

Original Research Article

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## Ergonomic Study on Drudgery Reduction Using Easy Planter for Transplanting Tomato Seedlings

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### ABSTRACT

Vegetable transplanting is a laborious, time consuming and drudgery prone field operation task when performed manually by farm women for almost all crops grown. This directs for interventions in terms of improved technologies to relieve women from high energy demands, time spent and associated drudgery particularly for transplanting activity. To resolve this problem Krishi Vigyan Kendra, Kalikiri, conducted on farm trial on use of easy transplanter to prove the efficacy of improved technology in reducing drudgery among women engaged in transplanting activity in tomato seedlings. The study was conducted in two years 2017-18 and 2018-19, twenty five farm women were selected in the age group of 25-35 years 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 transplanting operation by using fingers in squatting and bending position which decrease the work efficiency as time progresses. Results showed that the postural stress and severity of pain in various body parts was reduced by adopting new technology. Significant influence was observed in improved practice ( $<0.001$ ) on drudgery index of easy planter over farmers practice. Hence, the use of easy transplanter improved tool is recommended over the existing ones for drudgery reduction.

#### Keywords

Easy transplanter,  
Anthropometry,  
Drudgery,  
Ergonomics,  
Posture and fatigue

#### Article Info

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### Introduction

In India, the rural women play a significant role in agriculture and other agro based activities. On an average, women work for about 8-9 hours/day in agricultural operations like transplanting, weeding, harvesting, threshing and storage etc. with the use of traditional types of equipment and an average of 4 hours in household activities. During this activity their body gets tired and their

efficiency reduces. Verma *et al.*, (2013) and Gite and Singh (1997) found that during the farm activities women adopt an unnatural body posture due to which their physiological workload increases and also they face many types of muscular-skeletal problems, as a result, the efficiency of women to work decreases to a greater extent. Traditional method of transplantation takes longer. Women generally adopt squatting and bending posture while doing the activity and maintain

it for long hours, which cause musculo-skeletal problems. Since the majority of Indian farmers having small land holdings, they are unable to procure high cost machinery for vegetable cultivation (Kumar *et al.*, 2008). The cheaper technologies which can be beneficial over the traditional cultivation practices are the current need of vegetable farming (Bergamo *et al.*, 2016).

Tomato and chillies is the major crop and is grown throughout the year in nearly 20,000 ha in Chittoor district of Andhra Pradesh. The transplanting operation is one of the most labor intensive in vegetable production system. It is largely done manually in India and most developing countries and incurs large investments in labor, time, and cost. Most of the farm women are doing transplanting of vegetable seedlings (grown in protrays) with traditional method like by hands. The women work in either standing-cum- bending or squatting posture for transplantation and it is a repetitive activity performed for long duration. Working in this posture can cause work related musculoskeletal disorders. Musculoskeletal disorders are one of the leading causes of occupational health hazard and disability in the developed and industrially developed countries (Genaidy *et al.*, 1993).

The development or modification of small drudgery reducing tools are need of the hour for Indian farm women to overcome the problem to easily manage basic farm operations like transplanting seedling with change in posture and obviously labour and time saving. This study highlights the research gaps and developments in smart transplanting technologies used in the field of vegetable cultivation so that to reduce drudgery, increasing the working efficiency of farm women and also reduce the cost of transplanting operation to farmers by introducing easy planter

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 and Singh, 1997). The main aim of this study was to reduce drudgery, increasing the working efficiency of farm women and also reduce the cost of planting operation to farmers by introducing easy transplanter in comparison to the traditional method.

## **Materials and Methods**

### **Locale of the study**

The study was conducted in the adopted villages, Addevaripalli, Mittapalli and Balamvaripalli of Krishi Vigyan Kendra of Acharya N.G Ranga Agricultural University Kalikiri, Chittoor district of Andhra Pradesh.

### **Selection of sample**

For the ergonomic evaluation, twenty five farm women subjects were selected randomly in the age group of 25-35 years with good health status and normal physiological parameters. The physiological characteristics and basic anthropometric data of selected subjects are given in Table 1 the BMI scores were interpreted as per the classification given by Garrow (1987).

### **Over all discomfort (ODR)**

ODR was measured on a 10-point visual analogue scale (0- no discomfort, 10-extreme

discomfort) that is an adoption of a technique developed by Corlett and Bishop (1976). A scale of 70 cm length was fabricated having 0 to 10 digit marked on it equidistantly representing 'no discomfort' and 'extreme discomfort' (Fig. 1). A movable pointer was provided to indicate the rating. At the end of each trial, the subjects were asked to indicate their overall discomfort rating on the scale.

### **Musculo-skeletal problems**

To assess the musculoskeletal discomforts and intensity of pain in different parts of the body before and just after the performing of the activity, body map was used (Corlette and Bishop, 1976). The intensity of pain reported in each body part was determined on a five point scale ranging from very severe pain to very mild pain (*viz.*, 5, 4, 3, 2 and 1 for the intensity of pain as very severe, severe, moderate, mild and very mild, respectively). Percentage of respondents having pain in different body parts was recorded (Fig. 2).

### **Drudgery index**

Drudgery was operationalized as physical and mental strain, fatigue, monotony and hardship experience by farm women while doing transplanting operations. Drudgery index (DI) was calculated on the basis of drudgery index as given by Kumar *et al.*, 2011.

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

X = Co-efficient pertaining to difficulty score.

Y = Co-efficient pertaining to performance score.

Z = Co-efficient 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

### **Statistical analysis**

Mean and standard deviation and analysis of variance (ANOVA) was used

### **Results and Discussion**

#### **Personal details of the respondents**

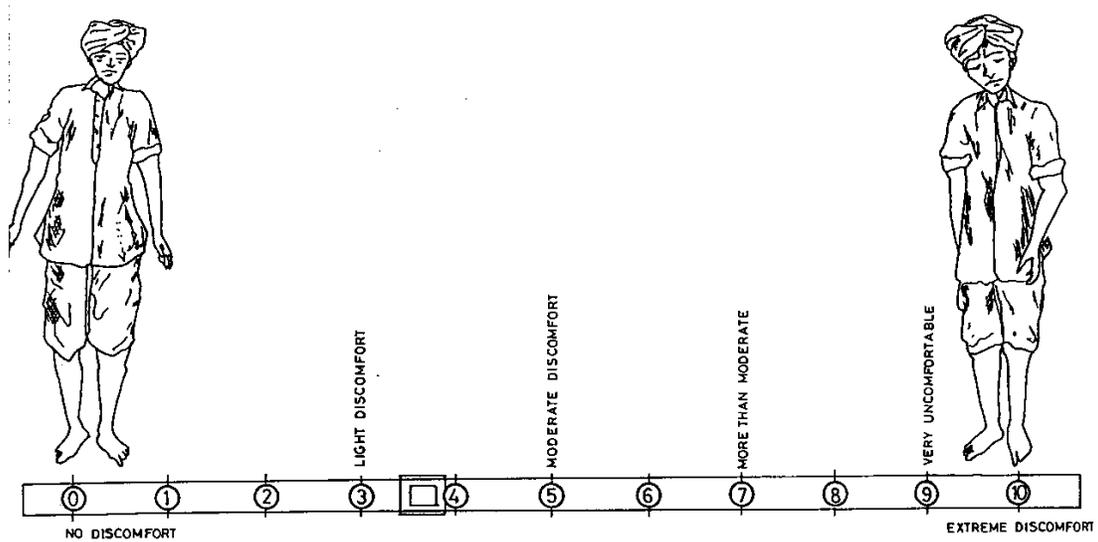
The average age of the respondents was found to be 35 years. Regarding their education level more than 80 per cent of the respondents were below metric level, 98 per cent were married and 70 per cent of the respondents were living in their own house.

Table 1 shows the comparison between both the planting methods. The area selected and the number of saplings to be transplanted was kept constant. The results revealed that the time spent in transplanting with the hand operated easy transplanter was less as compared to the traditional method.

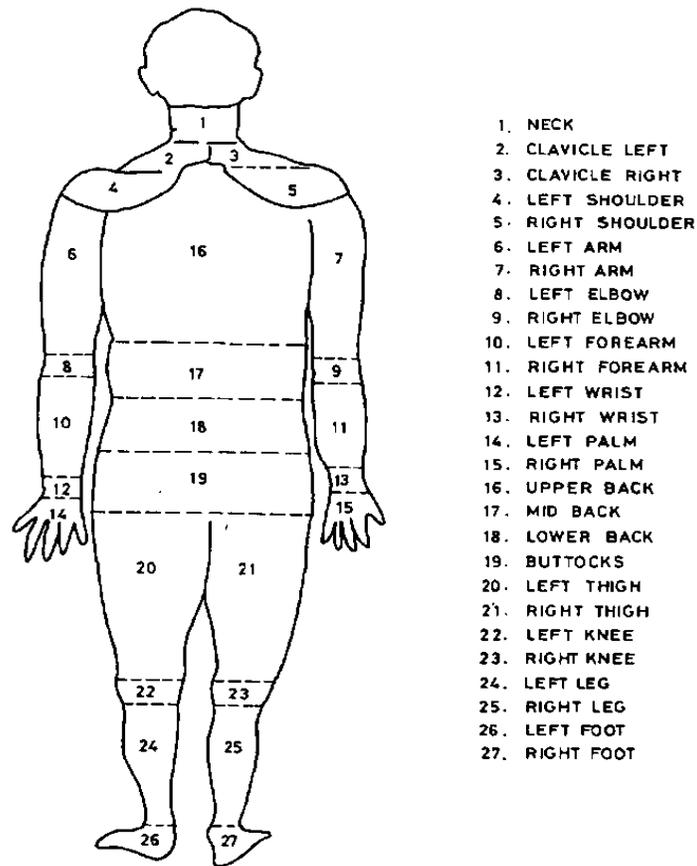
Thus, it can be said that with the use of easy transplanter, productivity is more in less time (Fig. 3). Mahajan *et al.*, (2014) also found out that when the harvesting of brinjal was done by improved method, the pace of work increased by 19.96 per cent thus increasing the work output.

Anthropometric data of the subjects are presented in Table 2. The mean age of the selected farm women was 30 yr with the average height of 157.4 cm and gross body weight was in the range of 42-62 kg. The mean body mass index was calculated to be 21.72 which meant that they were in the normal category.

**Fig.1** visual analogue discomfort scale for assessment of overall body discomfort



**Fig.2** Body map technique for assessing body part discomfort



**Fig.3** Easy transplanter



**Table.1** Comparison between transplanting with traditional method and hand operated easy transplanter

S. No	Parameter	Traditional method	Improved technology (easy transplanter)
1	Area covered	100m <sup>2</sup>	100m <sup>2</sup>
2	No.of seedlings transplanted	500	500
3	Time of operation	2.0 hr	1.15 hr
4	Posture adopted	Standing cum bending, squatting	Standing

**Table.2** Physical characteristics of the respondents (n= 25)

S. No	Physical character	Tools /techniques	Formulae	Range	Mean
1	Age (yrs)	-	-	25- 36	30
2	Height (cm)	Height measuring rod	-	150.1 – 170.2	157.41
3	Weight (kgs)	Weighing balance	-	42 - 62	53.85
4	BMI	-	Weight(kgs)/Height <sup>2</sup> (cm)	18.45 – 26.63	21.72

**Table.2a** Distribution of respondents as per BMI scores (N=25)

S. 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	20(5)
5	20.0 – 25.0	Normal	72(18)
6	25.5 – 30.0	Obese grade I	8 (2)
7	>30.5	Obese grade II	-

\*CED = Chronic energy deficiency; Figurers in parenthesis indicate no. of subjects

**Table.3** Discomfort in different body parts of the subjects during transplantation

S. No	Body parts	Frequency and percentage of subjects (n=25)	
		Farmers practice	Improved technology
1	Neck	17 (68)	5 (20)
2	Right shoulder	9 (36)	4 (16)
3	Right wrist	13 (52)	6 (24)
4	Lower back	19 (76)	2 (8)
5	Buttocks	6 (24)	1 (4)
6	Upper arm	7 (28)	3 (12)
7	Thighs	11 (44)	2 (8)
8	Hips	11 (44)	1 (4)
9	Feet	12 (48)	2 (8)

Figurers in parenthesis indicate per cent

**Table.4** Overall Discomfort Rate (ODR), Responses on musculo-skeletal problems and perceived exertion experienced by respondents (RPE)

Transplanting method	ODR	MSP	RPE
Farmers practice	8.0	Severe pain in shoulders, upper and lower back, hands neck and arms and fingers	Heavy
Improved technology (Easy transplanter)	4.0	Moderate to light pain in shoulder, upper and lower legs, and hands	Moderate

**Table.5** Summary of ANOVA for pooled analysis on drudgery score

Years	Treatments	Standard deviation	
		Mean	Standard deviation
2017-18	Farmers practice	77.35	5.98
	Improved technology	52.87	3.80
2018-19	Farmers practice	78.16	5.61
	Improved technology	51.48	3.73
Overall	Farmers practice	77.76	5.79
	Improved technology	52.17	3.77

Source	F-value	p - value
Years	0.163	0.688
Years * treatments	2.325	0.134
Treatments	467.5**	0.000

\*\* Significant at 1% level

### 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 easy transplanter as compared to moderate while using traditional method but the women were comfortable while working and they worked at a faster rate so easily. Hence transplanter has been a better implement. As evident from the data in table 2a, majority of the respondents (72%) were in normal category with regard to BMI Scores, 8 per cent of women had BMI scores in obese grade I range and 20 per cent women were in the range of low weight normal category.

The discomfort in different body parts of the subjects during transplantation are given in table 3. The discomfort and pain in lower back was felt by highest respondents (76%) due to squatting posture in traditional transplanting followed by neck (68%), right wrist (52%), feet (48%), thighs and hips (44%), right shoulder (36%), upper arm (28%) buttocks (24%), of respondents, respectively.

Awkward posture, lifting, forceful movement and manual work at rapid rate contribute to musculoskeletal disorder (Singh, 2010). It was found that pain and discomfort was comparatively low while using hand operated easy transplanter. Only 8 per cent respondents felt pain in lower back, thighs, feet, upper arm (12%) and shoulder (16%). This revealed that the women suffered from pain and discomfort more in lower back, Upper back and feet due to manual transplanting method, however, the

pain was reduced when the activity was performed with easy transplanter in standing position.

Transplanting is an activity where musculo-skeletal problems are very pronounced because the activity is time taking and performed continuously for prolonged hours. The traditional method employs continuous sitting posture which results in heavy work load and energy expenditure whereas developed prototype was used in standing posture and thus resulted in less musculo-skeletal problem, energy expenditure and work load (Table 4). Mattila and Vilkki (1999) also concluded that more suitable work postures may have a positive effect on workers' musculoskeletal systems and may allow for more effective control of work performance.

Repeated measures mixed ANOVA is carried out for pooled analysis of two years data with two treatments (Table 5). From the table it is identified that years have not shown any impact on drudgery index (DI). Similarly interaction effect of years and treatments was not found significant which indicates during two years both treatments performed in the same way. Further, treatments differed significant. Drudgery Index in which improved technology (easy transplanter) performed well with moderate drudgery (52.17) than farmer's practice (77.76). Hence improved technology *i.e.* easy transplanter is recommended for drudgery reducing implement.

This study indicated that the farm women perform multiple tasks in a traditional way

due to lack of updated knowledge and skill. 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. There is a need to design easily available and cost effective tools for maximum output. So, through results, it can be concluded that among the two methods, the transplanting of tomato seedlings grown in portrays done with the hand operated transplanter was found to be comfortable and light work based on the workload. It improves the work posture and thus reduces the physiological stress of the workers. Hence by the above study it can be concluded that to reduce drudgery and time while using the improved technologies has fetched postural comforts and increased their income which in turn improved farm women's livelihood and health.

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