Performance Evaluation of Tractor Mounted Hydraulic Elevator
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Abstract— Due to increase of height of horticultural crops it is difficult to harvesting and pruning. Some equipments & hand tools are available in market for harvesting and pruning, but those tools are non-useful for harvesting due to untrained labour, taller trees & high cost of equipment. Some mechanical equipments & machines are available in market for this purpose but this equipments & machines are very costly and require large space for holding hence it is very difficult to harvesting pruning of horticultural crops. Some skills are required for labours to climb on trees by using this available equipment hence to overcome & reduce this problem Tractor Mounted Hydraulic Elevator (TMHE) power by tractor PTO was tested for the mechanical harvesting and pruning of crops using digital load cell, Vibration meter, and digital Tachometer. Elevator stability study and pruner performance of the above machine was carried out on various crops at Dr. Balasaheb Sawant Kokan Krishi Vidyapeeth, Dapoli. Performance of various machines was tested for various varieties of crops. The study of Stability of machine has been done by using Digital weighing gauge The Reaction of front wheel of tractor with ground can be measured at various height on the of harvesting bucket are measured during rising and lowering action of harvesting bucket. Also the frequency analysis of elevator upper arm was studied by using theoretical methods. The study shows that, machine is stable up to 12 m height with load inside the bucket is 120 kg and angle of Bucket is 120 Degree to the turn table. The field testing of Tractor Mounted Hydraulic Elevator was conducted on Mango orchard at horticulture department, Dr. BSKKV, Dapoli, for different varieties. The average weight of fruits harvested per hour using Tractor Mounted Hydraulic Elevator was 58.84 kg/hr.

Key words: Tractor, Hydraulic Elevator

I. INTRODUCTION

The India is an agriculture based country, hundreds of fruit and vegetable types are grown in all parts of India. Last decades have seen the number of Indian fruit, vegetable suppliers and fruit, vegetable exporter’s rising to an all-time high. The total production of fruits and vegetables in the world is around 370 MT. India ranks first in the world with an annual output of 32 MT. Major Indian fruit incorporate mango, banana, citrus fruits, apple, guava, papaya, pineapple and grapes. Konkan region of Maharashtra in India is famous for Alphanso mango, cashew nut, kalipatti, sapota fruit and coconut. However Mango, cashew nut, kokum, jack fruit, are the major rain fed fruit crops in Konkan region. No other country in the world can surpass India in the number of mango varieties and the richness of the flavours. The climate of the country is ideally suited for mango cultivation. Alphanso is a very famous variety of mango fruit all over the world. The manual harvesting of this fruit is drudgeries and time consuming. During peak season, it is very difficult to get required number of skilled labours. Moreover skilled labours for climbing on mango trees are reducing day by day because of drudgery involve in this operation. India is the largest mango producing country, accounting about 60 % of world production, the export of fresh fruits are limited to Alphonso and Dashehari varieties of Mango. India’s share in the world mango market is about 15%. Mango accounts for 40 % of the total fruit exports from the country Mango account for approximately half of all tropical fruits produced worldwide and the worldwide production of mango is 33,445,279 tonnes. Manually operated low capacity gadgets and tree-shaking methods of mango harvesting are time consuming, drudgeries, damage fruits and also damage the tree branches. Mango fruits harvested with 8-10 mm long stalks appear better on ripening as undesired spots on skin caused by sap burn are prevented. Hence the Tractor Mounted Hydraulic Elevator (TMHE) Developed by Dr. BSKKV, Dapoli is proposed for harvesting and pruning of mango orchards up to 12 m height of tree. The control panel, attached to the Lifting Platform, controls the height, position and angle of rotation of the Tractor Mounted Hydraulic Elevator.

The harvesting and pruning of horticultural crops is quite difficult due to their tallness. There are small hand tools available for harvesting and pruning. But these tools of harvesting and pruning are restricted due tree height, unavailability of trained labours for climbing and cost of operation etc. The mechanized machines are available; these are heavy and costly and are not suitable for low land holding for Indian marginal famers. Harvesting and pruning of horticultural crops with the available hand tool is very difficult. The labor has to climb on the tree by carrying these hand tools which requires skill too. To overcome the above problems a Tractor Mounted Hydraulic Elevator (TMHE) powered by tractor PTO was tested for the mechanical harvesting and pruning of mango orchards. The reaction on the front wheel of tractor was noted to find out factor of safety for TMHE. The tilting of tractor should be avoided by designing factor of safety for TMHE.

II. MATERIALS AND METHODS

A. Experimental Setup

The Experimental study is carried out on tractor Mounted Hydraulic Elevator. The stability analysis of the front wheels of tractor were considered by influencing three parameters such as height in meters, reaction on front wheel in kg and angle of turn table in Degree.

The experimental setup for tractor mounted hydraulic elevator is as shown in fig.1.
Performance Evaluation of Tractor Mounted Hydraulic Elevator

The above Fig 1 consists of Tractor model to which hydraulic system of harvester is attached. The theoretical analysis of the elevator was carried out by using varying weights of 60 kg, 80 kg & 120 kg respectively. The Reaction on front wheel of machine for particular load in Bucket is tested during the Experimentation. The overall test was carried out for same height but with varying load & varying angles and same procedure is carried out for varying heights. This test is carried out for three different loads and various heights with various inclinations.

The tractor Mounted hydraulic elevator is designed and developed by following standard engineering material and accessories at Dr Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli Dist -Ratnagiri. The stability analysis of the tractor mounted hydraulic elevator is carried out on digital weighing bridge having load capacity of 60 tones which is attached with display unit. The Schematic Diagram of tractor mounted hydraulic Elevator is as shown in fig 2.

B. Experimental Procedure

The overall set of Tractor Mounted Hydraulic Elevator is shown in schematic diagram Fig 4 in this Diagram the front wheels of tractor are kept on weighing Bridge. The hydraulic arrangement for the bucket is attached to the POP unit of tractor. The hydraulic arrangement consists of two arms linked to each other. At the end of arm 2 bucket is attached which is nothing but the passage for the man to stand out for pruning of fruits. For the circular movement of arms there is arrangement of turn table. At the outward side of bucket there is provision of control panel which helps to control the movement of bucket in particular direction.

The following photograph (Fig 4) shows actual set up of Experimental Work.
The overall procedure for this experimentation is given in following stages,

- Stage 1: In this stage the height of elevator from ground surface was kept at 1.0 meter. The load inside the bucket was kept 60 kg, for set of this condition different reaction on tractor front wheel were noted on strain gauge display panel by changing angle of rotation from 0-180° at an interval of 20° after this reading same procedure is carried out for 2, 4, 6, 8, 10 and 12 meter respectively and for the changing positions of bucket load or reaction acting on the front wheel is recorded in display unit center.

- Stage 2: In this stage the height of elevator from ground surface was kept constant at 1.0 meter. The load inside the bucket was kept 80 kg, for set of this condition different reaction on tractor front wheel were noted on strain gauge display panel by changing angle of rotation from 0-180° at an interval of 20° after this reading same procedure is carried out for 2, 4, 6, 8, 10 and 12 meter respectively and for the changing positions of bucket load or reaction acting on the front wheel is recorded in display unit center.

- Stage 3: In this stage the height of elevator from ground surface was kept constant at 1.0 meter. The load inside the bucket was kept 120 kg, for set of this condition different reaction on tractor front wheel were noted on strain gauge display panel by changing angle of rotation from 0-180° at an interval of 20° after this reading same procedure is carried out for 2, 4, 6, 8, 10 and 12 meter respectively and for the changing positions of bucket load or reaction acting on the front wheel is recorded in display unit center.

### III. RESULTS OF PRESENT STUDY

From experimental Study following Results are obtained. These results are tabulated as follows.

- **Test Result of Stability analysis of Front Wheel Pair of T.M.H.E for 60 kg load in bucket (Refer Table 4.1)**

### Table 4.1: Stability analysis for front wheel of T.M.H.E at 60 kg load

<table>
<thead>
<tr>
<th>Height in M</th>
<th>Reaction at different angle (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle in °</td>
<td>0°  20° 40° 60° 80° 100° 120° 140° 160° 180°</td>
</tr>
<tr>
<td>1</td>
<td>320 330 340 350 360 370 380 390 400 410</td>
</tr>
<tr>
<td>2</td>
<td>280 290 300 310 320 330 340 350 360 370</td>
</tr>
<tr>
<td>4</td>
<td>260 270 280 290 300 310 320 330 340 350</td>
</tr>
<tr>
<td>6</td>
<td>240 250 260 270 280 290 300 310 320 330</td>
</tr>
<tr>
<td>8</td>
<td>230 240 250 260 270 280 290 300 310 320</td>
</tr>
<tr>
<td>10</td>
<td>200 210 220 230 240 250 260 270 280 290</td>
</tr>
<tr>
<td>12</td>
<td>160 170 180 190 200 210 220 230 240 250</td>
</tr>
</tbody>
</table>

#### IV. DISCUSSION

**A. Data Analysis**

In this section we do the analysis by plotting the graph of Reaction Vs angle For Each load condition with varying height of bucket. Analysis should be carried out for each load separately with varying heights and inclinations. Detail analysis of each step is shown in graphical format as follows.

**B. Analysis For 60 kg Load with varying heights**

1) **For 60 kg load with 1 m Height**

![Graph 4.1](image)

**Fig. 4.1: Influence of Reaction on Angle of rotation for 60 Kg load at 1m height**

For 60 kg load in bucket and 1 m height of bucket the graph of Reaction Vs angle is shown in above fig. in this graph X axis represents angle in Degree whereas Y-axis represents reaction due to load on front wheel of tractor. From graph 4.1 it is concluded that for 60 kg load and 1m height as angle of bucket is goes on increasing the reaction on front wheel also goes on increasing. The reaction on front wheel is found to be 320 kg at 0 degree while it is 410 kg at 180 degree. The increasing reaction with increase in angle of positions of bucket load or reaction acting on the front wheel is recorded in display unit center.

2) **For 60 kg load with 2 m Height**

![Graph 4.2](image)

**Fig. 4.2: Influence of Reaction on Angle of rotation for 60 Kg load at 2m height**

From graph 4.2 it is concluded that for 60 kg load and 1m height as angle of bucket is goes on increasing the reaction on front wheel also goes on increasing. The reaction on front wheel is found to be 280 kg at 0° while it is 380 kg at 180°. The increasing reaction with increase in angle of rotation or tractor mounted hydraulic elevator is represented above.

3) **For 60 kg load with 4m Height**

![Graph 4.3](image)

**Fig. 4.3: Influence of Reaction on Angle of rotation for 60 Kg load at 4m height**

From graph 4.3 we observe that for 60 kg load and 1m height as angle of bucket is goes on increasing the reaction
on front wheel also goes on increasing. The reaction on front wheel is found to be 260 kg at 0° while it is 350 kg at 180°. The increasing reaction with increase in angle of rotation or tractor mounted hydraulic elevator is represented above.

4) For 60 kg load with 6 m Height

![Image](Fig. 4.4: Influence of Reaction on Angle of rotation for 60 Kg load at 6m height)

From graph 4.4 it is concluded that for 60 kg load and 1m height as angle of bucket is goes on increasing the reaction on front wheel also goes on increasing. The reaction on front wheel is found to be 240 kg at 0° while it is 330 kg at 180°. The increasing reaction with increase in angle of rotation or tractor mounted hydraulic elevator is represented above.

5) For 60 kg load with 8m Height

![Image](Fig. 4.5: Influence of Reaction on Angle of rotation for 60 Kg load at 8m height)

From graph 4.5 it is concluded that for 60 kg load and 8m height as angle of bucket is goes on increasing the reaction on front wheel also goes on increasing. The reaction on front wheel is found to be 230 kg at 0° while it is 330 kg at 180°. The increasing reaction with increase in angle of rotation or tractor mounted hydraulic elevator is represented above.

6) For 60 kg load with 10 m Height

![Image](Fig. 4.6: Influence of Reaction on Angle of rotation for 60 Kg load at 10m height)

From graph 4.6 it is concluded that for 60 kg load and 10 m height as angle of bucket is goes on increasing the reaction on front wheel also goes on increasing. The reaction on front wheel is found to be 200 kg at 0° while it is 290 kg at 180°. The increasing reaction with increase in angle of rotation or tractor mounted hydraulic elevator is represented above.

7) For 60 kg load with 12 m Height

From graph 4.7 it is concluded that for 60 kg load and 12 m height as angle of bucket is goes on increasing the reaction on front wheel also goes on increasing. The reaction on front wheel is found to be 160 kg at 0° while it is 250 kg at 180°. The increasing reaction with increase in angle of rotation or tractor mounted hydraulic elevator is represented above.

![Image](Fig. 4.7 Influence of Reaction on Angle of rotation for 60 Kg load at 12m height)

V. CONCLUSION

From The Experimental as well as practical analysis of Tractor Mounted Hydraulic Elevator it is concluded that

1) The reaction of front wheel pair decreases from the 1 m height of harvesting platform to the maximum height 12 m successively. Thus, if the height of harvesting platform from ground level increases, the additional load will be needed from tractor front wheel pair. Hence for increasing the height above 12 m meter for 60 kg

2) When the angle of rotation increased from 20° to maximum angle of rotation upto 180° the reaction of front wheel increases up to 12 m height of lifting platform from ground level. Hence the better stability was noted, while the movement of platform from rear wheel pair to front wheel pair.

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