

Original Research Article

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Ergonomic Evaluation of Drudgery Load Faced by Farm Women in Wheat Harvesting

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ABSTRACT

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A study was conducted in Ratlam district of Madhya Pradesh. Naveen, Vaibhav and Local sickle evaluated for harvesting wheat crop with 30 farm women. Harvesting is a main drudgery prone activity which is mostly done by farm women and to solve this problem Krishi Vigyan Kendra Ratlam, as per its mandate conducted front line demonstration on “Improved Sickle” in wheat Harvesting. A technically prepared serrated sickle and Vaibhav sickle was tested on farm women to improve work efficiency and to reduce the drudgery of women.

Introduction

The role of Indian women is very important in improving the economy of the country. There are 92 million women working in agriculture and allied sector and it is about 40% of the total rural workers in India (Singh *et al.*, 2007).

Women workers are about 25.5% the total workers in India as per census 2011. Among them cultivators are 24.9% agricultural labours are 18.5% and workers in household industry and other works are 47.2% women are important workers in agriculture. In the field of agriculture they work as female labours, farmers, co-farmers, female family, as farm managers and farm entrepreneurs (Prakash N. *et al.*, 2014). The sickle is widely used and is a very old tool which was curved

blade with a handle. It is used to cut or reap wheat crop. Sickle has two types of cutting edge i.e., plain and serrated with depth of 1 mm. Serrated sickle is only used in wheat harvesting but plain sickle is used everywhere so it is more in use shearing force is used in plain sickle while fractional force is used in serrated sickle. Different industry and research organization improved serrated sickle to use in harvesting more crops (Singh 2009).

All thought the role of women in livestock production, horticulture, post-harvest operation is important but it is ignored (Singh surbhi, 2010). In post-harvest activities a woman spends 38.7 hours on wheat producing per acre in one season. The post-harvest us

spend in activities were 121.5 hours per acre for this crop (Khan *et al.*, 2012).

Harvesting the wheat crop is a big problem for farmers/ farm women all over the world. In harvesting precaution is taken otherwise mature grain will easily detach from the ear heads/ponds as by fast working tools or machine. Women perform harvesting by local sickle with bending and squatting posture for hours together (Sing Alka, 2014).

E.g. 8-9 hours daily, large land holders use different harvesters but small and marginal farmers depend on hand tools operating labours due to various seasons. Harvesting is done in unnatural body posture for long time it increase the physiological work load of women and they face many musculo-skeletal body problems decreasing the work efficiency (Jyotsana, 2014).

Manual harvesting is very depending of labour and is full of drudgery. Tool design and used body posture therefore increases the discomfort of both healthy and less fit individuals (Sing Alka, 2014).

In present study, improved sickle of two organization were taken. Vaibhav sickle from Dr. Baba Sahab Konkan Krishi Vidyapthet (BSKKV), Dapoli and Naveen sickle from Central Institute of Agricultural Engineering (CIAE) Bhopal.

Then the performance of local sickle and improved sickle were compared.

A science that is concerned with a fit between people and their work is known as ergonomics. This science given priority to people first thinking of their abilities and limitations, ergonomics makes sure that equipment, tasks, information and environment suit each workers (Rajendran and Reddy, 2013).

If farm women, while working experience physical and mental strain, fatigue, monotony and hardship, it is known as drudgery (Kumar *et al.*, 2011).

This research is aimed to reduce their drudgery and increase their working efficiency by introducing improved sickle. The farm work demands women work which result is lot of fatigue and occupational health hazards added by improper posture. Improves sickle is lighter than local sickle and works in a comfortable posture (Sharma Barkha *et al.*, 2015).

We selected Chiklana and Lasudiya Nathi Village of KVK Ratlam for this study. 30 farm women were selected who were good in traditional sickle harvesting. There women had good health. The gradation of health status was done on the basis of BMI. Garrow's (1987) classification was used for BMI scores.

Heart rate of every respondent was tried as the heart rate monitoring machine. It was switched as to record the heart rate at every minute. Five minute interval as rest was given to record the resting heart rate. Respondents were asked to do harvesting for 30 minute and heart rate was recorded at an interval of one minute each and than five minute rest was given. Then the monitor was switched off and removed. The respondents work with traditional as well as serrated and vaibhav sickle during which heart rate was recorded in rest and in working condition. The following parameters were calculated on the basis of the result of heart rate records.

Brief description

Local (plain) sickle cuts the crop stalk by impact or pulling action while improved (serrated) sickle cuts it by sawing action. Improved sickle has serrated blade, ferrule

and wooden handle and weight duly 180 gm. Wrist fatigue is less and the drudgery during harvesting is reduce as compared to local sickle which are heavier i.e. weight about 350 gm (Singh, 2007).

Benefits/Advantage

Serrated sickle needs no sherpning of cutting edge often.

Cutting efficiency is increased and cutting force is reduced.

Due to serrated edge, sharpness of blade is more efficient and has longer life than normal sickle.

Handle of serrated sickle is convenient to grip and serrated blade cuts appropriately its light weight is easy to handle.

Handle and blade are fixed with a mental sheet that provide firmness to blade while cutting and ensures safety in use.

Material and Methods

Energy expenditure

During work and rest energy expenditure was also calculated. It was done by AHR, using the regression equation given by Verghese *et al.*, (1994).

$$\text{EER (kj/min)} = 0.159 * \text{HR (beats/min)} - 8.72.$$

Physiological workload

When an activity or a task is completed by muscular effect or physical effort, it is physiological workload. Work period is the period during which the activity was done. Recovery period is the period during which the physiological function return to resting level. At the end of the activity heart rate was

also recorded. Various sickle were used to calculate value of heart rate, total cardiac cost of work (TCCW) and physiological cost of work (PCW) for wheat harvesting.

$$\text{Total cardiac cost of work} \\ \text{Physiological cost of work} = \frac{\text{Total cardiac cost of work}}{\text{Duration of work (min)}}$$

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

$$\text{CCW} = (\text{Average working heart rate} - \text{Average resting heart rate}) * \text{Duration of work (min)}$$

$$\text{CCR} = (\text{Average recovery heart rate} - \text{Averaged heart rate}) * \text{Duration of recovery (5 min)}$$

Classification of workload

Workload of activity was categorized as per the following classification of workload (Table 2) in different occupations proposed by Varghese *et al.*, (1994)

Overall Discomfort Rating (ODR)

Corlett and Bishop in 1976 developed overall discomfort rating (ODR) for the assessment 70 cm. long graduated scale was taken with its left marked or 0 and its right end 10. 0 means no discomfort and 10 means extreme discomfort. There was a sliding pointer on the scale for discomfort marking. At the end of each trial discomfort rating was marked on the scale. All the thirty subjects gave discomfort rating which was marked on the scale. The average was calculated to get the mean rating.

Rating of perceived exertion

When there is pain there is discomfort. So gained discomfort due to pain was recorded

while performing harvesting. So rating of perceived exertion (RPE) was determined by 5 point continuum. Very light exertion was shown as 1 and very heavy exertion was mean as 5. Mean of there was calculated for all subjects for average score.

Musculo-skeletal problems

This human body map was used. It shown musculo-skeletal problem in different body parts (Corlette and Bishop 1988) it depends on a 5 scale point very mild pain 1 to very severe pain 5.

Results and Discussion

Physical characteristics of the participants: In the table 3 basic anthropometric data of the participants is shown.

The mean age of the selected farm women as mean on the table was 35 years. The average height was 162 cm and mean body weight was on the range of 42-73 kg. The calculated mean body mass index was 22.7 which meant that they were in the normal category.

The data in table 4 mean that majority of the respondents (73.3%) were on normal category in relation to BMI score, 10% of women had BMI score is obese grade 1 range and 16.6% women were in the range of low weight normal category.

Table 5 mean the heart rate response of all subjects during wheat harvesting using the local, the Naveen and Vaibhav sickle. It mean that the average heart rate of working female was 132.1 ± 3.36 beats/min by the local sickle by naveen sickle it was 127.8 ± 2.27 beats/min and by vaibhav sickle it was 130.1 ± 2.47 beats/min. The heart rate in local sickle, during harvesting of wheat increased to 52.1 beats/min, in naveen sickle it was 47.2 and in vaibhav sickle it was 49.6 beats/min.

During harvesting the energy expenditure by three types of sickle rate was also noted. It varied from 9.0 to 10.7 kj/min in local sickle with mean value of 9.85 kj/min. in naveen sickle it varied from 10.9 to 14.2 kj/min. with mean value 11.5 kj/min and in vaibhav sickle it was 11.3 to 12.6 kj/min with mean value of 11.9 kj/min.

Area covered

Vaibhav sickle covered $122 \text{ m}^2/\text{h}$ followed by $121.3 \text{ m}^2/\text{h}$ by Naveen sickle and $102.1 \text{ m}^2/\text{h}$ by local sickle.

Stroke

Maximum stroke/min was calculated Vaibhav sickle 43.8 stroke/min, followed by Naveen sickle 42.9 stroke/min and that of local sickle was 38.7 stroke/min only.

Total Cardiac Cost of Work (TCCW)

1581 cardiac beats were recorded with Naveen sickle followed by 1664 cardiac beats with Vaibhav sickle and 1738 with Local sickle. With Naveen sickle, total cardiac cost of work (TCCW) was less (9.9%) are over the local sickle (Table 6). Singh *et al.*, (2007) reported about improved sickle 15% saving in cardiac cost of work per unit of output was compared to local sickle.

Physiological Cost of Work (PCW)

Naveen sickle average physiological cost of work was 21.2 beats/min, for Vaibhav sickle it was 27.7 and for local sickle it was 28.9 beat/min. for Naveen sickle it was less (26.4%) are the local sickle. Drudgery of farm women was reduced to 16.5% by use of improved sickle with serrated edge as concluded by Gite and Agarwal (2000) who compared it with local sickle for harvesting wheat crop.

Table.1 Physical dimensions of sickle

S.No	Particulars	Local	Naveen	Vaibhav
1	Total weight, g	260	230.0	202.0
2	Total sickle length, cm	30.5	36.0	35.0
3	Length of cutting edge,cm	17.5	24.0	21.5
4	Chord length of the blade,cm	17.9	21.5	18.0
5	Length of handle,cm	12	12.0	13.0
6	Diameter of handle,cm	8.0	10.0	10.0
7	Pitch of teeth,mm	1.5	2.0	2.0
8	Radius of curvature of blade,cm	9.8	13.5	10.0
9	Blade concavity	3.4	3.6	4.6

Table.2 Classification of workload

Physical work load	Physiological variables	
	Energy expenditure (KJ/Min)	Heart beats (beats/min)
Very light	Upto 5.0	Upto 90
Light	5.0-7.5	91-105
Moderate	7.6-10.0	106-120
Heavy	10.0-12.5	121-135
Very heavy	12.6-15.0	136-150
Extremely heavy	< 15.0	Above 151

Table.3 Physical characteristics of the respondent (N= 30)

Physical characteristics	Range	Mean
Age in years	21-45	35
Height (cm)	147-175	162
Gross weight in kg	47-73	59.7
Body Mass Index	18.6-26.4	22.7

Table.4 Distribution of respondents as per BMI scores (N=30)

BMI Scores	Interpretation	%
< 16.0	*CED grade III (severe)	-
16.0-17.0	*CED grade II (moderate)	-
17.0-18.5	*CED grade I (mild)	-
18.5-20	Low weight normal	16.6%
20.0-25.0	Normal	73.3%
25.5-30.0	Obese grade I	10.0%
> 30.5	Obese grade II	-

Table.5 Physical cost of agricultural workers during harvesting with sickles

Subjects	Resting Heart Rate (beats/min)	Working Heart Rate (beats/min)	Increase in Heart Rate (beats/min)	Resting Energy Expenditure Rate (KJ/min)	Working Energy Expenditure Rate (KJ/min)
Local	80.1±4.37	132.1±3.36	52.1±4.65	4.0±0.67	12.2±0.55
Naveen	80.5±3.87	127.8±2.27	47.2±4.36	4.08±0.61	11.5±0.36
Vaibhav	80.4±2.55	130.1±2.47	49.6±3.88	4.07±0.40	11.9±0.41

Table.6 Physiological workload of women harvesting wheat with various sickles

S.NO	Parameters	Local	Naveen	Vaibhav
1	Area covered, m ² /h	102.1±5.20	121.3±3.62	122±2.43
2	Stroke/min	38.7±2.34	42.9±2.57	43.8±2.14
3	Cardiac cost of work (beats/min)	26.0	23.6	24.8
4	Total cardiac cost of work (TCCW)	1738	1581	1664
5	Physiological cost of work (PCW)	28.9	21.2	27.7

Table.7 Musculo-skeletal discomfort of women during wheat harvesting

Body parts	Mean score
Neck	1.7
Shoulder	3.0
Upper back	1.6
Upper arm	3.6
Lower back	4.8
Buttocks	1.9
Wrist	2.5
Fingers	3.7
Knee	4.0
Calf	2.0
Feet	1.9

Table.8 Mean value of overall discomfort rating, responses on musculo-skeletal problems and perceived exertion experienced by respondents

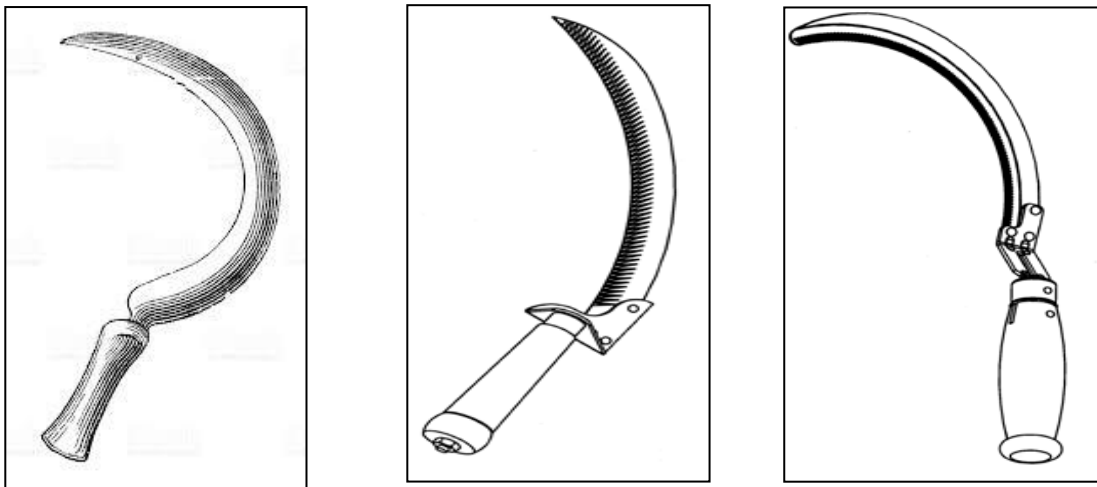
Harvesting Method	ODR	MSP	RPE
Local Sickle	7.3	Severe pain in shoulders, upper back, hands and fingers	Heavy
Naveen Sickle	4.2	Moderate to light pain in shoulder, hands and arm	Moderate
Vaibhav Sickle	4.0	Moderate to light pain in shoulder, hands and arm	Moderate

ODR – Mean value of overall discomfort rating

MSP - Musculo-skeletal problem

RPE - Rating of perceived exertion

Fig.1 Naveen and Vaibhav improved sickles used in the study



Local

Naveen

Vaibhav

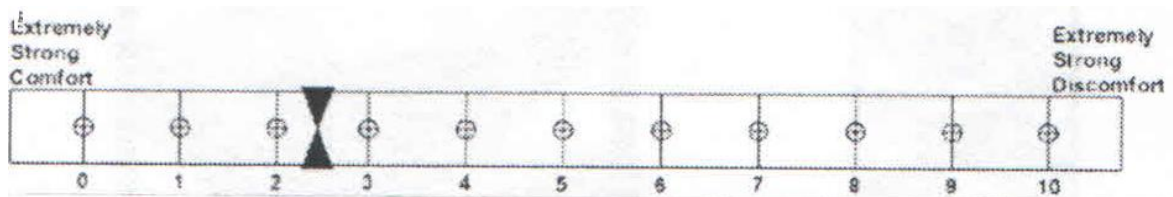


Figure B. Overall Discomfort Rating Scale

Musculo-skeletal Problems

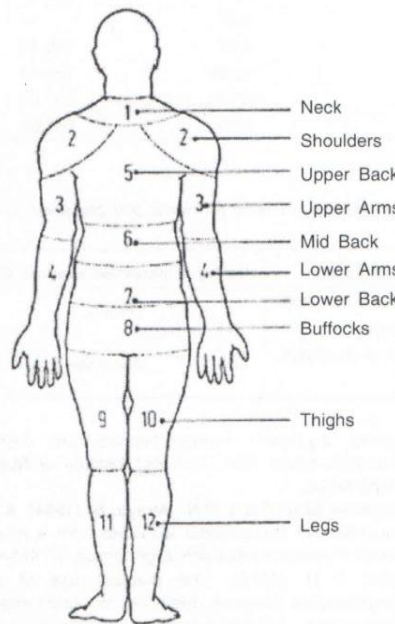


Figure C. Body map

Musculo-skeletal problems

There are many causes of fatigue and musculo-skeletal disorders. One of them is adopting a particular posture to work for longer time, even years. It results in reduced working efficiency of the worker. Almost all the women reported to severe to moderate discomfort in lower back. The mean score was 4.8 lower back, 4.0 knee, 3.0 shoulder, upper arm 3.6, neck 1.7. All the women used traditional sickle for cutting wheat and the severe discomfort caused in palm 3.9, finger 3.7 and wrist/hand 2.5 might be due to use of traditional sickle. Field working women during harvesting reported severe pain in lower back and knee. It was because of working for long duration in squatting posture (Jyotsna *et al.*, 2005) (Tables 7 and 8).

Overall Discomfort Rating (ODR)

The activity of harvesting wheat consumes lot of time and performed for long hours continuously. It results in pronounced musculo-skeletal problems.

Rating of perceived exertion (RPE)

The rating of perceived exertion was heavy in local sickle but light to moderate after the use of Naveen and Vaibhav sickle.

General discussion was conducted after completing the study to receive the feedback for improved method (Naveen sickle and Vaibhav sickle) and old method (local sickle) with farm women. In the discussion it was stated that local sickle is very heavy due to heavy handle. It cover less area require more time and labour for harvesting the crop.

Working in squatting posture for long period create more skeletal problems and leads to body hazards to the particulars ladies. Farm women told several positive points regarding

improved method (Naveen sickle and Vaibhav sickle). They all said that Naveen and Vaibhav sickle were easy to handle due to light weight which was the leading point.

Another important point was that it cuts the crop from bottom level. This helps to avoid burning problem of residues at the field. The serrated blade cut the crop sharply and covers more area in less time that saves time and money. It also minimizes the muscular problems of body.

These finding clearly show that improved farm equipments that are women friendly are better in every respect in harvesting the crop. Naveen sickle, as the results show, is better than the local sickle. It cover more area in given time, minimizes the drudgery and the perceived exertion was also low. It saves time and money expenditure on labour. It is very easy to handle and body problems are less. Only drawback noted was that left handers can't use it. One important point that emerged from the end users was that these advanced technologies should be adopted by the farm women but it will take time to reach it at rural area. Great efforts are needed for new technologies to practice in rural area.

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