 work pulse. Their mean value of OCR was noticed to be 0.95 + 0.06 and 1.06 + 0.07 l / min for 4 row and 6 row paddy seeders respectively. They operated at the energy expenditure rate 19.9 + 1.3 kJ/min and 22.0 + 1.5 kJ/min with 4 row and 6 row paddy seeder respectively. The relative cost of workload was recorded to be 48.7 % and 54.4 % of their VO₂ max with 4 row and 6 row pregerminated paddy seeders respectively.

As per the grading of energy cost of work, both the seeders may be categorized as very heavy type of operation. The mean values of Overall discomfort rating of the subjects were observed to be 6.5 + 0.3 and 7.0 + 0.4 for 4 row and 6 row seeder respectively. The field capacity recorded to be 0.09 ha/day for 4 row and 0.12 ha/day for 6 row seeder. The maximum operating time for 4 row and 6 row paddy seeders were observed to be 28 and 32 mins respectively. Rest period of 10 mins and 12 mins are required for 4 row and 6 row seeder for achieving normal heart rate.

Keywords: Ergonomical evaluation, pregerminated paddy seeder, Working Heart Rate, OCR, RCWL

**MANUAL TRANSPLANTING OF RICE: AN ERGO-ECONOMICAL
ANALYSIS IN ORISSA**S K Mohanty¹ and G C Satapathy²

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Email: skmohantyaet@yahoo.com, santosh_mohanty26@yahoo.co.in**Abstract**

Ergonomical Evaluation of two row and four row manual rice transplanters were conducted. The physiological and mechanical parameters were compared with that of random transplanting methods. Fifteen female subjects in the age group of 18-45 years were selected as per the anthropometric data surveyed in Orissa. Working heart rate (WHR), Oxygen Consumption Rate (OCR), Blood Pressure (BP) were measured of each subject and the average data from 6th minute to 15th minute of continuous operation are analyzed. Pulling force and Overall Discomfort Rate (ODR) were measured during the transplanting operation.

The mean value of WHR and OCR was recorded to be 134.7 beat min⁻¹ and 1.03 l min⁻¹ for male workers and 130.4 beat min⁻¹ and 0.99 l min⁻¹ for female workers while transplanting with 2-row rice transplanter. But in case of 4-row rice transplanter the mean value of WHR and OCR was recorded to be 138.5 beat min⁻¹ and 1.13 l min⁻¹ for male workers and 135.4 beat min⁻¹ and 1.09 l min⁻¹ for female workers. Average area coverage per day in random transplanting was varied in the range 0.02 to 0.04 ha / day. The average area coverage per day in 2-row transplanting and 4-row transplanting was varied in the range of 0.05 to 0.07 ha / day and 0.09 to 0.11 ha/day respectively.

The cost of operation of 2-row transplanting and 4-row transplanting was calculated to be Rs 2227 and Rs 1584 per hectare of rice field against Rs 3500 in random transplanting methods.

Keywords: Ergonomical evaluation, Rice, Working Heart rate, Oxygen consumption rate, Overall discomfort rate, cost of operation

ERGONOMIC EVALUATION OF POUNDING OF RICE WITH TRADITIONAL TOOL

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Abstract

Pounding of rice for preparation of indigenous food items is a food processing activity in rural Assam. Pounding is performed by rural women for preparation of flake rice, roasted powdered rice, plain powdered rice etc. The traditional tool used by the rural women for pounding is called '*Dhenki*'. The processing of food products with this indigenous tool is highly time consuming and laborious.

Therefore, an attempt was made to assess the physiological workload, muscular and postural stress involved in the process of pounding rice. Twenty rural women without any health problem and who are actively involved in pounding of rice were selected for experiment. Heart Rate for the experiment was recorded with Polar Heart Rate. Physical fitness was assessed by using Step Stool Ergometer Rating of Perceived Exertion (RPE) was calculated using Borg's 5 point rating scale while Body Map was used to identify pains in different body parts.

Majority of the respondents belonged to 'Ectomorphic' group. PFI showed that about 53 percent of the respondent had 'high average' physical fitness. Average and Peak heart rate values while pounding were found to be 118.18 b.min⁻¹ and 123.60 b.min⁻¹ respectively. The resting heart rate values of rural women were 80 b/min⁻¹. The average and peak energy expenditures were observed to be 10.04kJ/min and 10.93 kJ/min. The physiological workload of pounding of rice was categorized as 'Moderately Heavy' and 'Heavy' activity respectively. Average rating of perceived exertion (RPE) was 3.8 in 5 point scales. About 73 percent of the respondents experienced incidence of pain in low back, buttock, thigh, knee joint, ankle, and feet from 'moderate' to 'severe' while pounding.

Ergonomic intervention through improved work station would reduce the drudgery of rural women in pounding of rice.

Keywords: Dhenki, physiological workload, muscular stress