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

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A B S T R A C T

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.

Keywords: Sickle, Drudgery, Ergonomics.

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 every were 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 (Singurbhi, 2010). In post-harvest activities a women 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 Vidyappteh (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).

\[
EER (\text{kJ/min}) = 0.159 \times \text{HR (beats/min)} - 8.72.
\]

**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.

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

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

\[
\text{CCW} = (\text{Average working heart rate} - \text{Average resting heart rate}) \times \text{Duration of work (min)}
\]

\[
\text{CCR} = (\text{Average recovery heart rate} - \text{Averaged heart rate}) \times \text{Duration of recovery (5 min)}
\]

**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 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.

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.

Area covered

Vaibhav sickle covered 122 m²/h followed by 121.3 m²/h by Naveen sickle and 102.1 m²/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 | 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.N0 | 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      | 1738             | 1581             | 1664             |
|      | (TCCW)                          |                  |                  |                  |
| 5    | Physiological cost of work      | 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

Musculo-skeletal Problems
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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