A field experiment was conducted at ICAR Research Complex for Eastern Region, Patna (25° 35' N latitude and 85° 04' E longitude) during the Kharif 2016 to study the performance of weeders i.e. cono and Mandava weeder in SRI under the irrigated ecosystem. Maximum weeding efficiency was recorded with Mandava weeder as compared to cono-weeder. Mandava weeder consumed minimum man-days/ha. Therefore, Mandava weeder may be promoted at farmer’s fields in wider scale as it reduces energy use of small and marginal farming community of the Indo-Gangetic Plains of the Eastern India.
Specification of cono and Mandava weeder

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Comparative performance of manual weeders under system of rice intensification in Indo-Gangetic plains

Research Complex for Eastern Region, ICAR Parisa, P.O. B.V. College, Patna, Bihar 800

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Key words: SRI, weeder, field capacity, weeding efficiency

Oryza sativa L.) is grown under diverse conditions ranging from irrigated to rainfed upland, and deep water. Traditional crop management, i.e., puddling and transplanting, requires a large amount of water, energy and labour, and becoming scarce and expensive (Mishra, 2012). Weeds are considered to be one of the major biotic constraints in achieving higher productivity as they cause a reduction of 10% rain yield in rice field (Kumar et al., 2016). Intensification of Rice (SRI) is a modern and innovative method of rice cultivation for reduced use of water and labour and to increase the crop productivity. But this system is much infested with because growing under the limited water management. Echinochloa spp., Cynodon dactylon, Cynodon quadrispidifera and Cyperus spp. are the major weeds associated with SRI. Herbicides were proved but the continuous and indiscriminate use of herbicides for a longer period may result in buildup of resistant weeds and development of herbicide resistance. Adoption of rotary or cono-weeder use in field has a significant role in improving the growth, and economics of rice. Weed management with these tools not only uproots the weeds between rows but also ensuring the better soil aeration. Different types of weeders are available for weeding these designs are location specific and designed to meet the requirement of soil type, crop cropping pattern and availability of the local resources (Goel et al., 2008). Hence, performance of manual weeders was evaluated in SRI system in the middle Indo-Gangetic plains.

The experimental site was sub-tropical in nature exhibiting high humidity and medium rainfall. The rice cv. ‘IR 1509 (120 days duration) was used as test material. The monthly mean maximum and minimum temperature during the crop growing period ranged from 29.2 - 35.4°C and 12.2 - 23.2°C, respectively. The rice seedlings were transplanted at 25×25 cm apart. The specification of the experimental weeders is mentioned in Table 1.

Table 1. Specification of cono and Mandava weeder

<table>
<thead>
<tr>
<th>Cono weeder</th>
<th>Mandava weeder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length: 2040 mm</td>
<td>Length: 1500 mm</td>
</tr>
<tr>
<td>Nominal width: 194 mm</td>
<td>Width (handle): 460 mm</td>
</tr>
<tr>
<td>Working width: 125 mm</td>
<td>Nominal width: 150 mm</td>
</tr>
<tr>
<td>Height: 1120 mm</td>
<td>Working width: 120 mm</td>
</tr>
<tr>
<td>Width (handle): 500 mm</td>
<td>Height: 1000 mm</td>
</tr>
<tr>
<td>Type of handle: T-Type</td>
<td>Type of handle: T-Type</td>
</tr>
<tr>
<td>Number of rotors: 02</td>
<td>Number of rotors: 01</td>
</tr>
<tr>
<td>Weight: 6.1 kg</td>
<td>Weight: 5.1 kg</td>
</tr>
<tr>
<td>Unit Cost: ` 1200/- (approx.)</td>
<td>Unit Cost: ` 1000/- (approx.)</td>
</tr>
</tbody>
</table>

Effective field capacity: Effective field capacity in m² per hour is the average output of the weeder per hour and calculated from total area weeded in ha and the total time taken by weeder (Mehta et al. 2005).

Effective field capacity = Area covered by weeder
Total time taken × 10000

Where, Area covered in m² and total time in h.
study the performance of weeder s i.e. cono-
dava weeder under the irrigated ecosystem. 
the experimental plot was clay loam (sand: 
+, silt: 39.64% and clay: 37%). The climate of

Comparative performance of manual weeder s under system of rice intensification in Indo-Gangetic plains

Field capacity = \( \frac{W \times S}{10 \times 10} \) ............(4)
here, \( W \) = theoretical width of cut in m, \( S \) = f travel in km/h, \( E \) = field efficiency (%)

Weeding efficiency (%) = \( \frac{W_i - W_2}{W_i} \times 100 \) .........(5)
here, \( W_i \) = number of weeds before weeding, \( W_2 \) = number of weeds after weeding

Damage: It was calculated by counting the 
number of injured plants and total number of plants in 
plot and expressed in percent (%) (Biswa 
2004).

\( D = \frac{A \times 100}{B} \) .................(6)
here, \( D \) = Plant damage (%), \( A \) = Injured plant 
\( B \) = Total no. of plants in sample plot

The human energy co-efficient 1.96 MJ was 
d as suggested by De et al. (2001)

Force measurement: The force requirement 
was determined in field using spring 
and three persons involved in test (Figure 1).
Balance was fixed between pulling wire and 
son pulled weeder, while another person 
data of spring balance and third person just 
dle of weeder along with line of action.

broad-leaved weeds (BLW) Triane hupalus et 
pula castrum L., Euphorbia hirta L.; sedges 
Cyperus rotundus L. and Cyperus iria L. were 
important weed flora during the experiment. 
Relative dominance of BLWs, grasses and sedges 
recorded as 84, 11 and 5%, respectively.

Field capacity of Mandava weeder was higher 
(0.0168 ha/hr) than cono-weeder (0.0149 ha/hr). 
Lower value of effective field capacity for cono-
weeder was also reported by Shakya et al. (2016). 
The wide difference in the values of field capacity 
both the weeder s may be due to difference in width 
cutting parts (blades) as well as forward speed. 
Mandava weeder facilitates worker by providing 
push and pull action to the implement as compared 
cono-weeder. Field efficiency was higher by 
Mandava weeder (89%) as compared to cono-
weeder (87%). Higher field efficiency of weeder 
because of minimum time loss in turning and due to 
operation (Shakya et al. 2016). Weed density 89/2 
and 96/m² was recorded before weeding with 
cono-weeder and Mandava weeder, respectively 
(Table 2). The maximum weeding efficiency 
found with Mandava weeder (88%) as compared 
cono-weeder (71%) which might be due to greater 
soil contact and soil inversion capacity of the weeder.

The wide difference in the values of weed 
efficiency in both weeder s may be due to difference 
in shape of blades and depth of operation.
The average value of plant damage factor for cono-
Mandava weeder were obtained 7.58 and 6.71 
respectively, which was 30 % lower in developing 
cono-weeder reported by Shakya et al. (2016). 
Involvement of man power was examined 
respect to weeder used in controlling weeds of
1. Pushing force measurement

A major weed associated with crop was grasses, clover weeds and sedges. Among grasses, Echinochloa crus-galli (L.), Chlorella colonia (L.) Less., Echinochloa crus-galli (L.) Gaertn., Leptochloa chinensis (L.) Nees, and Cynodon dactylon (L.) Pers.; under SRI, and it was noted that Mandava weeder consumed the minimum man-days/ha (7.44). **Human energy**: The highest human energy consumed by cono-weeder (131.39 MJ/ha) compared to Mandava weeder (116.65 MJ/ha). Cono-weeder required the highest energy, it was found to be economical in terms of eco-energetic (Table 3). But Mandava weeder was not only more efficient in terms of eco-energetics but also used in completing weeding in lesser time.

**Pushing force measurement**: Result showed pushing forces of 98·74 N and 68·64 N are required for

<table>
<thead>
<tr>
<th>Weed density (no./m²) and weed control efficiency (WCE) as affected by two weeder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grazes (no. m⁻²)</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Eeder</td>
</tr>
<tr>
<td>A weeder</td>
</tr>
</tbody>
</table>


83

mm water depth, respectively in cono-weeder, n mandava-weeder; they were 89.38 N and 68·64 N, respectively (Table 4).

**Economics Evaluation**: Ergonomic study was out with 5 male workers for weeding in SRI. Pneumatic rod and weighing balance were used sure the physical characteristics and stop for recording time. Polar Heart Rate Monitor 0 (Finland) was used for recording heart rate. To evaluate the weeding through nic point of view, 5 workers in age group of 6 yrs were selected and average age as 33.8 dy height of 167.8 cm and weight 66.60 kg, ily (Table 5).

**Physiological stress of weeding was determined basis of parameters i.e. heart rate during work, energy expenditure and cardiac cost of hile performing activity (Table 6).**

There was 10.4% increase in working efficiency with usage of the mandava weeder. The human energy requirement for weeder in SRI output recorded by Mandava weeder was 168 m³/hr as compared to cono-weeder (149 m³/hr). During weeding with cono and Mandava weeder, AHR were 27.6 and 24.4 beats/min, respectively. Energy expenditure was 8.57 kJ/s and cardiac cost 1.17 beats/m² for cono-weeder. However, in case of Mandava weeder it was found 7.68 kJ/s and 1.08 beats/m² of energy expenditure and cardiac cost, respectively. Mandava weeder saved 21.88% cardiac cost and increases efficiency 10.38%.

**SUMMARY**

Two weeding tools were evaluated in the experiment. Maximum weeding efficiency was recorded by mandava weeder as compared to cono-weeder. Mandava weeder consumed minimum man-days/ha. Therefore, mandava weeder may be promoted in farmer’s fields in wider scale as it reduces energy output of small and marginal farming community of Gangatic Plains of the Eastern India.

**ACKNOWLEDGEMENTS**
Comparative performance of different weeding tools in maize

The senior authors sincerely acknowledge to ‘Sir Jamshed Ji Tata Trusts’ Mumbai for technical and financial support to conduct the present study.

REFERENCES


<table>
<thead>
<tr>
<th>Water levels</th>
<th>Cono-weeder</th>
<th>Mandava weeder</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mm</td>
<td>196.2</td>
<td>188.58</td>
</tr>
<tr>
<td>98.74</td>
<td>98.39</td>
<td>89.38</td>
</tr>
<tr>
<td>68.64</td>
<td>68.64</td>
<td>61.14</td>
</tr>
</tbody>
</table>

*Pushing force vs. water levels in ricefield*

<table>
<thead>
<tr>
<th>Physical characteristics of selected male farmers (N=5)</th>
<th>Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs)</td>
<td>33.80±9.18</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>167.80±3.96</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>66.60±4.28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Particular</th>
<th>Cono-weeder</th>
<th>Mandava weeder</th>
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<tbody>
<tr>
<td>Heart rate (beats/min)</td>
<td>108.8±10.47</td>
<td>103.2±10.64</td>
</tr>
<tr>
<td>Heart rate during rest (min)</td>
<td>81.2±5.59</td>
<td>78.8±7.39</td>
</tr>
<tr>
<td>Activity expenditure (kcal/hr)</td>
<td>149</td>
<td>168</td>
</tr>
<tr>
<td>Output (m/hr)</td>
<td>11.15</td>
<td>8.71</td>
</tr>
<tr>
<td>Energy requirement (MJ/ha)</td>
<td>131.39</td>
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</tr>
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*Performance of male farmers during field operation (N=5)*

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cono-weeder</th>
<th>Mandava weeder</th>
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<tbody>
<tr>
<td>Working heart rate</td>
<td>108.8±10.47</td>
<td>103.2±10.64</td>
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<tr>
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References (8)
nutrient uptake and soil health of boro rice as influenced by cultivars and herbicides

Rakesh Kumar

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V.P. Singh

energy consumption in rainfed soybean cultivation in Madhya Pradesh

Hukum Chandra

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1. To study the effect of different doses of common salt application on weed dynamics in jhum rice
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