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Drudgery Reduction for Farm Women: An Ergonomic Assessment of Improved Agricultural Tools and Implements

Premlata Singh[1], Jogender Singh[2] and Rahul[3]

ABSTRACT

In spite of technological advancements, there are hardly any deliberate efforts made to generate women friendly technologies to increase their efficiency and effectiveness and reduce drudgery. It is paradox in the context that farm women account for more than 90 percent of agricultural work force and 75 percent of female population is engaged in agriculture (Census 2001, GOI). Such a large work force is associated in the field but are still being deprived of the benefits of farm mechanization in order to minimize their health risk and drudgery. Ergonomics of tools and implements can give interfaces for better design of equipment in order to increase efficiency without jeopardizing health. A comparative study was conducted for some selected agricultural implements to evaluate cardio vascular load, energy expenditur, yield, perceived exertion and musculo-skeletal problems in use of traditional as well as improved tools, viz., weeders, sickle, cleaner-grader, fertilizer broadcaster and bhindi plucker. Percentage reduction in cardio- vascular rate and energy expenditure for the above tools was 1.85, 3.47, 6.66, 12.53; 16.40, 32.40; 4.87, 11.32; and 7.60, 13.17, respectively. The findings revealed that application of improved tools in agricultural operation, not only reduces drudgery of farm women but also aims at higher economic production. However, variations were observed depending upon the design of the tools.

The vital role of farm women in nearly all stages of crop production was recognized. While men tend to do the bulk of the heavy intermittent jobs, it is the women who do much of the crop husbandry, particularly weeding, harvesting and post harvesting operations, storage etc. Though many of the tasks performed by males are getting mechanized, the women continue to toil in labour intensive jobs. Women are involved in agricultural tasks which incurs maximum drudgery because of the predominantly unskilled nature of the work assigned due to gender discrimination, hardships arising from under- employment and under-paid employment and inadequate opportunities for the acquisition of new skills compounded by the handicaps of illiteracy. As the research system in agriculture is men oriented, no attempts have been made to generate women specific home and farm technologies to reduce drudgery and it has also been observed that mechanization besides increasing the efficiency of farm women, crates more work for them due to increased intensity of cultivation.

The interventions were made to familiarize women to improved agricultural implements and training to equip them with skills and knowledge. The application of ergonomics principles is imperative in the present situation in order to design tools and farm equipment was conducted in relation to the operational comfort of rural women with the objective of determining energy expenditure cardio-vascular rate and physiological responses on the use of selected tools and women specific equipments. A comparative analysis of traditional practice with that of improved implements has been carried out.

METHODOLOGY

The present study was conducted under NATP' MM Project. "Empowerment of Women in Agriculture" with the help of selected farm women in three blocks of Delhi. The perceived attributes were recorded to appreciate the benefits of improved implements as against traditional practices. Ergonomic assessment was done in order to evaluate the improved tools and

[1] Professor, Division of Agriculture Extenstion, IARI, New Delhi, [2] SMS, KVK, Kurukshetra, Haryana. [3] SMS, KVK, Tripura

Table 1. Ergonomic data for different equipments

Type of equipment	Name of the equipment	Average Output	Average Working Heart		Average Energy Expenditure		% reduction in HR (Improved over traditional)	% reduction in EE (Improved over traditional)
			Resting	Working	Resting	Working		
Improved	**Improved Sickle (Naveen)**	54.2 m²/ hr	83.9	109.3	4.62	8.65	6.66	12.53
Traditional	Traditional Sickle	56.1 m²/hr	83.9	117.1	4.62	9.89	—	—
Improved	**Twin Wheel Hoe Weeder**	130.12 m²/hr	83.1	116.1	4.49	9.73	1.85	3.47
Traditional	Traditional (Hand Hoe)	32.12 m²/hr	83.1	118.3	4.49	10.08	—	—
Improved	**Grubber Weeder**	112.5 m²/hr	82.5	114	4.40	9.4	3.22	6.09
Traditional	Traditional (Hand Hoe)	31.8 m²/hr	82.5	117.8	4.40	10.01	—	—
Improved	**Hanging type cleaner cum grader with sac holder**	204 kg/hr	81.0	92.91	4.16	6.05	16.40	32.40
Traditional	Sieve	69 kg/hr	81.0	111.13	4.16	8.95	—	—
Improved	**Fertilizer broadcaster**	7168 m²/hr	834	118.5	4.54	10.12	8.37	14.52
Traditional	Application by hand	4296 m²/hr	83.4	129.3	4.54	11.84	—	—

implements. The criteria for selecting the tools and implements were high energy demanding with greater working heart rate; greater utility among the rural women; tools that are well accepted among farm women in terms of improving work efficiency by reducing drudgery.

Indian farm women are involved in almost all drudgery prone activities. As a results of which they are not included in economically productive category. However, we need to give a new look to this because such activities are indispensable for sustaining and maintaining agriculture. Drudgery factor is attributed in terms of fatigue, time and output. Ergonomics seek to make a better match between workers physical capability and limitations and work place conditions and activities. This can be done through better design and operations of tools, equipments and control. The women energy nexus involves the challenges engendering energy and the challenges of empowering women through energy. As studies reveal that women work more than men, their back breaking tasks could be displaced by agricultural mechanization.

Accordingly for the present study, following handy tools and implements were studied which had maximum utility for farm women. Single and twin wheel hoe weeder, sickle, hanging type cleaner and grader with sac- holder and fertilizer broadcaster. Available models of these hand tools were subjected for the study. Their specifications are tabulated in Table.

Selection of Subject

An overall physical structure of women was taken in to consideration randomly from the villages. Physical dimensions for study include age, stature (height in cms) and biological weight. No specific measuring kit or scale for reference was used. Standard women were selected for study like overweight and underweight persons were excluded. The criteria was same for age and height. Randomly healthy farm women were identified and selected. During selection, one simple thing was maintained that women were involved rigorously to in traditional practices were only the subject.

Physiological Cost Measurement

The heart beat rate was measured using Polar Heart Rate Monitor in studies ambulatory positions directly in the field. Polar heart rate monitor is a compact portable instrument to monitor the heart beat rate and this can be used in the field directly where other instruments can not be used.

Respondents used the same type of working instruments for both the practices viz., traditional and improved. The subject workers were asked to rest before the start of each experiment for stabilizing their rate at normal level. The resting period is same for both the practices.They were asked to perform weedings, harvesting and other usual tasks in their normal way and the heart rate was recorded. Then they were asked to do the same operation by use of improved implements. Each of the experiments were replicated three times. Energy requirements and work output studies were conducted with one subject at a time. Then after computing the average working heart rate and average energy expenditure, percentage reduction was calculated for both the practices.

The following mathematical formula were adopted

1. Percentage reduction in heart rate :

$$\frac{\text{Traditional heart rate-Improved heart rate}}{\text{Traditional heart rate}} \times 100$$

2. Average energy expenditure :
   Average heart rate x (0.159 – 8.72)

The rating of perceived exertion (RPE) was also recorded using one to five point scale ranging from very light, light, moderate heavy, heavy and very heavy. Basing on this, muscular skeletal problems were noted down as perceived by the farm women. These problems created health disorders and thus causing drudgery. Studies were conducted to have an overall idea about the extent of drudgery associated with traditional practices.

RESULTS AND DISCUSSION

The extent of drudgery involved in numerous agricultural activities contributed by farm women is shown in Table 4.

Drudgery in Agriculture

Most drudgery prone activities in agriculture are carrying load on head, harvesting, weeding, transplanting, post harvesting, cutting, cleaning and grading. Drudgery was calculated using paired technique. Drugerous activities include harvesting (cutting 22%), weeding (17%), manure application (3%) and cleaning, grading (3%) and rest being shared by other tasks.

The plight of farm women in this regard is quite noteworthy and considerable as they suffer from handicaps of illiteracy, poor health, lack of scientific information about advanced technology and unemployment.

In order to reduce drudgery and improve efficiency of farm women, need was assessed to promote application of improved farm equipment among farmers. Through mission mode project funded by NATP, use of tested appropriate farm implements was promoted and their ergonomics was assessed. Implements popularized include twin wheel hoe, grubber weeder, hanging type cleaner grader, sickle and fertilizer broadcaster.

The average working measurement responses with respect to sickle, twin wheel hoe weeder, grubber weeder, hanging type cleaner grader and fertilizer broadcaster are minimized in Table 1. From the data it is evident that operational rate with respect to heart rate and energy expenditure differed for every improved tools when compared with traditional practice.

Harvesting and Post harvesting Implements

As rural women devote maximum time and energy in harvesting tasks like cutting, picking, cleaning, grading etc., interventions made in this regard were improved sickle and hanging type cleaner-grader.

Sickle

It is a serrated blade used for cutting of crops like wheat, soybean, rice and grasses. Though there is not much variation in traditional and improved practice, the wooden handles of sickle has bent at the rear end for better grip to avoid hand injury during operation.

Average working heart rate which actually determines the work pressure reduced to 109.3 from 117 b/min and percentage reduction was 6.66. Reduction in energy expenditure was worthy note (12.53%) and average output varied slightly (1.9 m/hour) from old one. Rating of perceived exertion (RPE) was moderate heavy to light for improved method.

Hanging Type Cleaner and Grader

It is a batch type hand operated equipment to replace existing traditional practice i.e. natural wind or horizontal/vertical sieving to clean the grains. As traditional method employ more energy and time, cardio-vascular load is more. Average working heart rate for specially designed tool (imported) and traditional was 92.91 beats and 111 b/min. More the working rate more is the work load. Energy expenditure for the same varied by 2.90 units. More is the energy consumption, higher is the fatigue. Average output for traditional and improved method recorded was 69 kg/hour and 204 kg/hour, thus showing a remarkable increase. RPE varied from light to moderate heavy. For traditional, musculo- skeletal problems (MSP) marked pain in neck, lower arms, back, knees, feet whereas application of cleaner grader causes moderate pain in elbows. A noticeable increase of output can be directly related to its efficiency, which is further enhanced as it is provided with a sac holders, which holds the sack in vertical position for easy loadings of cleaned grains.

Intercultural Operations

Studies reveal that women participate in such operations very often. Weeding and fertilizer/ manure application are commonest of them all. Traditionally both the activities are done by hand but interventions made in this regard to reduce drudgery are twin wheel hoe weeders and fertilizer broadcaster.

Twin Wheel Hoe Weeder and Grubber Weeder

It is provided with a long handle and two wheels for rapid cutting of weeds. Average working heart rate showed wide variation of 1.85 beats/min and 2.2 b/min when compared with traditional practice.Percentage reduction in heart rate was 1.85 and 3.22 (improved vs. traditional). Cardio–vascular load is indicated through the fatigue factor which can be perceived through exertion experienced while operating with the two. RPE for both the implements was similar i.e. moderate heavy. Energy expenditure received a 3.47 percent reduction for twin wheel hoe and a high of 0.89 percent for grubber. Output was calculated to compare the working efficiency of both the practices. For twin hoe; average output varied from 13m 130. 1-1 X/hour as compared to 32.12 by hand hoe (traditional) and for grubber weeder it was 112.5. A remarkable 31.8 units increase in output assure its acceptability among farm women, as outcome is productivity.

Fertilizer Broadcaster

It comprises of a container with belt to tie it while throwing fertilizer and give comfort to farm women as not being carried out all along the field. Moreover, it ensures precise and uniform application. Average working heart rate and energy expenditure shifted by 10.83 and 1.72 units, respectively and percentage reduction for both was 8.37 and 14.52 as calculated. Average output

showed a cent per cent increment over traditional method. RPE ranged from moderate heavy to heavy.

An overall summery of findings for all the implements studied shows that maximum reduction in HR (16.40%) was for hanging type cleaner grader and minimum for twin wheel hoe weeder (1.85). RPE for all showed a positive shift whereas for grubber weeder it was rather constant. Maximum reduction in energy expenditure was for cleaner grader (32.40%) and minimum for twin hoe (3.47%). Output calculated for hanging was considerably high. Thus, it can be inferred from ergonomic findings that hanging type and fertilizer broadcaster can prove to be better interventions in reducing drudgery of farm women. However, all the tools have wider scope of applicability and compatibility.

CONCLUSION

Traditional and improved sickle (Naveen sickle) do not have significant differences in their work efficiency. Fatigue factor is also too high in case of cleaning grains by sieves which can be replaced by the use of hanging type cleaner grader which can be noticed by cardio- vascular load. It is also evident that variation in energy requirement is also remarkable. Use of improved implements can have wider acceptability because of these reasons. Physiological responses in terms of musculo-skeletal problems also show changes in their magnitude. However, the perceived variation for all the parameters may differ due to changes in designs and engineering specifications. Hence, farm women must be conscious about both the practices. Importance of ergonomics has been well established and recognized in industrial sector but in agriculture also it has got wider implications.

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