



## Research Article

# PERFORMANCE OF THREE-PRONGED WHEEL HOE ON THE DRUDGERY REDUCTION OF FARM WOMEN AGAINST TRADITIONAL PRACTICES

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**Abstract:** Agriculture is a primarily unorganized sector in which women are the backbone of agricultural work force because they perform more than 79% of farm activities like winnowing, weeding, grading, threshing and cleaning. Weeding is one of the drudgery prone operations in agriculture and horticultural crops. In order to reduce the drudgery among farm women, KVK, Reddipalli, Anantapuramu has introduced three-pronged wheel hoe as drudgery reducing tool and demonstrated for three years from 2016-17 to 2018-19 in adopted villages covering 60 farm women in crops like Tomato, chilli, bhendi & cluster bean. Study indicated that due to introduction of this improved three pronged wheel hoe labour employed for an acre reduced from 7 to 3, labour wages per acre reduced from Rs.1316, time taken for weeding per acre was reduced from 6.7 hr to 5.3 hours, overall discomfort rate was reduced from 8.2 to 4.4 and Musculo-skeletal problem (MSP) was also reduced from high to low in demonstration compared to control. Further the drudgery index was also moderate in demonstration compared to high in control.

**Keywords:** Drudgery, Three pronged wheel hoe, Weeding efficiency, Drudgery index, ODR

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## Introduction

Weed control is a major problem for farm women. Majority of the farm women do control weed using hand tools like sickle, khurpi and so on. Though, this method proves useful yet it demands labour and is full of drudgery. During these activities they adopt bending and squatting body posture due to which their physiological workload increases and also, they face many types of musculo-skeletal problems as a result of which the efficiency of women to work decreases to a great extent. 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 [1]. Behera and Swain (2005) reported that manually operated weeders have found acceptability due to their low cost [2]. Ergonomics is the scientific study of the relationship between man and his working environment that includes ambient conditions, tools and 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 might be 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 [3]. Therefore, to assess the performance of Three-Pronged Wheel Hoe on Drudgery Reduction of Farm Women has been planned with keeping in view of following objectives.

To examine the efficiency of improved technologies over traditional methods.

To test the ergonomic parameters over various improved agriculture technologies to reduce fatigue of workers.

To examine exertion by farm women in both methods by overall discomfort rating (ODR).

## Materials and Methods

### Three Pronged Wheel Hoe

Three pronged 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 long handled tools 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 prongs: 3 Nos

Wheel diameter (mm): 200- 600

Working depth (mm): Up to 60

Weight (kg): 8-12



Fig-1 Three pronged wheel hoe



Fig-2 Hand hoe

## Hand Hoe

### Hand hoe Specifications

Blade: Mild steel angle and lat

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

The health of farm women is one of the important resources for agricultural development. Therefore, drudgery reduction measures need to be initiated to avoid occurrence of health hazards among farmwomen. If appropriate drudgery reduction technologies are made available to the farm women at home and farm, it would definitely be contributed in reducing their drudgery, increasing their work capability, increasing farm production resulting in improved quality of life [4].

Wheel hoe is manually operated equipment for weeding and intercultural operations. It consists of wheels, frame, v-blade, v clamp and a handle. The cutting and uprooting of weeds in field is done through push and pull action. It is light weight, simple to operate which improves the work posture and also reduces the drudgery of the women workers. This is operated at optimum soil moisture condition and preferably after 20-25 day of sowing when the weeds are small (1 to 3 cm.) in height for better weeding performance [5].

The study was carried out for three years from 2016-17 to 2018-19 at KVK adopted villages and other villages of Anantapuram district under frontline demonstrations. Farmwomen aged between 25-45 years, without having physical deformity and having good experience at the control and operating traditional hand hoe were selected randomly. Anthropometric measurements were collected, the health status of women was calculated based on their Body Mass Index (BMI), by using the classification of BMI given by Garrow (1987) [6,7]. Efficiency of the implement in comparison to hand hoe or farmers practice is calculated as per the following parameters.

## Weeding Index Percent

Weeding efficiency of weeder is the number of weeds that can be removed by a specific weeder in a given time. It is calculated by using the following formula.

$$E = \{(w_1 - w_2) / w_1\} \times 100$$

Where, e= weeding index

w<sub>1</sub> = Number of weeds/m<sup>2</sup> before weeding

w<sub>2</sub> = Number of weeds/m<sup>2</sup> after weeding

## Drudgery Index

Drudgery was operationalized as physical and mental strain, fatigue, monotony and hardship experience by farm women while doing weeding operations [8].

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

## Overall Discomfort Rate

Overall Discomfort Rate had been calculated by using a 10 points psychophysical rating scale (0= no discomfort, 10= extreme discomfort) which is an adoption of Corlett and Bishop (1976) technique. 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 overall discomfort rating on the scale. The ratings were averaged to get the mean rating.

## Musculo skeletal Problems

Working in squatting posture for longer period might be the reason that almost all the women reported, as a result, the working efficiency of the workers is greatly reduced. Musculo-skeletal problems and posture problems were evaluated by asking the respondents as to where they felt the pain in their body while weeding or after weeding operation.

## Severity scale

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.

## Results and Discussions

Basic anthropometric data of the subjects have been presented in [Table-1]. The mean age of the selected farm women was 33.5 years with the average height of 153.6 cm and body weight was in the range of 43-65 kg. The mean body mass index was calculated to be 24.3 which meant that they were in the normal category.

Table-1 Physical Characteristics of the respondents (N=60)

Physical Characteristics	Range	Mean
Age in years	25-45	33.5
Height (cm)	143-186	153.6
Weight in kgs.	43-65	56.8
Body Mass Index	19.5-27.2	24.3

## Workload

The classification of workload during the activity period was done on the basis of average energy expenditure. The activity was classified as moderate while using three pronged wheel hoe as compared to heavy while using traditional hand hoe but the women were comfortable while working and they worked at a faster rate with three pronged wheel hoe. As evident from the data in [Table-1], majority of the respondents (80%) were in normal category with regard to BMI Scores.

Table-2 Output efficiency of Improved method Wheel hoe and hand hoe

Parameter	Improved method Wheel hoe m <sup>2</sup> /hr	Hand hoe m <sup>2</sup> /hr
Output	129.8	75.6
Weeding efficiency%	70.50%	92.60%

## Output

The result [Table-2] depicts the work output of the weeding activity with the traditional and improved technology. Three pronged wheel hoe had significantly higher work output than the hand hoe. The output capacity was higher using three pronged wheel hoe (129.8 m<sup>2</sup>/hr) as compared to with hand hoe (75.6 m<sup>2</sup>/hr). It means that work output was near about twice, as compared to traditional implement. By seeing the benefits of three pronged wheel hoe, more number (76) of farm women in demonstrated villages were shown interest to adopt this technology and they themselves purchased three pronged wheel hoe using them weeding in vegetable and flower crops.

## Overall discomfort rating (ODR)

Weeding in vegetables 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 pronged wheel hoe was 8.2 and 4.4 [Table-3] 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 causes 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.

Table-3 Mean value of overall discomfort rating (ODR), Responses on musculo-skeletal problems and perceived exertion by respondents

Weeding method	ODR	MSP	RPE	DI Score
Improved method	4.4	Moderate to light pain in shoulder, hands and arms	Moderate	57.3
Traditional Method	8.2	Severe pain in shoulders, upper back, hands fingers, wrist and knees	Heavy	75

ODR=Mean value of overall discomfort rating, MSP= Musculo-skeletal problem, RPE= Rating of perceived exertion

Table-4 Comparative parameters of observation between three pronged wheel hoe and hand hoe

SN	Parameters	Wheel hoe			Hand hoe		
		2016-17	2017-18	2018-19	2016-17	2017-18	2018-19
1	Work done area (h)	0.4	0.4	0.4	0.4	0.4	0.4
2	Labour employed (no.)	5	5	4	13	13	7
3	Labour wages (Rs/-)	750	1250	1000	1950	3250	1750
4	Time taken for weeding (hr)	6	6	4	7	7.3	6
5	Total no. Weeds before operation/sq.mt	61	62	61	68	64	62
6	Total no. Weeds after operation/sq.mt	18	15	18	5	7	10
7	Weeding efficiency (%)	70.5	75.8	73.6	92.6	89	93.3
8	Overall discomfort rate (ODR)	4.4	4.4	4.4	8.2	8.2	8.2
9	Musculo-skeletal problem (MSP)	Moderate to light pain in shoulder & hands were observed.			Severe pain in upper back and light pain in shoulders were observed.		

Table-5 Significant difference between various parameters in trial over control for three years (2016 to 2019), (N-30)

SN	Components	Mean value		Mean difference	't' - cal value
		Trial	Control		
1	Labour employed (no./acre)	3	7	-4	-12.8**
2	Labour wages (Rs/-)	1000	2316	-1316	-2.67**
3	Time taken for weeding (hr./acre)	5.3	6.7	-1.4	-1.65*
4	Overall discomfort rate (ODR)	4.4	8.2	-3.8	-2.63**
5	Musculo-skeletal problem (MSP)	1.2	2.6	-1.4	-1.94*

\*\*significant at 0.01 level of probability, \*significant at 0.05 level of probability, \*\*0.01 't' - critical value-2.04, \*0.05 't' - critical value-1.69

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 pronged wheel hoe. The rating of perceived exertion was also reported as moderate with use of three pronged wheel hoe.

In order to test the effectiveness of three pronged wheel hoe statistically 't' test was applied to find out, whether there is any significant difference existed between the trial and control in terms of labour employed, labour wages, time taken for weeding, weed population and weeding efficiency and presented in [Table-6]

From the above table, it is very clear that parameters like labour employed, labour wages, overall discomfort rate were found to be negatively significantly correlated at 0.01 level of probability and parameters like time taken for weeding and Musculo-skeletal problem (MSP) were found to be negatively significantly correlated at 0.05 level of probability. This clearly shows that negatively significant correlation of above parameters with trial is positive for the farmers as he needs the reduction in number of labours, wages of labour, ODR, MSP and time taken for weeding operation.

### Drudgery Index

The drudgery index of weeding with hand hoe and three pronged wheel hoe was determined by calculating the time co-efficient, frequency of performance coefficient and difficulty coefficient. By using this three pronged 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. The study indicated that in order to ensure health, safety and wellbeing 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 pronged 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.

It may further reveal that moderate drudgery index score of 54.5 to 56.33 percent was recorded compare to traditional practice 76.78 to 83.33 percent recorded as maximum over three years period. In the recommended weeding practice i.e. with three pronged wheel hoe, the same amount of work could be done in almost half

of the time and work efficiency was increased by 93.3 percent than normal weeding. Improved technologies for weeding activity for farm women are recommended so they can increase their efficiency, reduce the drudgery with time saving while performing weeding activity.

Drudgery index (DI) score between 70 & above = Maximum drudgery

Drudgery index (DI) score between 50 & 70 = Moderate drudgery

Drudgery index (DI) score between 50 & below = Minimum drudgery

Comparative Performance of improved wheel hoe with hand hoe on various parameters

Years	Treatments	N	Mean	Std.Dev
2016-17	Improved Tech	10	54.51	3.08
	Farmers practice	10	76.78	2.13
2017-18	Improved Tech	10	57.92	6.03
	Farmers practice	10	81.12	6.12
2018-19	Improved Tech	10	56.33	3.26
	Farmers practice	10	83.33	8

From the above table it was very clear that, the weeding area covered with both wheel hoe and hand hoe was similar size (0.4ha). The labour employed with wheel hoe/acre was five compared to 13 numbers in hand hoe method. The labour expenditure/acre was also high (Rs.1950/-) in hand hoe method compared to wheel hoe (Rs. 750/-). Time taken to do weeding/acre were also less (5 hours) in three pronged wheel hoe compared to hand hoe (7 hours). However weeding efficiency was found to be good (92.6%) in hand hoe method and but overall technical feasibility and economic viability wise three pronged wheel hoe was found to be good compared to traditional hand hoe method.

### Conclusion

It was found to be compatible, easy to handle and applicable in yield situation as well as most efficient for weeding vegetable fields. It was observed that use of three pronged wheel hoe improved posture and efficiency of worker. The body discomfort was reduced with use of this weeder because it involved standing posture eliminating muscular fatigue and excessive loading of inter-vertebral discs of backbone. This could be concluded that three pronged wheel hoe was ergonomically sound, women friendly with reduced drudgery reducing resulted in improved workers efficiency.

**Application of research:** Three pronged wheel hoe was found useful in terms of saving time, human effort, increasing work capacity and productivity.

**Research Category:** Agriculture Engineering

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**Cultivar / Variety / Breed name:** Nil

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