

## ERGONOMIC ASSESSMENT OF EAR CUTTER FOR JOWAR HARVESTING

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### ABSTRACT

An ear cutter designed and developed by AICRP-FRM center with the help of College of Engineering, MAU, Parbhani was assessed ergonomically for Jowar harvesting. Ear cutter was again assessed ergonomically after its modifications. The data was compared with traditional method of Jowar harvesting i.e. use of sickle. The subjects of the study were farm women in the age group of 20-45 years who were normal, non pregnant, non lactating and without any major illness and handicaps. Circulatory stresses and physiological cost for ear cutting were measured by sub dividing the activity –pedaling and cutting. Physical fitness was determined by subjecting farm women to step stool test. With the help of Heart Rate monitor (Polar sport tester TM), resting, working and recovery heart rate were recorded till complete recovery during sub stage of the activity. Results indicated that there was increase in Heart rate by 3-4 beats per minute while using ear cutter than the traditional method of Jowar harvesting, but the total cardiac cost of work and physiological cost of work was not increased significantly. Output of operation was significantly increased by 17.34 kg per labourer per 30 minutes than the traditional method. Field trials revealed that use of ear cutter helped in reducing the frequency of postural changes as no postural change was needed while pedaling and cutting. It can be concluded that Ear cutter developed is women friendly and is recommended for performing the Jowar harvesting to increase the output four times more than the traditional method.

**Key words :** Ear cutter, Physiological cost of work, Heart rate

The contribution of farm women in Indian agriculture is estimated to be 50-60 per cent (Anon1981). Though Women's contribution in agriculture production is significant, the introduction of machinery for women dominated operation is very low. It is necessary to design and introduce suitable and simple farm tools for farm operations which are women friendly (Kumar and Parvathi, 2001). In India, the farming practices are too haphazard and nonscientific and hence need some forethought to implement a new technology (Karthikeyan and Thomas, 2004).

Jowar and Bajara have considerable area under crop and are important cereal crops of Maharashtra. These crops are harvested manually with the help of sickle and allowed to dry for one or two days in the farm in the form of bundles. Before threshing, these ear are cut by farm women with the help of sickle. The work is being performed in traditional way in open extreme environmental condition. This ear cutting is solely performed by farm women. Thus, keeping in view the most neglected and essentially required aspect of women drudgery due to Jowar ear cutting activity in bending position, the study was conducted with the following objectives

- Design and develop new drudgery reducing technology for Jowar harvesting
- To measure the ergonomic cost of activity Jowar harvesting using traditional method and by using an ear cutter.

### METHODOLOGY

A total sample of 30 farm women from the age group of 20-45 years who were normal, non pregnant, non lactating and without any major illness and handicaps, engaged in jowar harvesting activity was selected in order to achieve the objective of present investigation. Before starting the trials, all of them were well acquainted with newly developed ear cutter for Jowar harvesting. Cutting of ear manually with the help of sickle was traditional method and ear cutter used for jowar harvesting /cutting was considered as an improved method. Cutting of ear with the help of ear cutter require two labourers. So the activity was divided in to two stages i.e. pedaling and cutting. Specifications of the ear cutter are given in Table1. Its operation and construction is shown in Fig. 1 and 2.

### Equipment :

- Step test stool for physical fitness.
- Polar heart rate monitor for continuous heart rate record.
- Goniometer for postural analysis.

Table 1: Specifications of the ear cutter

S.No.	Specifications of Ear cutter	
1.	Weight (kg) (Approximate)	80
2.	Length (cm)	170
3.	Width (cm)	74
4.	Material used	Iron & wood
5.	Cost (Rs.)	4,500/-
6.	Source	Local artisan
7.	Diameter of the wheel (cm)	25
8.	Thickness of the sprocket (cm)	0.25
9.	Length of the sprocket (cm)	0.5



Fig. 1 : Experiment on Jowar harvesting

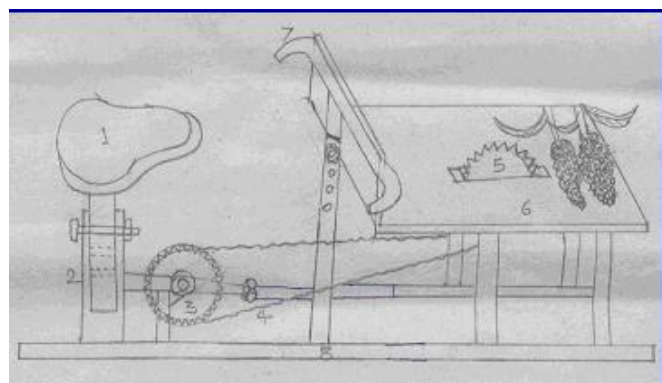


Fig 2 : Drawing of the ear cutter

1. Seat, 2. Iron seat holder, 3. Wheel, 4. Wheel chain,
5. Cutting Wheel, 6. Iron sheet desk, 7. Handle, 8. Iron frame

**Physical fitness test :**

A standardized simple step stool test was used for the appraisal of physical fitness of all the farm women.

**Procedure :**

All the subjects were prepared by giving a rest of 15 minutes under shed and data on resting heart rate was recorded. Treatments to the subjects were given at

random to avoid bias effect of training, weather etc. Heart rate was recorded at rest, during entire period of working (30 minutes) and recovery thereafter for a period of five minutes. 35

**Measurement of parameters :**

Average working Heart Rates (b.m<sup>-1</sup>)(AWHR): Working heart rate was recorded with the help of heart rate monitor, six times at every five minutes till the completion of activity.

Average peak heart rate (b.m<sup>-1</sup>)(APHR): It was noted down while performing the activity for 30 minutes.

Average and peak energy expenditure (kj.m<sup>-1</sup>)(AEE and APEE): It was calculated by using following formula.  $EE (kj.m^{-1}) = 0.159 \times \text{Heart rate (b.m}^{-1}) - 8.72$

Total cardiac cost of work (TCCW) (b.m<sup>-1</sup>): TCCW was calculated by using the following formulae  $TCCW = \text{Cardiac cost of work} + \text{Cardiac cost of recovery}$  where,

Cardiac cost of work = (Average working heart rate – Average resting heart rate) X Duration

Cardiac cost of recovery = (Average recovery heart rate – Average resting heart rate) X Duration

Physiological cost of work(PCW) (Beats): It was calculated by following formula

$$PCW = TCCW / \text{Total time of work}$$

Output parameter :

Out put in kgs/labourer/30minutes

**RESULTS AND DISCUSSION**

In order to reduce the drudgery of farm women while performing the activity –jowar harvesting .an Ear cutter was designed and developed by AICRP-FRM Unit, College of Home Science, Marathwada Agriculture University, Parbhani in collaboration with College of Agricultural Engineering, MAU, Parbhani. After conducting the ergonomic evaluation of this ear cutter it was found that few modifications are necessary to increase the speed in order increase the output. Certain modifications in the design of the ear cutter were made (Table 2) and experiment on ergonomic evaluation of jowar harvesting was repeated. The results of this study were tabulated and are depicted herewith.

Table 2 : Modifications made in the eared cutter

S.No.	Modifications
1	Iron sheet desk instead of wooden
2	Changes in seat arrangement
3	Sharpness of cutting wheel
4	Alteration in the height of the handle
5	Addition of double sprocket chain system

**Physical characteristics of the subjects:**

It was observed that average age of the subject was 31 years, height was 153 Cms. Gross weight of all selected farmwomen was found in the range of 38- 58 kg, where as average lean body mass was 31.16 kg. The average body mass index was 19.09 kg/m<sup>2</sup> and average aerobic capacity of the farmwomen observed was 30.68ml/kg/minute.

**Physiological workload while performing the activity using existing method and improved method :**

Data form Table 3 reveal that the average working heart rate while performing Jowar harvesting by traditional method was 96 b.m<sup>-1</sup> Whereas for improved method it was 99 b.m<sup>-1</sup> and 100 b.m<sup>-1</sup> for pedaling and cutting, respectively. It indicates that when Jowar harvesting was performed by ear cutter, the heart rate increased significantly by 3 and 4 beats per minute, respectively in case of pedaling and cutting. Peak heart rate, average and Peak energy expenditure followed the same trend. Results were non-significant in case of total cardiac cost of work, physiological cost of work and rated perceived exertion.

The output of operation per labourer by traditional

method was 5.98 kg for 30 minutes. The highest output i.e. 47.66 kg per two labourers was noted in case of II experiment conducted with modification in ear cutter. It was observed that output was significantly increased by 17.34 kgs per labourer per 30 minutes after the modifications. It indicates that modifications made in the design of ear cutter is satisfactory and acceptable.

**Postural analysis of the activity using traditional method and improved method :**

The frequency of postural change indicated that to complete the harvesting activity of 30 minutes by traditional method, on an average, woman required to change posture such as sitting-2 times, bending-4 times and squatting position-2 times. Using improved method, no postural change was needed while pedaling and cutting. Thus, it can be concluded that there is 100 percent improvement in posture of women workers with improved method postural analysis. The activity revealed that the angle of deviation decreased by 5° and 7° at cervical region in case of pedaling and cutting stage of improved method, respectively. Angle of deviation at lumber region decreased by 6° in case of cutting stage.

Table 3 : Physiological workload while performing the activity using existing method and improved method (Season- *kharif*) Activity –Jowar harvesting

Physiological Parameters	Traditional method with sickle	Improved method		Significant reduction in improved over existing		“t” value	
		Pedaling (I)	Cutting (II)	I	II	I	II
Average working heart rate (b.m <sup>-1</sup> )	96 ± 5.60	99 ± 2.95	100 ± 4.85	+ 3 (3.12)	+ 4 (4.16)	2.60**	2.96**
Average peak heart rate (b.m <sup>-1</sup> )	101 ± 6.41	106 ± 3.80	105 ± 4.15	+5 (4.95)	+4 (3.96)	3.67**	2.87**
Average Energy expenditure (b.m <sup>-1</sup> )	6.46 ± 0.89	7.1 ± 0.44	7.18 ± 0.77	+0.64 (0.99)	+0.72 (11.1)	3.55**	3.42**
Peak energy expenditure (b.m <sup>-1</sup> )	7.39 ± 1.08	8.15 ± 0.59	7.96 ± 0.64	+0.76 (10.8)	+0.57 (7.71)	3.45**	2.37*
Average TCCW (b.m <sup>-1</sup> )	658 ± 185	647 ± 176	673 ± 207	-11 (1.67)	+15 (2.27)	0.23 <sup>NS</sup>	0.30 <sup>NS</sup>
Average PCW (b.m <sup>-1</sup> )	21.75 ± 6.18	21.56 ± 5.85	22.3 ± 6.9	-0.21 (0.96)	+0.55 (2.52)	0.12 <sup>NS</sup>	0.31 <sup>NS</sup>
Average RPE	2.28 ± 0.45	2.32 ± 0.33	2.18 ± 0.31	+0.04 (1.75)	-0.10 (4.38)	0.4 <sup>NS</sup>	1.11 <sup>NS</sup>
Total time fixed for the activity (min)	30	30	30	--	--	--	--

Table 4 : Out put of operation (kgs) by traditional method and using improved method

Sr. No. and year of Expt	Traditional method	Improved method by using ear cutter		“t” value
	Output per labourer	Output per laborer	Output per two labourer	
1. Expt I	5.98 kg	6.49kg	12.98kg	3.92**
2. Expt II	5.99 kg	23.83 kg	47.66 kg	33.81**

***Incidences of musculo-skeletal problems faced by farm women while performing the activity using existing method and improved method :***

Incidences of muscular skeletal problems were significantly reduced in improved method as compared to existing at wrist, shoulder joint, upper arm and lower lumbar. But there was increase in body pains at thigh muscles, upper lumber and ankle/feet pedaling and cutting.

**CONCLUSION**

When jowar harvesting was performed by using ear cutter, the output of operation was four times more (per labourer) than traditional practice. Frequency of postural change and angle of deviation at cervical region was highly reduced.

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