CULTI-HARROW: A TIME AND ENERGY SAVING LAND PREPARATION IMPLEMENT FOR SUGARCANE FARMING

P.R. Singh*, Rajendra Gupta and A.K. Singh

Abstract

Cultivation of sugarcane is an energy intensive task. Tillage is one of the important operations performed before planting. With conventional tillage tools, field preparation alone requires about 940 MJ ha⁻¹ energy, which is one third of the total operational input energy. Considering these facts, a land preparation implement named culti-harrow was designed and developed at the Indian Institute of Sugarcane Research, Lucknow, India. Culti-harrow is a combination of three implements namely cultivator, harrow and planker. The results of a trial on the time taken to prepare an hectare of area, quantity of diesel consumed and bulk density of soil discussed here indicated the usefulness of culti-harrow as a time saving and energy efficient tillage implement to prepare the field with the desired level of soil tilth.

Key words: Culti-harrow, diesel consumption, bulk density, depth of tillage

Sugarcane is an important cash crop of India being cultivated in approximately four million hectare land. For better performance of the crop, tillage is the most important operation to be carried out before planting. Tillage is physical manipulation of soil with tools and implements to produce good tilth for better germination and subsequent growth of crop. Land preparation for sugarcane cultivation is a major contributor to overall production costs. In Australia, Braunack et al. (1999) gave estimates of the number of tillage operations for conventional land preparation to be eight to 10, while McMahon and Teske (1989) reported it to be up to 18 times. De Beer et al. (1993) estimated that mechanization could constitute as much as 50% of the total production costs. Hence, determining techniques which can reduce the need for the number of soil cultivations whilst still maintaining or improving yields is a practical way for farmers to reduce their costs and increase net profit. In India, sugarcane fields are generally prepared using cultivator or disc harrow or both. In northern sub-tropical part of the country, farmers generally perform two cultivating, two harrowing and one planking operations to prepare the field for planting sugarcane. With the increased number of tractor passes on the field surface, soil compaction increases and hard pan is formed in addition to higher fuel consumption. So a need was felt to design and develop an implement that is capable of providing the same or better tilth with lesser number of tractor passes and saving in energy.

Conventional tillage implements

Cultivator

Cultivator is an implement used for finer operations like breaking clods and working the soil to a fine tilth in the preparation of seedbed. It is used to further loosen the previously ploughed land before planting/sowing. It is also used to destroy weeds that germinate after ploughing. Cultivators stir and pulverize the soil, either before planting (to aerate the soil and prepare a smooth, loose seedbed) or after the crop has begun growing (to kill weeds). Unlike a harrow, which disturbs the entire surface of the soil, cultivators are designed to disturb the soil in careful patterns, sparing the crop plants but disrupting the weeds.
Cultivator has two rows of tynes attached to its frame in staggered form. The main objective of providing two rows and staggering the position of tynes is to provide clearance between tynes so that clods and plant residues can freely pass through without blocking. Provision is also made in the frame by drilling holes so that tynes can be set close or apart as desired. The number of tynes ranges from 7 to 13. The shares of the tynes can be replaced when they are worn out.

**Disc harrow**

The purpose of harrowing is to break up clods and to provide a finer finish, a good tilth or soil structure that is suitable for seedbed use. Such coarser harrowing may also be used to remove weeds and to cover seed after sowing. Harrows differ from cultivators in that they disturb the whole surface of the soil. The disc harrow consists of a number of concave discs of 45-55 cm in diameter. These discs are smaller in size than disc plough, but more numbers of discs are arranged on a frame. These discs are fitted 15 cm apart on axles. Two sets of discs are mounted on two axles. All the discs revolve together with axles. The discs cut through the soil and effectively pulverise the clods. Depth of cut and degree of tilth can be changed by changing disc angle.

**Culti-harrow: New tillage implement**

The culti-harrow designed at the Indian Institute of Sugarcane Research, Lucknow, is a hybrid of cultivator, harrow and planker (Fig 1). This implement has the benefit of cultivator and harrow. Cultivator tynes provided at the front of the implement enter the soil, thereby tearing and loosening it. Cultivator tynes are followed by the disc harrow gangs which break up clods of soil loosened by cultivator tynes and provide a finer finish, a good tilth or soil structure that is suitable for planting sugarcane. Since harrow gang disturbs the whole top soil of the field, the operation of culti-harrow uproots the weeds present in the field. Harrow gang is followed by a planker that breaks the larger soil clods, does minor leveling operation and gently compacts soil surface to conserve the soil moisture. All these operations are performed in one single pass.

**Performance evaluation of culti-harrow**

To evaluate and compare the performance of culti-harrow, a field testing was performed at the research farm of Indian Institute of Sugarcane Research, Lucknow, with four tillage treatments: (i) cultivator (4 pass) + planking (ii) harrow (2 pass) + cultivator (2 pass) + planking (iii) harrow (3 pass) + planking (iv) culti-harrow (3 pass) (Fig. 2). The preceding crop in the field was mustard and soil moisture at the time of testing was 18% (db). For testing purpose, one hectare field was divided into four parts of approximately 0.25 ha each. The exact length and width of each part were 55 m and 45 m respectively. To record the fuel consumption in a particular tillage treatment, diesel tank of the tractor was filled completely before starting tillage operation and again filled completely after completion of tillage operation with a known volume of fuel. Total time required
for completion of tillage operation in a known area of the field was recorded with stop watch. Depth of tillage was recorded with depth gauge. Bulk density of the soil was determined using core cutter method.

Results of the present study on the evaluation of implements (Table 1) indicated that the time required to prepare one hectare area was the lowest when field preparation was done using three passes of culti-harrow. However, highest time was required to prepare field with 2-passes of harrow + 2-passes of cultivator+planking. Although total fuel requirement to prepare field was the lowest (17.52 l) when field was prepared with 3-passes of harrow+planking, the depth of field preparation was less than that with 3-passes of culti-harrow. The time required for field preparation and soil bulk density was also more. The use of culti-harrow not only saved time but also prepared field unto desired depth and of desired tilth.

References


<table>
<thead>
<tr>
<th>Tillage implement / operation</th>
<th>Time required to cultivate one ha</th>
<th>Time required for planking one ha</th>
<th>Total time required to prepare one ha</th>
<th>Diesel required for tillage of one ha (l)</th>
<th>Diesel required for planking of one ha (l)</th>
<th>Total diesel required for tillage of one ha (l)</th>
<th>Depth of cultivation (cm)</th>
<th>Bulk density (g/cc) (initial =1.42 g/cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivator (4 pass)</td>
<td>4h 34min</td>
<td>36 min</td>
<td>5h 10min</td>
<td>24.70</td>
<td>3.05</td>
<td>28.25</td>
<td>19.0</td>
<td>1.26</td>
</tr>
<tr>
<td>Harrow (2 pass)+ Cultivator (2 pass)</td>
<td>4h 51min</td>
<td>36 min</td>
<td>5h 27min</td>
<td>20.90</td>
<td>3.05</td>
<td>24.45</td>
<td>13.0</td>
<td>1.21</td>
</tr>
<tr>
<td>Harrow (3 pass)</td>
<td>4h 1min</td>
<td>36 min</td>
<td>4h 37min</td>
<td>13.97</td>
<td>3.05</td>
<td>17.52</td>
<td>13.0</td>
<td>1.20</td>
</tr>
<tr>
<td>Culti-Harrow (3 pass)</td>
<td>3h 32min</td>
<td>Not required</td>
<td>3h 32min</td>
<td>20.86</td>
<td>0.00</td>
<td>20.36</td>
<td>15.0</td>
<td>1.18</td>
</tr>
</tbody>
</table>