



Ergonomic Study on Drudgery Reduction Using Three Tyne Wheel Hoe For Weeding in Tomato

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ABSTRACT

Agriculture has been established as one of the drudgery prone occupation of unorganized sector due to lack of access to improved agricultural technologies. Weeding is a main drudgery prone activity mostly performed by farm women and to resolve this problem Krishi Vigyan Kendra, Kalikiri conducted front line demonstrations on use of three tyne wheel hoe to prove the efficacy of improved weeder in reducing drudgery among women engaged in weeding activity in tomato. Twenty farm women were selected randomly for the study. The main focus was to change the attitude, skill and knowledge towards recommended practices in the work. The women traditionally carried out weeding operation by using tools like hand hoe in squatting and bending position which decrease the work efficiency as time progresses. In the recommended weeding practice i.e. with three tyne wheel hoe, the same amount of work could be done in almost half of the time and work efficiency was increased by 93.8 per cent than normal weeding. Farm women adopted the improved technique as it increased the efficiency to work, reduced the drudgery and helped in avoiding bending or squatting posture. It lessened the exertion and fatigue to make the farm women comfortable.

Key Words: Drudgery, Fatigue, Posture, Weeding, Three tyne wheel hoe.

INTRODUCTION

Tomato is the major crop and is grown throughout the year in nearly 20,000ha in Chittoor district of Andhra Pradesh. The availability of labour is a major problem in tomato cultivation from planting to harvesting and the intercultural operation requires more number of labourers. It includes weeding, soil loosening and earthing up. Traditional hand tools like spade and khurpi are used by farm women for doing weeding operation. In order to perform this operation, farm women sit in squatting position which increases drudgery leading to back pain and fatigue. The percentage share of women as cultivators, agricultural labourers, workers in household industry and other workers stood at 24.92, 18.56, 2.95 and 47.20, respectively (Prakash *et al*, 2014).

Further, timely weeding can be achieved by using mechanical weeders which perform simultaneous job of weeding and hoeing, thus reduce the time spent on weeding, cost of weeding and drudgery

involved in manual weeding (Goel *et al*, 2008). Behera and Swain (2005) reported that manually operated weeders have found acceptability due to their low cost.

Ergonomics is the scientific study of the relationship between man and his working environment that includes ambient conditions, tools, materials, methods of work and organization of the work. The performance of man – implement system may be poor, if ergonomic aspects are not given due attention. It may also cause clinical or anatomical disorders and will affect worker's health. Proper attention to ergonomics aspects in design and operation will help in increasing the man implement system efficiency and also in safeguarding the workers' health (Gite, 1997).

The main aim of this study was to reduce drudgery, increasing the working efficiency of farm women and also reduce the cost of weeding operation to farmers by introducing three tyne wheel hoe.

MATERIALS AND METHODS

Three Tyne Wheel Hoe

Three tyne wheel hoe is manually operated equipment for weeding. It consists of wheel frame and the wheel hoes were widely accepted as weeding tool for weeding and inter culture in row crops. It is a long handled tool operated by push and pull action.

Wheel hoe specifications:

Overall length (mm) : 1400- 1500

Overall width (mm) : 450- 500

Overall height (mm) : 800- 1000

Number of tynes : 3 Nos

Wheel diameter (mm) : 200- 600

Working depth (mm) : Up to 60

Weight (kg) : 8-12



Fig A: Three tyne wheel hoe

Hand Hoe

Hand hoe Specifications

Blade : Mild steel angle and flat

Handle: Wood

Dimensions of blade-Length : 12cm, Width : 8cm, Thickness-1.5cm

Handle diameter: 2-3cm

Handle length: 45-60cm

Angle between blade and handle: 40-50° C

Weight: 0.3-0.4kg



Fig B: Hand hoe

The study was carried out in 3 villages of Kalikiri and Piler mandals of Chittoor district. Twenty farm women who had good experience at the control and operating traditional hand hoe were selected randomly. They were healthy and had no physical ailment. The grading of health status of women was one on the basis of basal metabolic index (BMI). The BMI scores were interpreted as per the classification given by Garrow (1987). Following parameters were calculated to know the efficiency of the implement when compared to farmers' practice i.e. hand hoe.

Weeding Index percent

Weeding efficiency of weeder was the number of weeds that can be removed by a specific weeder in a given time. The weeder was tested on the same field to determine weeding index. It is calculated by using the following formula:

$$e = \frac{(W1 - W2)}{W1} \times 100 \text{ where,}$$

e = Weeding index, per cent

W1 = Number of weeds/m² before weeding

W2 = Number of weeds/m² after weeding

Drudgery Index

Drudgery was operationalized as physical and mental strain, fatigue, monotony and hardship

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experience by farm women while doing weeding operations (Kumar *et al*, 2011).

Drudgery Index (DI) was calculated on the basis of

$$\text{Drudgery Index} = [(X+Y+Z)/3] \times 100.$$

X = coefficient pertaining to difficulty score.

Y = Coefficient pertaining to performance score.

Z = Coefficient pertaining to average time spent

DI score between 70 and above = Maximum drudgery

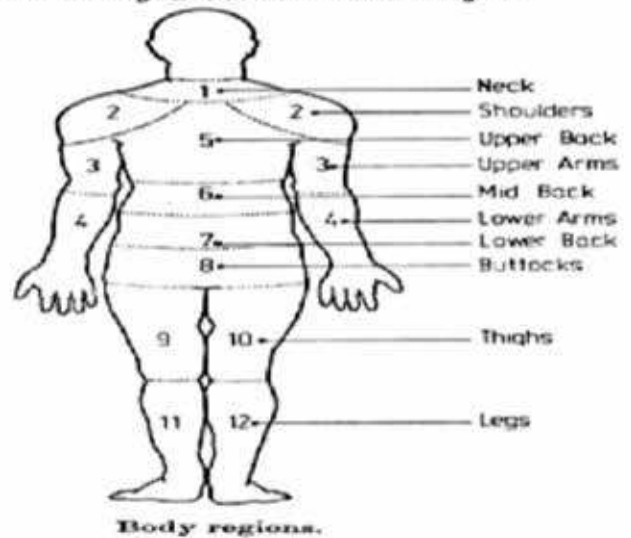
DI score between 50 and 70 = Moderate drudgery

DI score between 50 and below = Minimum drudgery

Musculo-skeletal problems

Incidence of musculo-skeletal problems was identified using the body map (Fig. C) indicating pain in different parts of the body before and just after the completion of the activity.

A Technique for Assessing Postural Discomfort



Severity scale

5. Very severe 4. Severe 3. Moderate 2. Mild 1. Very mild

Fig. C: Body map technique for assessing body part discomfort

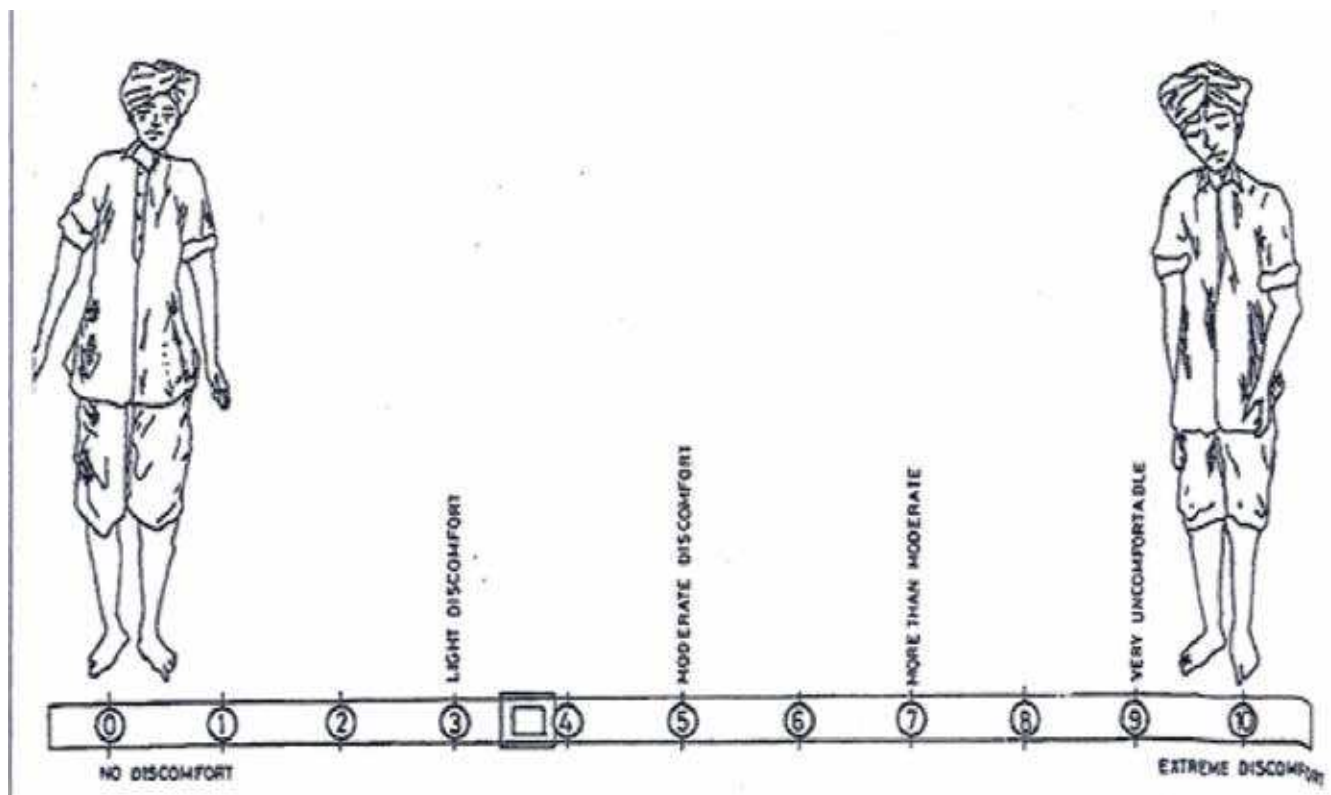


Fig D: Visual analogue discomfort scale for assessment of overall body discomfort

Five-point scale was used to record the intensity of pain in the various body parts viz., 5, 4, 3, 2 and 1 for the intensity of pain as very severe, severe, moderate, mild and very mild, respectively.

Overall discomfort rating (ODR)

Overall discomfort rating (ODR) consists of a 70cm long graduated scale with its left marked as 0 and its right ends 10 which are representing 'no discomfort' and 'extreme discomfort', respectively. A sliding pointer was provided on the scale to mark the level of discomfort. At the end of each trial, subjects were asked to mark their overall discomfort rating on the scale. The overall discomfort ratings given by each of the twenty subjects were averaged to get the mean rating.

RESULTS AND DISCUSSION

Basic anthropometric data of the subjects have been presented in Table 1. The mean age of the selected farm women was 33 yr with the average height of 155.8 cm and gross body weight was in the range of 45-69kg. The mean body mass index was calculated to be 23.90 which meant that they were in the normal category.

Table1. Physical characteristics of the respondents (N=20)

Sr. No.	Physical characteristic	Range	Mean
1.	Age in years	24-45	33
2.	Height(cm)	145-166	155.8
3.	Gross weight(kg)	45-69	57.85
4.	Body Mass Index	19.2-28.2	23.90

Table 2. Distribution of respondents as per BMI scores. (N=20)

Sr. No.	BMI score	Interpretation	Per cent
1.	< 16.0 -	*CED grade III (severe)	-
2.	16.0-17.0	*CED grade II (moderate)	-
3.	17.0-18.5	*CED grade I (mild)	-
4.	18.5-20	Low weight normal	5.0
5.	20.0-25.0	Normal	80.0
6.	25.5-30.0	Obese grade I	15.0
7.	> 30.5	Obese grade II	-

*CED = chronic energy deficiency

Workload

The classification of workload during the activity period was done on the basis of average energy expenditure. The activity was classified as heavy while using three tyne wheel hoe as compared to moderate while using traditional hand hoe but the women were comfortable while working and they worked at a faster rate so three tyne wheel hoe happened a better implement. As evident from the data in Table 2, majority of the respondents (80%) were in normal category with regard to BMI Scores, 15 per cent of women had BMI Scores in obese grade I range and 5 per cent women were in the range of low weight normal category.

Output

The result (Table 3) depicts the work output of the weeding activity with the traditional and improved technology. Three tyne wheel hoe have significantly higher work output than the hand hoe. The output capacity was higher using three tyne wheel hoe (119.2 m²/hr) as compared to with hand hoe (61.5 m²/hr) i.e. the percentage increase in output was 93.8 per cent for three tyne wheel hoe. It means that work output was near about twice, as compared to traditional implement so working by three tyne wheel hoe is recommended. By seeing the benefits of three tyne wheel hoe, more number of farmers in demonstrated villages were shown interest to adopt this technology and they themselves manufactured three tyne wheel hoe in nearby welding shops and using them weeding in vegetable and flower crops.

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Table 3. Change in output by use of three tyne wheel hoe and traditional hand hoe

Sr. No.	Parameter	Hand hoe m ² /hr	Three tyne wheel hoe m ² /hr	Per cent change improved over existing
1.	Output,	61.5	119.2	93.8
2.	Weeding efficiency%	92.6	80.3	13.3

Table 4. Mean value of ODR, MSP, RPE, DI Score by respondents.

Weeding method	ODR*	MSP*	RPE*	DI Score*
Hand hoe	8.2	Severe pain in mid back, hands, shoulders, knees.	Heavy	75
Three tyne wheel hoe	4.4	Moderate to light pain in shoulder, hands and arms.	Moderate	57.3

*ODR=Mean value of overall discomfort rating; *MSP=Musculo-skeletal problem; *RPE=Rating of perceived exertion; *DI= Drudgery Index score;

Overall discomfort rating (ODR)

The weeding in tomato is an activity where musculo-skeletal problems are very pronounced. The reason is weeding activity is time taking and performed continuously for prolonged hours. The traditional method employs continuous sitting posture while weeding with traditional hand hoe. The overall discomfort rate of hand hoe and three tyne wheel hoe was 8.2 and 4.4 (Table 4) i.e. more than moderate and light discomfort respectively.

Musculo-skeletal problems

The musculo-skeletal problems and posture were evaluated by asking the respondents as to where they felt pain in their body after weeding with traditional and improved technology. The data (Table 4) depict that weeding with traditional tools in strenuous posture cause severe pain in shoulders, mid back, hands and knees. The women perceived the task as heavy. On the contrary, using improved weeding tool induced moderate to light discomfort/pain in shoulders, hands and arms. They were relieved from back pain and improved tool employed standing posture and eliminated continuous sitting posture as well as some movement is also employed while working on a three tyne wheel hoe. The rating of perceived exertion was also reported as moderate with use of three tyne wheel hoe.

Drudgery Index

The drudgery index of weeding with hand hoe and three tyne wheel hoe was determined by calculating the time co-efficient, frequency of performance coefficient and difficulty coefficient. By using this three tyne wheel hoe, moderate drudgery (drudgery index score 57.3) was recorded whereas in traditional practice (hand hoe) maximum drudgery (drudgery index score 75) was recorded.

This study indicated that in order to ensure health, safety and well being thereby improving the quality of work life and achieving higher productivity, it is essential that working implement must be designed ergonomically and should be women friendly. The weeding efficiency of the three tyne wheel hoe was found satisfactory. It was women-friendly tool because it increased the work efficiency, reduced drudgery and provided comfortable working posture. It reduced the exertion and fatigue and women felt comfortable. By introducing such small tools, the work and work environment can be improved, physiological workload can be reduced in the weeding and the efficiency and work output can be improved significantly. Hence, promoting such tools among the farm women engaged in the agricultural operation should be done at the priority.

CONCLUSION

Three tyne wheel hoe was found useful in terms of saving time, human effort, increasing work capacity and productivity. It was found to be compatible, easy to handle and applicable in field situation as well as most efficient for weeding vegetable fields. It was observed that use of weeder, improved posture and efficiency of worker. The body discomfort reduced with use of weeder because it involved standing posture eliminating muscular fatigue and excessive loading of inter-vertebral discs of backbone. This proved that weeders were ergonomically sound, women friendly, drudgery reducing and improved worker's efficiency.

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