



An ergonomic evaluation of grain picking activity of farm women

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ABSTRACT

A study on an ergonomic evaluation of the grain picking activity of women using conventional and improved grain picker was conducted in Madurai district of Tamil Nadu. Twenty women workers were made to perform grain picking activity by conventional and improved method. Data on time and work study, physiological parameters, hand grip strength and musculo-skeletal disorder of the women were collected. The results revealed that the improved method of grain picking activity showed high picking efficiency (66.86%), minimum reduction in grip strength of right hand (17.52%) and reduced physiological cost of work (19) when compared with conventional method of grain picking.

INTRODUCTION

Today is an era of women who have diverse role to play in society. Often they handle two or more tasks simultaneously. They are, therefore, prone to suffer from work-related diseases, which are further complicated by social, psychological and physiological issues. Roughly, 1 out of 300 female is suffering from some occupation related disease. In India, women play a significant and crucial role in agricultural activities (Srivastava and Bihari, 2000). The women work force in agriculture and allied sectors is estimated to be around 92 million which amounts to 40 per cent of the total rural workers in the country (Singh *et al.*, 2007). Women are active partners

in farming and undertake management along with men. There are certain unit operations in production agriculture in which women dominate in production agriculture, post harvest management and agro processing (Aggarwal *et al.*, 2013).

Various studies on women in agriculture point to the fact that women are generally employed in the operations which are either not mechanized or least mechanized and involve a lot of drudgery. Most of the activities are not only drudgeries but time consuming also. Various tasks performed by women not only demand considerable time and energy but also sources of drudgery for rural women (Srinath *et al.*, 2010).

Srivastava (1985) stated that all women irrespective

of land status of family provide 14 to 18 hours of productive physical labour in different chores. Women spends long hours with much labour in respective operations resulting in fatigue and drudgery. Farm women performs each and every field activity right from sowing to harvesting and in performing these activities, the risk of developing musculoskeletal problem occurs mainly due to the inconvenient work postures (Chauhan and Saha, 1999). Postures, especially those involving severe flexion or lateral twisting and bending, have been found to be significantly related to low back pain (Punnett *et al.*, 1991). Low back problems are common among farmers, and appear to be associated with the frequency of using postures requiring back flexion, carrying and lifting of heavy loads and exposure to whole body vibration (Penttinen, 1987). Women are increasing their workload and taking care of a wider scope of agriculture tasks, but the degree to which they have access to improved technologies need special consideration (Aggarwal, 2007). In traditional farming, there are concerns related to drudgery, slow pace of work, primitive tools and methods where ergonomics might bring solutions by contributing to the work efficiency and productivity justified factors. eg weeders, hoes etc. (Nag *et al.*, 1980). Research has shown that many important risk factors can be successfully addressed in agricultural work using ergonomic approaches (Nag and Nag, 2004). Grain drying is a process of drying the harvested cereal/ pulses to maintain a required level of moisture to prevent spoilage during storage. In Tamil Nadu, women are involved in drying and storage of grains at field level, industry level and household level. Hence, the study has been aimed to assess the grain picking activity performed by women using conventional and improved grain picker based on ergonomic principles.

MATERIAL AND METHODS

Baseline data :

Twenty women workers involved in grain picking activity of Madurai district of Tamil Nadu were selected for the ergonomic evaluation of grain picking by conventional and improved method. The grain picker developed by G.B. Pant University of Agriculture and Technology was used for improved method of ergonomic evaluation. A framed interview schedule was used to record the physical characteristics of the selected women, time and work study, physiological parameters, hand grip

strength and musculo-skeletal disorder of the women.

The physical characteristics of women workers such as age, body weight, height were recorded. Body Mass Index (BMI) was derived by measuring weight and height of the woman using Quetelet Index in the following formula :

$$\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height (m)}^2}$$

Body type as per BMI according to Quetelet's Index is graded as ectomorph (BMI < 18), mesomorph (BMI = 18 to 25) and endomorph (BMI > 25).

Time and work study:

The grain picking activity performed by selected women workers for a period of 30 minutes for each worker were recorded by using video camera for analysis of time and work study.

Physiological cost of work:

The selected women were made to perform the activity for a period of thirty minutes each in both the methods (Fig. A and B). A polar heart rate monitor was used for recording of heart rate of the subjects. The resting heart rate, working heart rate and recovery heart rate of the subjects were recorded as per the standard protocol



Fig. A : Farm women performing grain picking activity using conventional grain picker



Fig. B : Farm women performing grain picking activity using improved grain picker

of five minutes rest, twenty minutes of continuous work cycle and five minutes of recovery. The recorded heart rates were then analyzed for calculation of physiological cost of work by using the following formulas :

$$\text{Physiological cost of work (PCW)} = \frac{\text{TCCW}}{\text{Total time of activity (in minutes)}}$$

where,

$$\text{Total cardiac cost of work (TCCW)} = \text{CCW} + \text{CCR}$$

$$\text{Cardiac cost of work (CCW)} = \text{Average heart rate (AHR)} \times \text{Duration of activity}$$

$$\text{Average Heart Rate (AHR)} = \text{Average working heart rate} - \text{average resting heart rate}$$

$$\text{Cardiac cost of recovery (CCR)} = (\text{Average recovery heart rate} - \text{Average resting heart rate}) \times \text{duration of}$$

recovery (in minutes)

The energy expenditure during the activity was calculated using the formula given by Varghese *et al.* (1994) as follows

$$\text{Energy expenditure (KJ/min)} = 1.59 \times \text{Avg working HR (bpm)} - 8.72$$

Grip strength:

The strength of grip muscles of women were recorded using hand grip dynamometer at two different intervals *i.e.*, before and after work performance. The selected women were instructed to be in a standing position, arms at their side, not touching their body. Then they were asked to hold tightly the dynamometer with as much force as possible, being careful to hold tightly only once for each measurement. Three trials were made with a pause of about 10-20 seconds between each trial to avoid the effects of muscle fatigue. The same above procedure was performed separately for both the right and left hand. The data thus obtained for each parameter was analysed using SPSS 16 version. The percentage reduction in grip strength was calculated by using the following formula,

$$\text{Grip strength in percentage (\%)} = \frac{\text{Sr} - \text{Sw}}{\text{Sr}} \times 100$$

where, Sr = Strength of muscles before work

Sw = Strength of muscles after work

OBSERVATIONS AND ANALYSIS

Women workers involved in picking of grains *viz.*, paddy and pulses in drying yards were selected for conducting the study. The height of the women workers were recorded by using a non-stretchable measuring tape and their body weight was recorded by using a digital weighing scale. The physical characteristics of the women interviewed are presented in Table 1.

The mean age of the women workers involved in grain picking activity was 47 years and their average

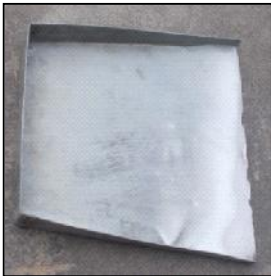
Table 1 : Physical characteristics of the women involved in grain picking activity		
Parameters	Mean (n=20)	±SD
Age (years)	47.65	8.00
Height (cm)	154.58	4.15
Weight (kg)	53.57	10.44
Working hours/day	9.25	1.48
No. of years of working in field	19.10	7.11
BMI	22.37	4.05

working hours per day was found to be 9 hours performing various activities like grain drying, picking and storage. The mean work experience of the workers was 19 years of which most of the subjects (55%) work experience was in the range of 10 to 20 years followed by more than 20 years (30%). The Body mass index of the women performed in grain picking activity was in

the normal weight range of 18.5 to 24.99 for 70 per cent of the women.

Model 1:

The tool was made of Galvanized iron with two handles on top of it. The opening of the grain picker was found to be damaged due to repeated usage.

Sr. No.	Description of the tool	Conventional method	Improved method	
1.	Photograph and name of the tool	 Model 1		
		 Model 2		
2.	Specifications (cm)	Model 1	Model 2	Improved Model
	Length	35	32.5	37
	Width	29	26	25.5
	Depth	7.5	5	4
	Circumference of handle	9	Nil	7
	Material of construction	Galvanized iron	Galvanized iron	Galvanized iron
3.	Weight in kg.	1.5	1.0	1.2

Field performance data (time and work)	Conventional method (n = 20)	Improved method (n = 20)
Weight of grain picked / lift (kg)	3.15	5.23
No. of lifts / min.	25.75	33.75
Picking efficiency (%)	-	66.86
Rating on time load		
Very slow - 5	3.25	2.9
Slow - 4		
Moderate- 3		
Fast - 2		
Very fast - 1		

Model 2:

The tool was made of Galvanized iron without handles to hold.

Improved method:

The tool was made of galvanized iron with cushion handles and was having a sharp edge for easy picking of the grains. The weight of the tool was 1.2 kg which made simple for the workers to hold and perform their activity.

The mean amount of grain picked per lift was 3.15 kg and 5.23 kg for the conventional and improved method, respectively (Table 3). As the number of lifts per minute increases in improved method, there was an increase of 66 per cent picking efficiency against the conventional method. The rating on time load was found to be fast (2.9) than conventional method as it was found to be in moderate time load (3.2). This may be due to the fact that in the improved method of grain picking activity, the women workers could complete the work with comfortable handles provided in the grain picker and also the quantity of grain picked per lift was more when compared with the conventional grain picker which resulted in accomplishing the task in less time.

Physiological stress of the women workers performing grain picking activity was determined on the basis of various parameters like average and peak working heart rate, energy expenditure, physiological cost of work and work load based on heart rate recorded

while performing the activity. Table 4 shows that the average and peak working heart rate was found to be less in improved method than in conventional method of grain picking. The average working heart rate was 107 bpm in improved method whereas in conventional method it was 118 bpm. The same trend was observed in mean and peak energy expenditure also. The total cardiac cost of work (TCCW) and Physiological cost of work (PCW) were observed to be less in improved method. The findings of the study are in conformity with Dilbaghi *et al.* (2008) who found that maximum output of work in improved sickle and reduction in total cardiac cost of worker with improved sickle over conventional sickle. Hasalkar *et al.* (2005) studied the physiological cost of work for women while performing decortications of groundnut using one existing and two developed decorticator models. They revealed that the average working heart rate was low and within the acceptable work load limits of women for 20 minutes activity in developed standing model of groundnut decorticator. Singh *et al.* (2012) found that farm women performing dehusking and shelling of maize cobs using ergonomically developed hand operated maize dehusker and sheller reduced the physiological cost of work and economic cost than the existing method.

Also the work load rating as per the heart rate of the women workers were found to be in the range of light work (2.7) for improved method whereas it was

Table 4 : Measurement of physiological parameters of the women involved in grain picking activity			
Sr. No.	Physiological parameters	Conventional method (n = 20)	Improved method (n = 20)
Heart rate (beats/minute)			
1.	Avg. working heart rate	118±2	107±3
2.	Peak working heart rate	136±3	119±3
Energy expenditure (kj/min)			
1.	Avg. energy exp.	10.15	8.22
2.	Peak energy exp.	13.03	10.25
Cardiac cost			
1.	Avg. cardiac cost of work (CCW)	759	515
2.	Avg. cardiac cost of recovery (CCR)	105	66
3.	Avg. total cardiac cost of work (TCCW/ 30 min. duration)	864	581
4.	Avg. physiological cost of work (PCW)	29	19
Work load category as per HR			
	Very heavy - 5	3.2	2.7
	Heavy - 4		
	Moderate - 3		
	Light - 2		
	Very light - 1		

moderate work (3.2) for conventional method of grain picking.

Table 5 shows that the hand grip strength after completion of work was decreased in both the method of grain picking. But the percentage reduction in grip strength after the completion of grain picking activity was found to be less in improved method for both right (17.52 %) and left hand (15.90 %) whereas it was more in conventional method *i.e.*, for right hand (36.71%) and left hand (31.80%) in (Table 5). The data revealed that the reduction in grip strength was less in improved method than the conventional method, which indicated that the improved tool enabled better performance. Metgud *et al.* (2008) showed that there was a significant decrease in hand grip strength ($P < 0.001$) with increasing tenure of the work and at the end of the day's work for women workers performing spinning of wool in conventional method which indicated muscular fatigue.

Musculoskeletal symptoms generally are experienced in different phases with numbness as the first stage, following stiffness, swelling and resulting in pain. Analysis of the MSD revealed that majority of the women workers (70%) they had pain in the region of upper limb such as shoulder, upper arm, elbow, lower

arm, wrist and palm and the remaining 30 per cent of them experienced stiffness in the upper limb (Fig. 1). This may be due to the continuous lifting of the grain picking at a faster pace in bending posture. Scutter *et al.* (1997) reported that one-third of agricultural workers surveyed reported neck pain at least once a week. Cent per cent of the workers expressed pain in their lower back region and lower limb region such as upper legs, lower legs, ankles and feet. This may be due to the continuous bent posture adopted throughout the entire cycle of grain picking for many years. Manual materials handling and lifting are the major causes of work-related low back pain and impairments (Waters *et al.*, 1993) with other factors such as bent and/or twisted position (Rihimaki, 1991 and Hagberg, 1992). Manual material handling is the most frequent (36% of all the claims) and costly (35% of total cost) category of compensable loss (Leamon and Murphy, 1994) and is associated with the largest proportion (63 -70%) of compensable low back disability (Snook *et al.*, 1978). The prevalence of low back pain (LBP) in farmers has been reported to be around 50%, which is higher than other manual laborers (about 37%) (Walker-Bone and Palmer, 2002). Hence, redesigning of the tool to reduce the fatigue is the need

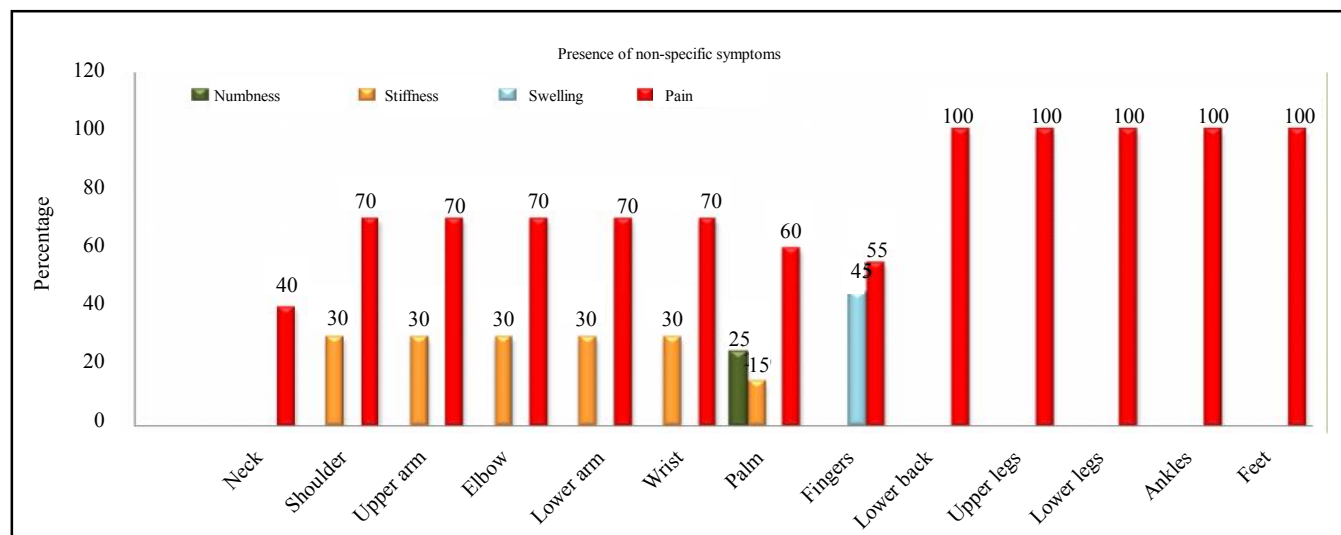


Fig. 1 : Presence of non-specific symptoms of the women in conventional grain picking activity

Grip strength	Conventional method (n = 20)		Improved method (n = 20)	
	Right hand	Left hand	Right hand	Left hand
Before work (kg)	24.60	20.00	24.60	20.00
After work (kg)	15.57	13.64	20.29	16.82
Reduction in grip strength (%)	36.71	31.80	17.52	15.90

of the hour. Kishtwaria and Ranab (2007) observed that there were a significant changes in the physiological parameters and musculoskeletal problems faced by women farmers while working with the improved tools as compared to the existing tool.

It can be concluded that the improved method of grain picking activity could be recommended as there was an eminent improvement in the picking efficiency, production rate and minimum reduction in grip strength which resulted in reduced physiological cost of work.

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