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Ergonomic Evaluation of Farm Women's Drudgery in Rice Production System: Current Research Trends

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ABSTRACT

Women are the backbone of the agricultural workforce but worldwide her hard work has mostly been unpaid. She does the most tedious and back-breaking tasks in agriculture, animal husbandry and homes. Farmwomen's participation was crucial in various operations such a sowing/transplanting (86%), weeding (84%), storage of grains (78%), land preparation (72%), cleaning seed for sowing (70%), gap filling (68%), manure and fertilizer application (68%), harvesting (64%), and threshing and winnowing (62%). During the peak season of sowing and harvesting rural women spend 8-9 hours in the field. Women's contribution to the operations related to wheat and rice cultivation is significantly higher than that of men in terms of man days of work done. All of these activities contribute to an increase in the physiological costs and physical loads to a great extent. It also causes unbalancing of the body with heavy workloads. Musculoskeletal disorders are common among farm workers especially lower and upper back disorders due to bending and squatting body posture in manual rice transplanting and uprooting activity. Considering the above facts and points of view, it was proposed to investigate changes in the physiological responses and perceived exertion due to heavy workloads and body postures in the rice production system. This study aims to better understand how the manual rice production system activity performs, identify potential health risk factors, and gain insight into the health effects of the task.

Keywords: *Farm women, Agriculture, Health risks, Drudgery, Ergonomics.*

INTRODUCTION

After China, India is the second-largest rice producer in the world. In terms of both production and acreage, paddy is the dominant crop in India. According to reports, nine percent of paddy is wasted during drying, milling, storage, shipping, and handling because of the employment of traditional processes used in cultivation [45]. In India,both the production and the processing of paddy crops are handled by women.The majority of farm labor is performed by women worldwide, particularly in developing nations like India. In India's rural population, farmers and agricultural labourers make up 34 percent and 41.4% of the total population, respectively, according to the 2011 census, in which women make up 10.3% and 17.7% of cultivators and agricultural laborers, respectively. In the agricultural industry, women have long been significant and prominent collaborators. Since ancient times, women have played a significant role in India's agricultural pursuits. Women have had a direct or indirect impact on the development of agriculture and animal husbandry. Despite the large proportion of women in the agricultural labour force, there have been no appreciable changes in the status of women farmers [22, 27].

The extent of participation of women in agriculture farms and allied activities in the Rice Production System

In the process of providing a living for the family, women play a distinctive and accepted role in the marketing of both agricultural and handcraft products. The majority of farm women are found working in the horticulture, sericulture, poultry, goat, and dairy industries [23]. The major farm operations mainly performed by farm women were cutting, picking, cleaning grains, drying grains, storage, processing, weeding and winnowing. Socioeconomic factors like age, family income, and land ownership had a big impact on how much farm women participated in agriculture [9,62]. Although women actively participate in agricultural operations, they nonetheless face several obstacles. The farm women who worked in the paddy farming system were young, illiterate, from a middle caste, with medium family education status, and they were raised in nuclear families. Weed management, nursery management, time of planting, harvesting, season selection, and irrigation management all showed high levels of involvement. Farm women engaged in paddy farming showed low levels of involvement in post-harvest operation, seed treatment, main field preparation,disease management,pest management, selection variety, and marketing practices [27] .

Farm women were found to have a high level of decision-making behaviour in sowing, winnowing, seed processing, irrigation management, collecting harvested crops, storing them, preparing the field, choosing the best seed or variety, marketing, applying manures and fertilizer, weeding, harvesting, treating seeds, managing pest and disease outbreaks, and soil testing [7]. The post-harvest processing of product at the household level and the retention of produce for consumption were activities in which women participated fully but threshing and management of surplus produce at the commercial level only saw partial participation from women [3]. Although regional differences in women's labour market involvement are significant, women are almost always overrepresented in unpaid, seasonal, and part-

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time jobs [40]. A greater proportion of farm women were in their middle years, had completed elementary school, belonged to another underprivileged class, were from nuclear families, had small land holdings, had medium levels of experience in farming, belonged to farming groups, had medium annual incomes, had medium knowledge levels, and participated in medium levels of social and extension activities [8]. The majority of farm women encountered obstacles including dual responsibility of work at the farm and household work that prevented them from participating in agricultural activities [41] . In terms of grainage practices, farm women conducted the majority of the tasks alone and only had a minimal involvement in land preparation (70.00%), seed planting (51.67%), plantation maintenance (55.00%), and harvesting (55.00%) [17].

Physiological parameters and energy expenditure in the Rice Production System

Women work in agricultural and non-agricultural jobs under particularly demanding conditions that stress them out physically and mentally. The lack of necessary facilities, static postures, and stress on muscular strength and endurance in the workplace make the work very difficult. Everyday stress from work causes a variety of problems and health risks for the farmers (57]). For all age groups of female workers involved in farming, the physiological indicators of heart rate, pulse rate, oxygen consumption rate, and energy consumption rate increased more quickly [1,25,26,49]. To standardize occupational workload, the physiological responses of farm women during agricultural tasks and leisure activities [46]. The local transplanting method of paddy was used to measure the energy expenditure rate. Male workers energy expenditure ranged from 2.4 to 4.9 kcal/min, whereas female workers ranged from 2.3 to 3.5 kcal/min [29].

The physiological cost of farmers using a selected group of rice transplanters was compared to manual transplanting. All of the chosen rice transplanters, including the Yanmar rice transplanter, Yanji transplanter, and Redlands transplanter (29.46%), showed a substantial difference in heart rate and energy expenditure [16]. Heart rate ranged from 110.5 beats per minute in the Redlands 8 row riding type transplanter to 148.5 beats per minute in the traditional way of transplanting. For a few operations, the overall discomfort score ranged from 3.0 to 8.4 and was rated as light discomfort to more than moderate discomfort [58]. When operating the six-row paddy transplanter, the farmers heart rates raised from 75 beats per minute at rest to 131 beats per minute. When paddy seedlings were uprooted and transplanted, the farmers resting heart rates increased to 114 beats per minute from 78 beats per minute [19]. The physiological cost of work while weeding was 14.67 beats/min, and the overall cardiac cost of work was 6165.87 beats. Weeding was reported to need an average working heart rate of 94.36 beats per minute and an average energy expenditure of 6.28 kilojoules per minute. The majority of women thought weeding was a light to moderately heavy job, even though it was done in a squatting position for the majority of the days of the year [21]. The average working heart rate and oxygen consumption rate were assessed when harvesting with a serrated sickle and a traditional sickle, threshing with a paddy thresher and hand beating operation, respectively [15]. While it was 141 beats/min using the conventional method, the mean working Heart rate in the pedal-operated paddy thresher was discovered to be 134 beats/min. In a paddy thresher, the total cardiac cost of work (TCCW) and physiological cost of work (PCW) were measured at 1662 and 55, respectively [34,44].

For transplanting operations using a manually operated paddy transplanter, the average energy consumption for male and female employees was determined to be 30.70 and 32.58 kJ min-1, respectively. Based on heart rate, the procedure was classified as "heavy work." To achieve functional efficacy when transplanting the paddy by a six-row transplanter, it was discovered that a rest period of 14.30 minutes was required, followed by 30 minutes of work [73]. The rate of oxygen consumption and the relative cost of the workload were found to be highest in 4 row transplanters, then lowest in local practices, 3 row transplanters, 2 row transplanters, and row transplanters [56]. When using two-row and four-row manual rice transplanters, the average heart rates of the female employees were 138 and 148 beats per minute, respectively. When compared to conventional practise, the rice transplanters were able to cut back on labour by 36.1 and 69.8 percent in terms of physiological cost/ha [65]. Male and female agricultural laborers physiological reactions and energy consumption throughout various rice farming tasks were measured. Male workers' energy expenditure ranged from 2.4 to 4.9 kcal/min, whereas female workers' ranged from 2.3 to 3.5 kcal/min [29].**Perception of Drudgery and Workload of agriculture activities among rural women**

Environmental and occupational health issues among agricultural workers expressed high levels of concern about working in hot weather, agricultural injuries, pesticides, awkward posture and drudgery-prone activities. User Eco-friendly tools can increase working efficiency and reduce the working load health hazards on farm activities during agricultural activities [71]. The majority of farm women thought it was challenging to perform agricultural tasks. In agricultural work, farm women's perceptions of drudgery were significantly and negatively correlated with their annual income (0.50) and socioeconomic standing (-0.56). The drudgery perception of farm women was significantly and positively correlated with the extent of agricultural activities performed by farm women (0.76) [4].

The majority of on-the-farm and off-the-farm tasks in agriculture are performed by women farm laborers, who are thus subjected to mentally and physically demanding working environments [25]. The majority of farm women reported pain in their wrists, hands, and backs, as well as strain and tenderness in their knees and thighs [19].Farm women are subjected to exceedingly demanding working circumstances that can cause physical and mental stress. Due to the differences in body size, strength, and physiological parameters between farm women and male farmers, equipment and technology are not appropriate for women [25,57]. The women claimed that performing agricultural tasks in their fields requires them to put in over 2.5 hours more work per day. Because it takes more time to do this work, women are less able to engage in other income-generating activities, which puts them at risk [48]. Bending for a prolonged period increases their physical load and they also suffer many types of muscular problems because of these women's efficiency decreases dramatically. Non availability of labour during peak season is an added burden to the farmers [68].Climate Smart Agriculture technologies and practices such as direct seeded rice (zero tillage and low tillage using machine), green manuring (GM), laser land leveling (LLL), and system of rice intensification (SRI) were found to potentially reduce women's drudgery in agriculture along with improvement in

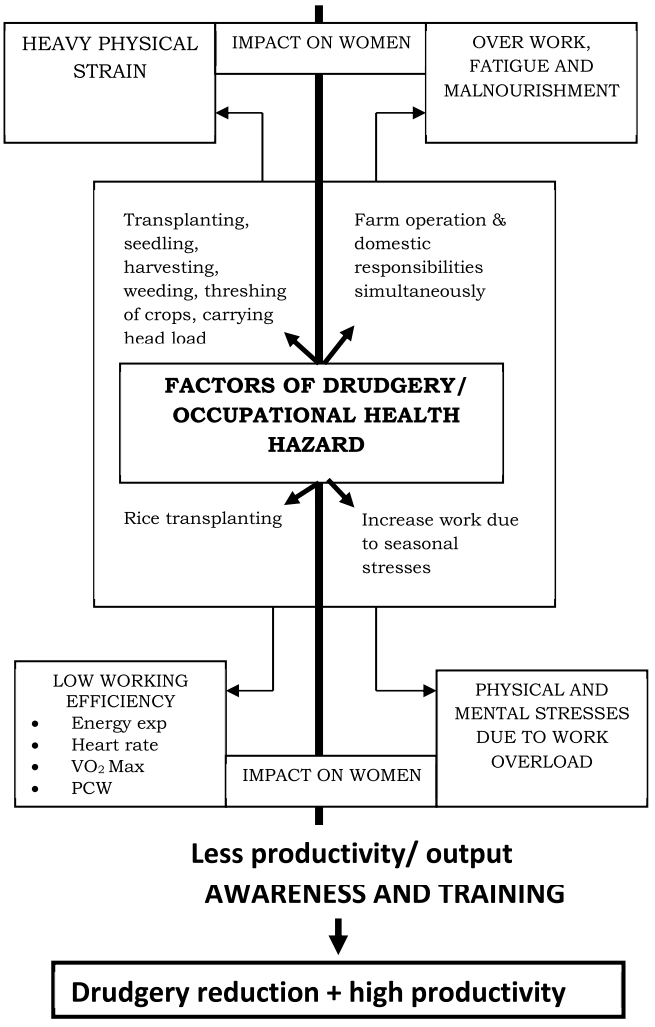
productivity and farm income [35]. The reduction in drudgery by the use of an improved serrated sickle was 16.51 % as compared to the plain sickle and 6.97 % as compared to the existing serrated sickle[42].Participation of farm women was higher in activities like grain storage, manual harvesting, picking of vegetables and animal dung collection and disposal. Awareness level of participants regarding drudgery reduction tools was very low [30].

Conceptual framework

Women perform multiple role in their lives, it is found that drudgery in relation to physical and mental fatigue and time consuming agricultural task throughout all the seasons. The occupation hazards will enhanced if a farm women is having repetitive task or facing postural discomfort in agricultural activities. This may lead to musculoskeletal problem which can be accessed on the basis of heart rate, energy expenditure, physiological cost of the work and VO_2 Max etc. if these factors exceed to normal limits then it may lead low to working efficiency, heavy physical strain, Musculoskeletal discomfort, whereas Mental and physical fatigue also will lead to less productivity. To reduce occupational health hazards and minimize the risk factors associated with farm activities, the need was felt the improvement of the working posture and atmosphere by introducing improved tools and technologies, appropriate training methods, knowledge and motivation which leads to drudgery reduction and high productivity of farm women.

Conceptual Frame Work of the Study

Farm Women In Rice Cultivation System



Postural Stress and Musculo-skeletal Disorders in Farm women in Rice Production System

The Safety of the workers and productivity of work in rice cultivation is impacted by the human drudgery. Musculoskeletal disorders (MSDs) are the most common work-related problems among farm workers involved in rice transplanting activity. The postural stress was analyzed by various methods, viz. OVAKO Working Postures Analysis System (OWAS), Rapid Upper Limb Assessment (RULA), Assessment of Repetitive tasks (ART), Rapid Entire Body Assessment (REBA), and Quick Exposure Check (QEC).

The physical strain of female farmers in agricultural activities seems to be too high because of heavy work tasks and relatively low VO2max [63].Lower back, hip, wrist, shoulder, and knee were highly affected. Higher prevalence of MSDs among the cultivators may be because of prolonged working hours and awkward postures. Ergonomic interventions such as modifying work-rest schedules, improving work postures, and introducing new design hand tools should be considered for improving work condition of the women cultivators [53].The farmers had to adopt different stressful postures during performing post-harvesting tasks. The Center of Gravity (CG) and spinal curvature in working posture were significantly deviated from neutral posture. The awkward work posture might be related to the MSD of the workers [67].Prevalence of MSDs among the female workers was very high and the most affected areas were the back and upper extremities. Stooping and squatting postures were the dominating postures in potato cultivation jobs. Postural stress might be the reason for the occurrence of MSDs [24,54].Prolonged work activity, high repetitiveness, and remaining constantly in an awkward posture for a prolonged period of time etc. were the major factors of drudgery, acute pain and discomfort among farm workers [5,50].

MSD is related to the inappropriate working postures, duration of jobs and repetitive movement of the body parts. The results of the other health hazards reveal that digestive disorders (66.8%) are also prevalent among the women agricultural workers[28,13]).Farm women adopted very difficult posture while planting/sowing, hand weeding, cutting/plucking and cleaning Planting/sowing and cutting/plucking were very painful activities (mean score 4.6); cutting/plucking was perceived as very heavy activities (mean score 4.6) [18].Improved methods of uprooting and transplanting can significantly reduce the cost of drudgery among farmers and workers should avoid bad work postures as far as possible during their work to reduce postural stress [12,5].Low socioeconomic status and poor access to health care also contribute to existing health problems in these farm workers [43].Female farm women suffer from various occupational risk factors i.e. environmental, ergonomic, musculoskeletal and safety factors at the workplace. Exhaustion due to extreme temperature was the main environmental risk factor reported by 80.8 percen of women [31].

Improved techniques and technologies on the drudgery of women in the Rice Production System

The advancement of the serrated sickle increased energy expenditure by an average of 195.36 KJ/min, 210 KJ/min, and 234 KJ/min when compared to the plain sickle in harvesting paddy. Additionally, the increase in oxygen consumption rate (OCR) and heart rate (HR) were 24.5, 22.2, and 20.5 beats per minute and 0.28, 0.25, and 0.23 L/min, respectively [42].To dry paddy, a solar drum drier was created, consisting of an outer fixed drum and an inner perforated drum that revolved inside

the outer drum at the specified speed. The dryer could hold 10,000 g at a time. When compared to paddy dried using a batch dryer, the results demonstrated a considerable decrease in broken brown rice for paddy dried using the drum dryer at 43–46°C. The paddy with an initial moisture content of 16% was found to have the highest stress-cracking index. The outcomes demonstrated that a longer drum should be taken into consideration to increase the slope and rotational speed of the inner drum for proportional ultimate moisture content .The thresher was created with the best design parameters and was found to be ergonomically suitable for reducing drudgery by reducing physiological ergonomic parameters like TCCW (Total Cardiac Cost of Work), CCW (Cardiac Cost of Work), EER (Energy Expenditure Rate), HR (Heart Rate), Pulse Rate, and Blood Lactate Concentrations [26].

A study on the amount of work involved in executing agricultural tasks manually and traditionally found that using enhanced technologies reduced the amount of energy required by farm women to complete some tasks compared to using human labor. Additionally, it was discovered that the production and efficiency of the work both rose with the use of upgraded technology. When compared to the traditional method, the perceived rate of exertion while weeding and transplanting was moderate rather than heavy [2].Farm mechanization decreases the number of women and overall labour of the farmer and diversification of the monoculture of rice towards rice-based high-value crops and aquaculture increases the welfare of everyone in society. This suggests that loans and greater technology access for impoverished farmers, particularly women, should be addressed [20]. A hand-cranking type manual paddy transplanter was designed. The average working heart rate, work pulse, and energy output per minute were 118.06 beats per minute (2.18), 35.8 beats per minute (3.96), and 10.03 (0.36) kJ/min, respectively. The average field efficiency was 60.4% and the field capacity was 0.03 ha.h1. The manual paddy transplanter had an operating cost of 69.7.h1 [32].

A comparison between the physiological cost of labour for operators of particular rice transplanters and manual transplanting was done.. Yanmar's rice transplanter used the least amount of energy, 9.89 kJ min1. In comparison to the Yanmar transplanter, the traditional method's energy consumption increased by 52.52 percent, followed by the Yanji transplanter's (43.11%) and the Redlands transplanter's (29.56%). According to ergonomic testing, the Yanmar 8 row self-propelled, riding type rice transplanter was determined to be the best for agricultural women workers [17].the three commercially available rice transplanter models Redlands 8 row riding type transplanter, Mahindra 4 row walking type transplanter, and Manual 2 row transplanter were ergonomically assessed and determined that the 8 row riding type transplanter was more suited and ergonomically pleasant for the farm women [58]. The ergonomics of the mechanised transplantation of rice seedlings by hill farm women using a manually controlled six row paddy transplanter were compared to the traditional way of transplanting. When operating the six-row paddy transplanter, the heart rate raised from 75 beats per minute at rest to 131 beats per minute. The technology was well received by the farm women since it eliminates the bending postures. Line sowing also encourages the use of mechanical weeders, which lessens the work and expense associated with subsequent weeding operations [19]. By enhancing women's engagement in farming activities, decision-making skills, and self-confidence, a specific emphasis on women-friendly technologies can significantly alter women's standing in agriculture [62]. The majority of farmers were not aware of newer agricultural equipment and tools that lessen labor-intensive tasks. Farm women are interested in receiving knowledge and using the upgraded implements and equipment [7].

Perceived health hazards problems faced by farm workers

Occupational health and safety (OHS) has become a serious concern on a global scale, affecting industries including agriculture. Numerous risks with unfavorable outcomes are connected to farming, including pathogen infection, exposure-related injuries, physiological problems, poisoning, respiratory infections, and musculoskeletal illnesses. The Centers for Disease Control and Prevention has listed agriculture as one of the top three most dangerous occupational groups in terms of injuries and work-related illnesses [6].

Both in established and developing nations, agricultural workers have been documented to experience high and unpredictable rates of injuries. Agricultural workers are more likely to suffer injuries because of machinery, hand tools, tractors, heavy lifting, farm animals, pesticides, and other substances. Additionally, some seasonal jobs may require long hours and little sleep, which could raise the risk of injury [36,66]. The most significant injuries experienced by farmers are contact and exposure to chemicals, fertilizers, soil and dust, contamination from bacteria, contact with animals, particularly cattle, injury from hand tools, and musculoskeletal issues. Due to significant investments in agricultural facilities, warehousing, and cold storage, it is anticipated that within a few years, the Indian agricultural business sector will be the main driver of the Indian economy [59].

Farmers spend a lot of time outside in the sun, which increases the risk of skin cancer on farms. Most farmworkers routinely come into contact with chemicals. Agricultural noise, which includes tractor, thresher, harvester, and other machine noises, is a serious problem for the health risks to farmers. Heat stress is when the body heats up more than it can handle. High temperatures, high humidity, strong sunlight, and workloads all raise the risk of heat stress [14].Approximately 36.2% of fatalities were brought on by farm equipment, including tractors. Farm equipment, hand tools, and other source injuries each had an Injury Incidence rate(IIR) of 3.2 per 1000 machines, 0.7 per 1000 tools, and 77 per 100,000 employees, respectively. There is a r=0.80 correlation between the number of farm machinery injuries and the number of injury-prone agricultural machines (the number of injuries rises as the number of machines grows) [34].

The farmers stated that they were aware of the health risks associated with pesticide usage and that they had experienced symptoms like nausea, diarrhea, skin irritation, and dizziness, which lasted on average of three days. Surprisingly, opinions on whether pesticides were to blame for their health issues were virtually evenly split, and a significant portion of respondents did not seek medical attention [52,68]. Accidents, pesticide-related illnesses, musculoskeletal and soft-tissue disorders, dermatitis, noninfectious respiratory conditions, reproductive health issues, farmworker children's health issues, climate-related illnesses, communicable diseases, bladder and kidney disorders, and eye and ear issues are a few potential farm work-related health issues [43].Farmers and farm workers experience high rates of low back, shoulder, and upper

extremity disorders. Musculoskeletal disorders may disproportionately affect farm youth and migrant workers due to the types of farm tasks performed [12, 61].Sources of disease in agriculture may be physical, chemical, biological, or psychosocial [72].

The majority of accidents were due to tractors (overturning, falling off, etc.), followed by threshers (14.6%), sprayers/dusters (12.2%), sugarcane crushers (8.1%), and chaff cutters (7.8%). With an estimated yearly fatality rate of 22 per 100,000 farmers, motorised machinery was the primary cause of the majority of fatal incidents. 8% of all accidents involved injuries related to hand tools, but they weren't fatal [39,47,70].The findings of Patel [47]indicated that 144 (60%) of the accidents involved farm tools and equipment, followed by spades, sickles, and axes. The most often hurt body parts were the feet and legs.

Injuries caused by the usage of specific agricultural hand tools, such as the knife, pick axe, weeding fork, spade, plain edge sickle, serrated sickle, and shovel, were reported to have affected 43 out of 45 farmers[42].The body parts most commonly afflicted are the fingers on both limbs, followed by the feet, ankle, hand, wrist, and lower back. It was also noted from this study that male agricultural workers are significantly more impacted than female agricultural workers. Incidence rates for male and female agricultural workers were 8.99 and 7.89 incidents per 1000 workers, respectively. Therefore, both groups of agricultural workers' productivity, health, and work performance were negatively impacted as a result of the injuries they sustained [11]. .Legs (8.9%), hands or wrists (10.7%), and fingers (10.7%) were the body parts that were hurt the most frequently. Machinery (28.6%), falls (23.2%), and animals (12.5%) were the main external causes [64,74].

Conclusion

Women are exposed to multiple roles in agricultural production. The total amount of drudgery undertaken in landing out rice cultivation operations by women is significantly higher than that carried out by men. The majority of on-the-farm and off-the-farm tasks in agriculture are performed by farm women who are subjected to mentally and physically demanding working environments. The safety of the workers and productivity of work is impacted by the human drudgery in rice cultivation. Farm women experienced high and unpredictable rates of injuries because of machinery, hand tools, tractors, heavy lifting, farm animals, pesticides, and other substances.

Future Scope of study: Similar type of study can be done on farm women performing various agricultural and horticultural crop production system Occupational health hazards of farmers involved in various agriculture activities can be reviewed.

Conflict of interest: There exists no conflict of interest

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