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Occupational Health Complaints of Female Agricultural Workers in Rice Cultivation System

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ABSTRACT

Female workers play a crucial role for the well being of rural families and work for 14-16 hours a day using the convenient tools and small farm implements. Inspite of her intensive involvement in most arduous agriculture and allied activities her work is not recognized in monetary term. By 2020, the number of female workers engaged in various agricultural activities, in Indian will be about 115 million. Therefore more emphasis will have to be given on development of gender friendly tools and equipments. Skill up gradation of these women workers will be necessary to enable them to operate the tools and equipments in comfortable and safe manner (Gite, 2014). Keeping this in view occupational health complaints of female agricultural workers in rice cultivation system are studied. The strength and efficiency of the female agricultural workers is $2/3^{rd}$ of male workers (Astrand and Rodahl, 1986). Thus studies on human energy measurements in agricultural operations of female workers can provide a rational basis for recommending methods and implements for performing the agricultural operations most efficiently and safely (Gite and Singh, 1997). Therefore, ergonomical study was conducted for different operations in rice farming system by using various farm implements and machines with female workers. Ergonomical parameters like working heart rate, oxygen consumption rate, energy expenditure rate and relative cost of work load (% of VO_{2max}) of female agricultural workers performing different operations in rice cultivation system were studied. Subjects in the age group of 18 to 45 years were selected for this study. The selected subjects had previous experience of using agricultural implements and machines as they are working in OUAT farm for many years. Everyday the experiment was conducted between 9.00 AM to 1.00 PM. The duration of each trial was kept 20 min continuously for recording of heart rate and oxygen consumption rate of subject. The heart rate, oxygen consumption rate during 6^{th} to 20^{th} min of work for each subject was measured as one's heart rate and oxygen consumption rate get stable after 3 to 5^{th} minute of continuous operation (Vidhu, 2001 and Mohanty, 2004). The energy expenditure rate was computed by multiplying 28.86 kJ/ min with VO_2 for Indian workers (Nag and Dutta, 1980). It was observed that the maximum aerobic power ($VO_{2\ max}$) of female workers varied from 1.56 to 1.81 l / min. The working heart rate (WHR) during different operations varied from 98.2 to 138.4 beats/min for female workers. The relative cost of work load (RCWL) of different operations varied in the range of 30.6 to 71.2 per cent for female workers. The highest energy expenditure rate (EER) was recorded (24.9 kJ/min) for female workers during conventional threshing operation by beating on stone surface. Design improvement in the existing tools, equipment and methods of work has significant effects onminimizing human strain, fatigue and increasing farm productivity. Extensive ergonomic research on farm operations and practices may generate a great deal of knowledge for the betterment of health, safety and productivity of billions of agricultural workers. In the present study the maximum oxygen consumption during farm operations was noticed in pre germinated paddy seeders (six – row) followed by 4 row paddy transplanter, grain threshing by beating on stone surface, water lifting by Tenda, Bund trimming with spade etc. Relative cost of work load was observed to be higher in weeding, transplanting, sowing seeds with seeders and threshing operations for workers. Sufficient rest pauses should be provided to the female agricultural workers to minimize drudgery and fatigue. The occupational health complaints observed during different field operations have been recorded with the help of a 10 point VAD scale. Each worker recorded the discomfort in their body parts during field operations using the body parts discomfort Score chart. It is observed that female workers perceived heavy exertion after the activity as it is performed under the higher temperature during May-June and maximum humidity level during July-August. Adopting unnatural body postures requiring frequent bending from the waist. Various type musculoskeletal discomforts were noticed especially in the lower and upper back, mid back, buttocks, left and right thigh, clavicle left and right, left & right shoulder etc. The findings of the study suggest that there is an urgent need to reduce drudgery of female workers in various farm activities. Steps should be taken for promotion and demonstration of female friendly tools and equipments so that the fatigue and occupational problems can be minimized.

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Key words: Occupational health complaints, Working heart rate, oxygen consumption rate, relative cost of work load,

1. Introduction

Human labourers contribute about 60 per cent of total cost of cultivation in paddy crop (Karunanithi and Tajuddin, 2003). Therefore it is of prime need to evaluate the ergonomic aspects of quantum of drudgery involved in agricultural activities in paddy cultivation. Ergonomical cost of work consists of the anthropometry, body size, health of the worker, basal metabolic rate, energy expenditure rate, oxygen consumption rate and type of working posture. Many ergonomical studies have been conducted on some selected implements but study on the complete set of operations in rice cultivation system with agricultural workers need to be studied. The strength and efficiency of the female agricultural workers is 70 percent of male workers (Astrand and Rodahl, 1986). Some implements and operations are best suited to female workers. Thus studies on human energy measurements in agricultural operations of both male and female workers can provide a rational basis for recommending methods and implements for performing the agricultural operations most efficiently and safely (Gite and Singh, 1997). Therefore, ergonomical study was conducted for different operations in rice farming system by using various farm implements and machines with both male and female workers.

2. Materials and Methods

2.1 Selection of the Subjects

Twelve subjects from in the age group of 18 to 45 were selected for this study. The subjects selected were closely to the 5^{th}, mean and 95^{th} percentile value of stature taken from the of anthropometric observations collected from all the agro-climatic zones of Orissa (Mohanty, 2004). The subjects selected for this study were engaged to perform different farm operations in rice cultivation in OUAT farm during Kharif 2010. During this period the mean dry bulb temperature, relative humidity, air velocity were 29.3 ± 3.1^{o} C, 75.3 ± 8.5% and 3.4 to 5.5.m/sec respectively. The selected subjects had previous experience of using agricultural implements and machines as they are working in OUAT farm for many years. Everyday the experiment was conducted from 9.00 AM to 1.00 PM. The duration of each trial was kept 20 min continuously for recording of heart rate and oxygen consumption rate of subject. The heart rate, oxygen consumption rate during 6^{th} to 20^{th} min of work for each subject was measured as one's heart rate and oxygen consumption rate get stable after 3 to 5^{th} minute of continuous operation (Vidhu, 2001 and Mohanty, 2004). The energy expenditure rate was computed by multiplying 28.86 kJ/ min with VO_2 for Indian workers (Nag and Dutta, 1980).

2.2 Cultural Operations

In rice cultivation system the main operations include land preparation, sowing or broad casting, transplanting, weeding, spraying, harvesting, threshing and winnowing. Land preparation activity is mostly done by male agricultural workers. Hence this ergonomically data has been recorded. Hand tools such as trench hoe and spade were used for further leveling the field. For effective work the spading rate of 18 to 21 scoops / min, throw distance of 1.0 m and throw height of 0.8 to 1.0 m were adopted for female agricultural workers (Pradhan et al 1986). For sowing in puddle field, 4 row, 6 row and 8 row pre-germinate seeders were used and these were drawn by female workers. Transplanting was done by using 2 row and 4 row manually operated rice transplanter and compared the physiological responses of workers with that of traditional manual transplanting. Hand weeding was done in squatting or bending posture in traditional transplanted rice field where as push pull type low land weeders were used for weeding in mechanically transplanted rice field. Harvesting was done by using local sickles as well as by power reaper. Transporting of harvested crop to threshing yard was done manually on overhead and by using yoke. Threshing was performed conventionally by beating over stone as well as by using pedal thresher and power thresher. Winnowing was done by using local made bamboo winnower and also by using hand operated winnower.

2.3 Classification of Workload

During physical activities the heart rate and oxygen consumption rate increase and the maximum values of these in normal healthy individuals are about 190 beats/min and 2.0 lit /min (*i.e.* up to VO_2 max) respectively. However, at this extreme workload a worker can work only for few seconds. The "acceptable work load"(AWL) represents that level of physical activity which can be sustained by an individual in an 8 hours working period in a

Physiologically steady state that does not cause fatigue or discomfort. It is generally expressed in terms of percentage of maximum aerobic power ($VO_{2\ max}$) (Muller, 1953). AWL was recommended to be 33 percent of VO_{2max} (Lehmann, 1962 and Blink, 1962). Based on investigations on a large number of industrial

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workers, a ratio of 3:1 between VO_2 max and the acceptable average oxygen uptake (VO_2) over 8.5 hours was suggested (Bonjar, 1968). Saha et al(1979) has suggested the acceptable work load (AWL) as 35 per cent of VO_{2max} for Indian workers.

3. Results and Discussions

3.1 Occupational health complaints

The occupational health complaints of selected subjects has been evaluated using a 10 point Visual Analogue Discomfort scale. Each worker pointed the marker on this scale after getting extended by using the selected tools and operations. The mean value of VAD score was observed to be maximum in case of sowing by 6 row pre germinated paddy seeder. Higher physiological cost like averaging heart rate, oxygen consumption rate was also recorded with other type of implement, followed by transplanting with 4 row paddy transplanter, grain threshing by beating methods, water lifting by low lift hand pump and etc. The musculoskeletal disorder was plotted on a 27 body parts mapping. Each worker mapped the body parts for each operation with help of the Body Parts Mapping scale.

3.1 Physical Characteristics and Health Status of Female Agricultural Workers

The mean height, weight and body surface area (BSA) of selected subjects were found to be 152.0 cm, 51.7 kg and 1.52 m^2 for female workers respectively. The $VO_{2\ max}$ of female workers observed to be vary 1.56 to 1.81 l/min for female workers (Table 1). Earlier studies reported similar results for the $VO_{2\ max}$ of Indian female subjects (Nag 1981; Nag et al, 1988; Gite 1996; Singh et al, 2001; Bimala et al, 2001, Vidhu, 2001 and Mohanty, 2004).

Figure1. Measurement of VO_2 (oxygen consumption rate) on treadmill

Table 1. Physical characteristic of the selected subjects

Physical Characteristics	Unit	Female		
		Mean	±SD	Range
Age	years	31.1	8.06	18 – 44
Weight	kg	51.7	4.91	53 – 59
Height,	cm	152.0	7.61	142.1 – 162.2
BSA	m^2	1.52	0.12	1.38 – 1.69
HR_{rest}	beats/min	70.3	3.2	65 – 76
OCR_{rest}	l/min	0.19	0.02	0.16 – 0.23
$VO_{2\ max}$	l/min	1.70	0.08	1.56 – 1.81
Body Mass Index	kg/m^2	22.3	0.82	20.5 – 23.3

Twenty six types of different agricultural operations starting from land preparation to harvesting and transportation those are mostly done in paddy cultivation system in Orissa is listed in Table-2. Although most of the operations are done by female workers, some operations like use of bullock drawn implements, spraying with knapsack sprayers, broadcasting of seeds and fertilizer, tractor and power tiller operations are

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not generally done by female workers. However after proper training during the study period, female workers could able to operate self propelled rice transplanter, power thresher and winnower.

3.2 Seed bed Preparation

Hand tools such as trench hoe and spade are used for leveling the field. The average working heart rate, oxygen consumption rate and the energy expenditure rate were found to 124.3 beats/min, 0.78 l/min and 16.3 kJ/min for female agricultural workers operating with trench hoe (2.5 kg, handle height 65 to 70 cm). While working with spade (3.5 kg) with handle length of 70 to 75 cm, a higher working heart rate, oxygen consumption rate and energy expenditure rate of was recorded 138.4 beats/min, 1.12 l / min and 23.5 kJ/min for female workers respectively were observed and this may be due to the higher weight of spade. The relative cost of work load of the workers operating the spade was found to be above the recommended acceptable work load limit of 35 per cent of their $VO_{2\ max.}$. However at this work load a worker can work only for few minutes (Saha et al 1979).

3.3 Sowing / Planting and Spraying

In case of conventional manual transplanting, the working heart rate, oxygen consumption rate and energy expenditure rate were recorded to be a lower value of 114.7 beats/min, 0.65 l/min and 13.6 kJ/min for female workers. Higher working heart rate in manual transplanting operation may be due to working in bending posture. Similar results were observed by Nag et al (1980).Although manually operated rice transplanter and seeders have higher field.

Table 2. Physiological parameters of selected subjects during paddy cultivation.

Sl No	Type of operation	Female				
		WHR beats/min	OCR, l/min	EER, kJ /min	RCWL, %	VAD scale (10 point)
1	Bund trimming with trench hoe	124.3	0.78	16.3	45.9	6.0
2	Bund trimming with spade	138.4	1.12	23.5	65.9	7.6
3	Manual uprooting of seedlings	120.2	0.81	17.0	47.6	5.2
4	Manual transporting of seedlings	112.7	0.69	14.4	40.6	5.8
5	Manual transplanting (Bending posture)	114.7	0.65	13.6	38.2	5.3
6	Transplanting with 2 -row paddy transplanter	130.4	0.82	17.2	48.2	7.2
7	Transplanting with4 -row paddy transplanter	134.8	1.19	24.9	70.0	8.3
8	Transplanting with power transplanter (Sitting type)	111.2	0.59	12.4	34.7	5.4
9	Sowing by pre-germinated paddy seeder (4-row)	130.2	1.02	21.4	60.0	7.9
10	Sowing by pre-germinated paddy seeder (6- row)	136.3	1.21	25.3	71.2	8.8
11	Fertilizer broadcasting (manually)	103.7	0.58	12.1	34.1	5.5
12	Walking on bund and scaring birds	102.5	0.55	11.5	32.4	5.8
13	Weeding by hand (Squatting)	100.2	0.58	12.1	34.1	5.8
14	Weeding by trench hoe (Bending)	120.2	0.75	15.7	44.1	6.3
15	Weeding with push pull type weeder	128.4	0.85	17.8	50.0	7.8
16	Water lifting by tenda	130.2	1.17	24.5	68.8	8.0
17	Water lifting by Pedal pump/ foot pump	126.8	0.85	17.8	50.0	7.9
18	Water lifting by Low Lift Hand pump	130.6	1.08	22.6	63.5	8.1
19	Harvesting with sickle in squatting posture	100.2	0.62	13.0	36.5	6.0
20	Harvesting with power reaper	120.3	0.86	18.0	50.6	7.9
21	Carrying paddy bundles on head (40 - 50 kg)	128.4	0.97	20.3	57.1	8.0
22	Grain threshing by beating on stone surface	132.5	1.19	24.9	70.0	8.2
23	Grain threshing by manual paddy thresher	124.3	0.76	15.9	44.7	6.4
24	Grain threshing by power thresher	110.6	0.65	13.6	38.2	6.0
25	Winnowing with Kulah	105.3	0.51	10.6	30.0	5.5

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26	Winnowing hand operated winnower	120.4	0.79	16.5	46.5	6.5

capacity, these machines required a higher working heart rate, oxygen consumption rate, energy expenditure rate due to the fact that the workers had to walk in puddled field and simultaneously drag the transplanter at a dragging force of 80.8 N for 2 row and 111.6 N for four row rice transplanter. It was also observed that transportation of seedlings manually required a working heart rate of 112.7 beats/min for female workers. During operation of six row pre-germinated paddy seeder, the working heart rate (128.8 beats/min), oxygen consumption rate (0.95 l/min), energy expenditure rate (19.9kJ/min) and relative cost of work load (48.7%) for four row pre germinated paddy seeder. This may be due to the reason that more effort is required to

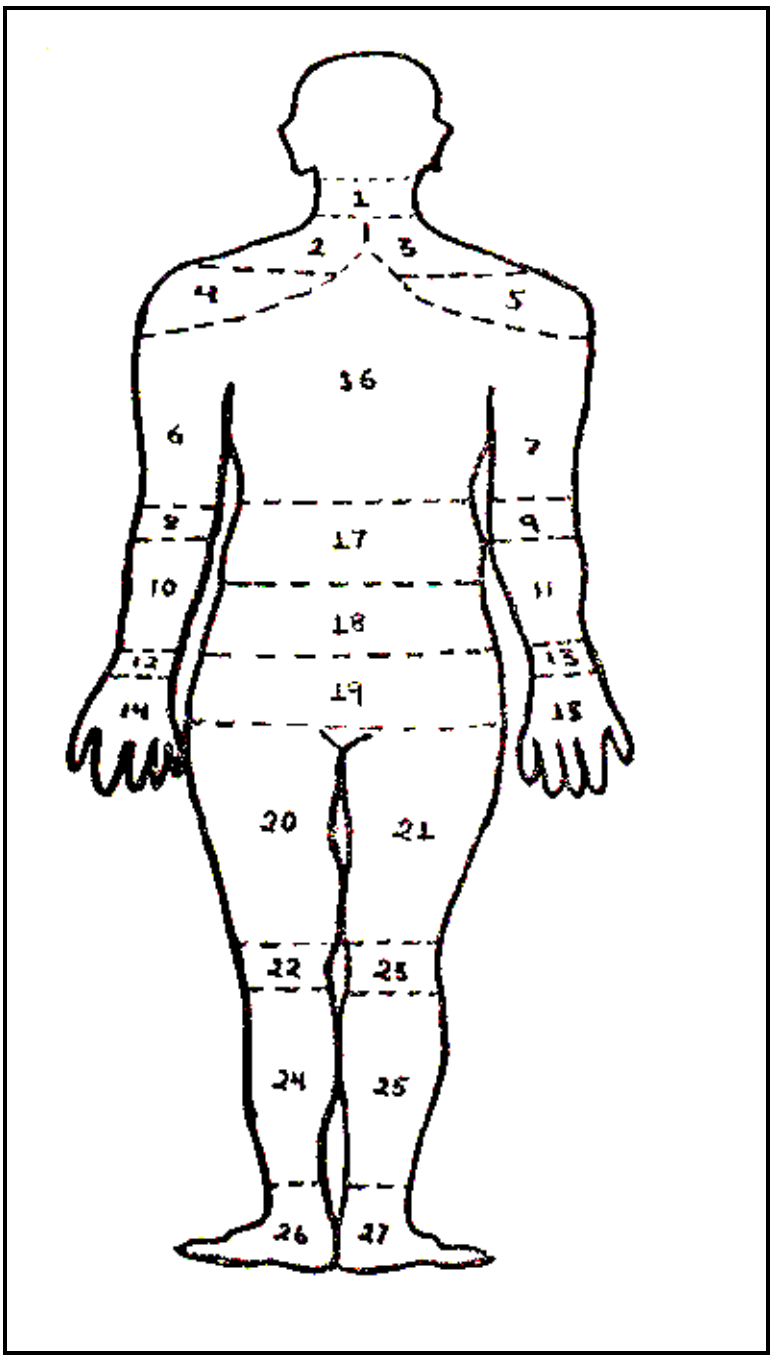

Figure 2. Body parts discomfort mapping.

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operate the six row seeder against four row paddy seeder was observed because of its more contact area. Similar oxygen consumption rate and working heart rate were observed by Nag and Dutt (1980) during test of pre-germinated paddy seeders. It was also observed that operation of 8-row paddy seeder required 28.1 per cent more energy expenditure rate over four row and 18.5 per cent over six row paddy seeder and that is why female workers could not operate the eight row paddy seeder.

3.4 Intercultural Operations and Irrigation

In upland rice, the women workers squatted on the ground with one or two legs flexed at the knee and removed the weeds by pulling out with their hands and sometimes using a worn out sickle which required energy expenditure rate of 12.1 kJ/min. While working with mechanical push pull type weeders in low land rice with handle height below 70 per cent of their shoulder height, it was observed that the working heart rate and energy expenditure rate 128.4 beats/min and 17.8 kJ/min for female 120.2 beats/min, 15.7 kJ/min for female workers during manual weeding by trench hoe in bending posture in upland. The relative cost of work load observed by the workers in weeding by hand was with in the acceptable work load limit of 35 per cent of their $VO_{2\ max.}$, but with use of mechanical weeders higher work load was noticed. Studies conducted by Nag and Dutt, (1979) and Singh et al, (2007) obtained the similar results. Low lift hand pumps (LLHP) and pedal pumps are used by female agricultural workers for lifting water. It was observed that during operation of a LLHP with a suction head of 3.5 m., the working heart rate found 130.6 beats/min for female workers 126.8 beats/min observed for female workers during operation of a pedal pump at the same suction head. The lower working heart rate recorded in case of pedal pump may be due to the fact that lower effort required to operate with foot than hands.

Figure No 3 Threshing with Improved Thresher

Figure No 4.Winnowing with Improved Winnower

3.5 Harvesting, Threshing and Transportation,

Local sickles are mostly used by the female workers for harvesting of paddy crop in Orissa. While harvesting with sickles, the working heart rate was observed to be 100.2 beats/min where as the energy expenditure rate was found to be 13.0 kJ/min for female agricultural workers. Studies conducted by Nag et al (1980) for harvesting with sickle observed similar results. During harvesting with self propelled reapers higher working heart rate, oxygen consumption rate, energy expenditure rate and relative cost of work load 120.3 beats/min,0.86 l/min, 18.6 kJ/min and 50.6 per cent for female workers were observed. This may be due to the reason that operator had to walk behind the reaper at higher speed while applying force for turning and changing gears. After the harvesting, the paddy bundles were transported to the threshing yard by carrying on head and sometimes on both sides of a thick bamboo strip (yoke) supported by shoulder. The weight of the paddy bundles transported varied form 50 kg (on head) to 80 kg (on yoke and shoulder). While both male and female workers transported the load on head, the male workers only used the yoke. The higher working heart rate, oxygen consumption rate and energy expenditure rate were recorded for both male and female workers for carrying the load either on head or shoulder with yoke. The oxygen consumption rate sometimes reached 1.09 l/min (55.9% of $VO_{2\ max}$) for male and 0.97 l /min (57.1% of $VO_{2\ max}$) for female workers when transported on head and further higher value of oxygen consumption rate of 1.21 l/min (62.1 % of $VO_{2\ max}$) were observed for male workers transported on shoulder with the help of yoke.

3.6 Winnowing

In traditional method grain cleaning is done by using Kulah and dropping the grain from 95th percentile value of height of a worker and it was found that working heart rate of d 105.3 beats/min were

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recorded for female workers during winnowing operation by Kulah The corresponding oxygen consumption rate was recorded to be 0.51 l/min for female workers. But when winnowing was done with a hand operated gear type winnower, a higher working heart rate of 120.4 beats/min were recorded for female workers and this higher heart rate may be due to the reason that workers had to apply greater force to the handle for continuous rotation of fan blades.

4. Conclusions

Design improvement in the existing tools, equipment and methods of work has significant effects in minimizing human strain, fatigue and increasing farm productivity. Extensive ergonomic research on farm operations and practices may generate a great deal of knowledge for the betterment of health, safety and productivity of billions of agricultural workers. In the present study the maximum oxygen consumption rate was recorded in pre-germinated paddy seeder (6- row), followed by operation in tenda, rice threshing on stone surface, for both male and female agricultural. workers. Relative cost of work load was observed to be higher in weeding, transplanting, sowing seeds with seeders and threshing operations for both male and female workers. Suitable work rest cycle may be followed to reduce the fatigue and drudgery involved in rice cultivation system in this region.

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