Performance Evaluation of Tractor Operated Groundnut Thresher

M. D. Amrutiya, J. M. Makavana, A. R. Kachhot, P. M. Chauhan and V. K. Tiwari

1Department of Farm Machinery and Power Engineering, College Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh - 362001, Gujarat, India.
2Department of Renewable Energy Engineering, College Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh - 362001, Gujarat, India.

Authors’ contributions

This work was carried out in collaboration among all authors. Author MDA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JMM and PMC managed the analyses of the study. Authors ARK and VKT managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The production of groundnut in India is being rapidly increased in the last ten years and is expected to increase further in coming decade. Farmer mostly used traditional cultivation practices for production of groundnut, which are labour and time intensive. Therefore, time saving machineries suited to labours should be used by growers to handle harvest and post-harvest operations for this crop. The performance evaluation of the thresher for groundnut crop was conducted with 50 hp tractor. The experiment was carried out at the Cotton Research Centre and Instructional Farm of College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh for kharif groundnut for Virginia Bunch type varieties of GG-20 and GG-22, respectively. The pod output

*Corresponding author: E-mail: makavanajagu@gmail.com;
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1. INTRODUCTION

The peanut, also known as the groundnut and taxonomically classified as *Arachis hypogaea*, is a legume crop grown mainly for its edible seeds, and they are rich in protein, oil and fiber. This plant is native to South America [1,2]. The botanical name of groundnut, *Arachis hypogaea*, is derived from two Greek words, Arachis meaning a legume and hypogaea meaning below ground, referring to the formation of pods in the soil. Peanut or groundnut is a self-pollinating, indeterminate, annual herbaceous legume crop [3]. It is also known as earth nut, peanut or monkey-nut [4,5,6]. It is commonly called the poor man's nut [7,8]. Peanut mostly grown due to its oil, protein and carbohydrates [3]. The oil of peanut is one of the most important vegetable oil regions where other oily vegetables cannot grow up [9]. Peanut has several uses as whole seeds or is processed to make peanut butter, oil, and other products [10]. Peanut is one of the most important oilseed plants in the world [11-15]. Its seeds contain 40 - 50% fat, 20 - 50% protein and 10 - 20% carbohydrate depending on the variety [16]. Groundnut is grown on nearly 24.73 million hectares in world with annual production of 403.70 lakh tons of nuts-in-shells and the productivity is 1630 kg/ha. It is grown on large scale in India, China, USA, Senegal, Indonesia, Nigeria, Brazil and Argentina [17-20]. The total area under groundnut cultivation in India is 4.56 million hectares, which accounts for the total production of 67.71 lakh tons with the productivity of 1466 kg/ha [21]. Country wise groundnut production for the year 2015-2016 is shown in Table 1.

More than 150 varieties of groundnut have been released by AICRP for different agro-ecological situations of India, however only a few age old varieties like TMV-2, TMV-7, GG-11, Chitra Kaushal, SV-xi, JL-24 and AK-12-24, K-6, CO-2, Polachi-1, GAUG-10, and new varieties like TG37-A, GBPD-4, Narayani, ICGV-91114, TPG-41, TG-38, VRI-6 are popular among the farmers for large scale cultivation [22-26].

The spreading, semi spreading and bunch types groundnut varieties are grown in Gujarat.
Table 2. State wise area, production and yield of groundnut

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>States</th>
<th>Area (Lakh ha)</th>
<th>Production (Lakh tons)</th>
<th>Yield (Kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gujarat</td>
<td>18.40</td>
<td>14.00</td>
<td>14.14</td>
</tr>
<tr>
<td>2</td>
<td>AP</td>
<td>13.90</td>
<td>10.30</td>
<td>7.75</td>
</tr>
<tr>
<td>3</td>
<td>Rajasthan</td>
<td>4.60</td>
<td>5.00</td>
<td>5.21</td>
</tr>
<tr>
<td>4</td>
<td>Tamil Nadu</td>
<td>3.40</td>
<td>3.40</td>
<td>3.52</td>
</tr>
<tr>
<td>5</td>
<td>Karnataka</td>
<td>6.60</td>
<td>6.50</td>
<td>5.91</td>
</tr>
<tr>
<td>6</td>
<td>MP</td>
<td>2.10</td>
<td>2.30</td>
<td>2.36</td>
</tr>
<tr>
<td>7</td>
<td>Maharashtra</td>
<td>3.20</td>
<td>2.40</td>
<td>2.40</td>
</tr>
<tr>
<td>8</td>
<td>Telangana</td>
<td>-</td>
<td>-</td>
<td>1.27</td>
</tr>
<tr>
<td>9</td>
<td>West Bengal</td>
<td>0.78</td>
<td>0.79</td>
<td>0.84</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>2.12</td>
<td>2.11</td>
<td>2.15</td>
</tr>
<tr>
<td>All India</td>
<td></td>
<td>55.10</td>
<td>46.80</td>
<td>45.55</td>
</tr>
</tbody>
</table>

(Status paper on groundnut, 2016)
Table 3. District wise groundnut production in Gujarat State (2015-16)

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>District</th>
<th>Area ('00ha)</th>
<th>Production ('000 tonnes)</th>
<th>Yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rajkot</td>
<td>2731</td>
<td>273</td>
<td>1680</td>
</tr>
<tr>
<td>2</td>
<td>Junagadh</td>
<td>2538</td>
<td>253</td>
<td>2052</td>
</tr>
<tr>
<td>3</td>
<td>Dwarka</td>
<td>1763</td>
<td>176</td>
<td>1627</td>
</tr>
<tr>
<td>4</td>
<td>Amreli</td>
<td>1419</td>
<td>142</td>
<td>2200</td>
</tr>
<tr>
<td>5</td>
<td>Jamnagar</td>
<td>1316</td>
<td>132</td>
<td>1856</td>
</tr>
<tr>
<td>6</td>
<td>Gir-somnath</td>
<td>1196</td>
<td>120</td>
<td>2413</td>
</tr>
<tr>
<td>7</td>
<td>Banaskantha</td>
<td>1166</td>
<td>117</td>
<td>1898</td>
</tr>
<tr>
<td>8</td>
<td>Bhavnagar</td>
<td>1093</td>
<td>109</td>
<td>1758</td>
</tr>
<tr>
<td>9</td>
<td>Kutch</td>
<td>447</td>
<td>45</td>
<td>2234</td>
</tr>
</tbody>
</table>

(SEA Kharif Groundnut Crop Survey 2015-16)

The spreading varieties like GAUG-10, GG-11, GG-13 etc. and GG-20 is semi-spreading while bunch type varieties of groundnut like JL-24, GG-2, GG-4, GG-7 etc. have been recommended and adopted by the farmers for cultivation in Saurashtra region. The groundnut is sown at the row spacing of 45 cm and 60 cm for bunch type and spreading type, respectively.

2. MATERIALS AND METHODS

A Groundnut Thresher which is Spike tooth type threshing cylinder type was taken for the study. In fact it is a modification of the drummy type. It is provided with an aspirator blower at the main grain outlet for final cleaning. Sieve assembly is also provided beneath the concave, driven by a crankshaft pulley, which gets its power from the cylinder shaft [27-29]. The working principle of a Spike tooth type threshing cylinder drum.

Table 4. Specification of groundnut thresher

A. General

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Name</td>
</tr>
<tr>
<td>2</td>
<td>Make</td>
</tr>
<tr>
<td>3</td>
<td>Model</td>
</tr>
<tr>
<td>4</td>
<td>Type</td>
</tr>
<tr>
<td>5</td>
<td>Year of manufacture</td>
</tr>
</tbody>
</table>

B. Power unit

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Type of prime mover</td>
<td>Tractor operated</td>
</tr>
<tr>
<td>3</td>
<td>Recommended power</td>
<td>35hp and above</td>
</tr>
<tr>
<td>4</td>
<td>Type of drive</td>
<td>PTO</td>
</tr>
</tbody>
</table>

C. Main drive

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type</td>
<td>Belt pulley</td>
</tr>
<tr>
<td>2</td>
<td>Size of belt, mm</td>
<td>2560</td>
</tr>
<tr>
<td>3</td>
<td>Diameter of pulley, mm</td>
<td>203</td>
</tr>
</tbody>
</table>
D. Threshing system

1. Cylinder

<table>
<thead>
<tr>
<th>1</th>
<th>Type</th>
<th>Beater</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Constructional feature</td>
<td>It is fabricated from circular CI flanges locked on the cylinder shaft at spacing. MS flat beater (perpendicular to the axis of cylinder) are welded on MS angle (3 nos.) fitted parallel to the axis of cylinder which are bolted to each flanges with nut bolts.</td>
</tr>
<tr>
<td>3</td>
<td>Diameter, mm</td>
<td>540</td>
</tr>
<tr>
<td>4</td>
<td>Width, mm</td>
<td>825</td>
</tr>
<tr>
<td>5</td>
<td>No.&amp; type of bearings</td>
<td>2 pillow block bearing</td>
</tr>
<tr>
<td>6</td>
<td>No. &amp; size of beaters/projections/bars</td>
<td>7 (4+3 fitted perpendicular to each other, on each MS angle (3 nos.), blade edge)</td>
</tr>
<tr>
<td>7</td>
<td>Spacing between beaters, mm</td>
<td>230</td>
</tr>
<tr>
<td>8</td>
<td>No. of flanges</td>
<td>2</td>
</tr>
</tbody>
</table>

2. Concave

| 1   | Type             | Semi-circular, open |
| 2   | Effective width, mm | 650               |
| 3   | Effective length, mm | 830               |
| 4   | Effective area, m² | 0.5395            |
| 5   | Concave clearance range, mm | 15-30             |
| 6   | Concave clearance, mm | 20                |
| 7   | Method of clearance adjustment | By raising and lowering the concave |
| 8   | Concavity, mm    | 265               |
| 9   | Nos. and spacing of cross bars, mm | 4, 245            |
| 10  | Method of fixing | It is mounted on two curved angle iron of size bolted by 2 nut bolts |

E. Sieve

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Parameters</th>
<th>Upper sieve</th>
<th>Lower sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type</td>
<td>Punched elliptical holes</td>
<td>Punched elliptical holes</td>
</tr>
<tr>
<td>2</td>
<td>Material and size</td>
<td>GI sheet, 0.79 mm</td>
<td>GI sheet, 0.79 mm</td>
</tr>
<tr>
<td>3</td>
<td>Size of holes, mm</td>
<td>32.09x2.07(F), 49.17x19.19(R)</td>
<td>56.43x7.77(F), 113.32x8.64(M), 49.38x19.14(R)</td>
</tr>
<tr>
<td>4</td>
<td>Density of holes in 100 cm²</td>
<td>36(F), 3(R)</td>
<td>5(F), 5(M), 3(R)</td>
</tr>
<tr>
<td>5</td>
<td>Size of sieve, mm</td>
<td>1445x760</td>
<td>1510x750</td>
</tr>
<tr>
<td>6</td>
<td>Effective size, mm</td>
<td>685x150(F), 710x420(R)</td>
<td>695x525(F), 695x225(M), 695x560(R)</td>
</tr>
<tr>
<td>7</td>
<td>Effective area, cm²</td>
<td>1027 (F), 2982(R)</td>
<td>3478(F), 1563(M), 3892(R)</td>
</tr>
<tr>
<td>8</td>
<td>Sieve slope, degree</td>
<td>5</td>
<td>10</td>
</tr>
</tbody>
</table>

F. Shaking Mechanism

<table>
<thead>
<tr>
<th>1</th>
<th>Pitman shaft</th>
<th>MS rod</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Material</td>
<td>655x38.0 φ</td>
</tr>
<tr>
<td></td>
<td>Size , mm</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>No and types of bearings on pitman shaft</td>
<td>One grease nipple is provided on each bearing cover.</td>
</tr>
</tbody>
</table>
### 2 Hangers

| Numbers | 4 |
| Length of angles, mm |  |
| Total | 200(F), 240(R) |
| Center to center | 145(F), 190(R) |
| Stroke length, mm | 55 |
| Nos. and type of bearing on each hanger | 2, Ball bearing |

#### G. Blower

| 1 Number | 1 |
| 2 Type | Suction type |
| 3 No. of blade | 4 |
| 4 Size of blade, mm | 730 x 175 x 0.80 |
| 5 Diameter, mm | 700 |
| 6 Provision for changing air displacement | Suction windows are provided |
| 7 Nos., location and size of window, mm | 2, LHS-RHS, 400 φ |
| 8 Nos. and type of bearings | 2, Pillow block bearing |

#### H. Crop feeding

| 1 Type | Hopper |
| 2 Method of feeding | Manual |
| 3 Size of feeding hopper, mm | 815 x 325 |
| 4 Height of hopper form platform, mm | 870 |
| 5 Height of feeding hopper from ground level, mm | 2300 |

#### I. Transport

| 1 Type | Tractor mounted |

#### J. Overall Dimensions

| 1 Length, mm | 2770 |
| 2 Width, mm | 1360 |
| 3 Height, mm | 2120 |
| 4 Ground clearance, mm | 430 |
| 5 Total mass, kg | 1160 |

#### K. Main pod/ grain outlet

| 1 Size, mm | 225×100 |
| 2 Inclination, degree | 5 |
| 3 Height of outlet from ground level, mm | 535 |

#### L. Foreign material outlet

##### 1. For stones/soil clods

| 1 Size, mm | 205x115 |
| 2 Inclination, degree | 5 |
| 3 Height of outlet from ground level, mm | 515 |
2. For soil powder

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Size, mm</td>
</tr>
<tr>
<td>2</td>
<td>Inclination, degree</td>
</tr>
<tr>
<td>3</td>
<td>Height of outlet from ground level, mm</td>
</tr>
</tbody>
</table>

3. Sieve overflow outlet

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Size, mm</td>
</tr>
<tr>
<td>2</td>
<td>Inclination, degree</td>
</tr>
<tr>
<td>3</td>
<td>Height of outlet from ground level, mm</td>
</tr>
</tbody>
</table>

4. Straw outlet

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Size, mm</td>
</tr>
<tr>
<td>2</td>
<td>Inclination, degree</td>
</tr>
<tr>
<td>3</td>
<td>Height of outlet from ground level, mm</td>
</tr>
</tbody>
</table>

3. RESULTS AND DISCUSSION

Experimental data collected during the course investigation. It is also including the evaluation of the various crop parameters like moisture content of pods and vine, pod-vine ratio. It also includes various performance parameter like crop feed rate, pod output capacity, percentage of blown pods [30,31], percentage of un threshed pods, percentage of broken pods, percentage of spilled pods, threshing efficiency and cleaning efficiency.

3.1 Field Testing and Evaluation

Performance of groundnut thresher was evaluated at Cotton research Centre and Instructional Farm of College of Agricultural Engineering & Technology, JAU, Junagadh for the varieties of GG-22 and GG-20, respectively.

3.2 Crop Parameters

The crop parameters such as crop variety and pod-vine ratio were determined during the study.

3.2.1 Type of crop and variety

The experiment was conducted on groundnut of GG-22 and GG-20 varieties. Both are Virginia Bunch type groundnut which are semi-spreading type.

3.2.2 Pod-vine ratio

Pod-vine ratio was determined by taking crop samples. The pods and plant matters (vine) were separated and it was observed as 0.3354 and 0.5836 for varieties GG-22 and GG-20 respectively.

3.3 Field Observations

Field observations such as moisture content, crop feed rate, fuel consumption and labour requirement were determined during the study.

3.3.1 Crop moisture content

The moisture content of pods and vine were measured by the oven drying method as shown in Appendix-III. It was found that moisture contents of pods are 11.73% (d.b.) and 6.81% (d.b.) for varieties GG-22 and GG-20, respectively. The moisture contents of vine are 11.53% (d.b.) and 12.92% (d.b.) for GG-22 and GG-20 varieties respectively.

3.3.2 Crop feed rate

Crop feed rate was measured as per standard method. Test results indicated that at threshing cylinder speed of 292 rpm and 421 rpm, the crop feed rate was varied from 2033.89 to 2117.65 and 1282.05 to 1333.33 for GG-22 and GG-20 varieties, respectively.

3.3.3 Fuel consumption

The hourly fuel consumption in case of threshing was 2.46 lit/hr and 2.14 lit/hr for the varieties GG-22 and GG-20, respectively. Both tests were carried out by 50hp tractor.

3.3.4 Labour requirement

Six labours were required during the threshing of groundnut crop. One labour was required for feeding of crop, one labour was required for straw handling, one labour was required for pod handling and others were required for crop handling.
Fig. 3. Various losses during threshing operation for GG-22 variety

Threshing Losses in GG-22 variety
- Blown pods: 3%
- Un-threshed pods: 0%
- Broken pods: 42%
- Spilled pods: 55%

Fig. 4. Various losses during threshing operation for GG-20 variety

Threshing Losses in GG-20 variety
- Blown pods: 4%
- Un-threshed pods: 2%
- Broken pods: 28%
- Spilled pods: 66%

Fig. 5. Percentage of threshed and unthreshed pods for GG-22 and GG-20 varieties

- GG-22: Threshed pods = 18.92%, Unthreshed pods = 81.08%
- GG-20: Threshed pods = 14.59%, Unthreshed pods = 85.41%
Table 5. Determination of threshing parameters

<table>
<thead>
<tr>
<th>Avg. crop feed rate kg/ha</th>
<th>Avg. pod output capacity</th>
<th>Percentage of blown pods</th>
<th>Percentage of unthreshed pods</th>
<th>Percentage of broken pods</th>
<th>Percentage of spilled pods</th>
<th>Threshing efficiency</th>
<th>Cleaning efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>GG-20</td>
<td>GG-22</td>
<td>GG-20</td>
<td>GG-22</td>
<td>GG-20</td>
<td>GG-22</td>
<td>GG-20</td>
<td>GG-22</td>
</tr>
<tr>
<td>1304.36</td>
<td>21115.55</td>
<td>407.60</td>
<td>524.66</td>
<td>6.07</td>
<td>14.51</td>
<td>14.59</td>
<td>0.361</td>
</tr>
</tbody>
</table>

Assumptions:

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Thresher</th>
<th>Tractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine life</td>
<td>8 years</td>
<td>10 years</td>
</tr>
<tr>
<td>Salvage value</td>
<td>10 % of initial cost</td>
<td>10 % of initial cost</td>
</tr>
<tr>
<td>Annual use</td>
<td>300 hours</td>
<td>1000 hours</td>
</tr>
<tr>
<td>Interest rate</td>
<td>10 %</td>
<td>10 %</td>
</tr>
<tr>
<td>Housing cost</td>
<td>1.5 % of initial cost</td>
<td>1.5 % of initial cost</td>
</tr>
<tr>
<td>Insurance cost</td>
<td>2.0 % of initial cost</td>
<td>2.0 % of initial cost</td>
</tr>
<tr>
<td>Repair &amp; maintenance</td>
<td>5.0 % of initial cost</td>
<td>5.0 % of initial cost</td>
</tr>
<tr>
<td>Fuel cost</td>
<td>-</td>
<td>64 Rs. / lit</td>
</tr>
<tr>
<td>Labour cost</td>
<td>300 Rs. Per day of 8 hr.</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 6. Threshing efficiency for GG-22 and GG-20 varieties

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>For variety GG-22, %</th>
<th>For variety GG-20, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>81.56</td>
<td>86.48</td>
</tr>
<tr>
<td>2</td>
<td>79.30</td>
<td>83.61</td>
</tr>
<tr>
<td>3</td>
<td>82.38</td>
<td>86.13</td>
</tr>
<tr>
<td>Av.</td>
<td>81.08</td>
<td>85.41</td>
</tr>
</tbody>
</table>

Table 7. Cleaning efficiency for GG-22 and GG-20 varieties

<table>
<thead>
<tr>
<th>Sr. no.</th>
<th>For variety GG-22, %</th>
<th>For variety GG-20, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>87.95</td>
<td>89.35</td>
</tr>
<tr>
<td>2</td>
<td>85.89</td>
<td>88.39</td>
</tr>
<tr>
<td>3</td>
<td>90.80</td>
<td>88.47</td>
</tr>
<tr>
<td>Av.</td>
<td>88.21</td>
<td>88.74</td>
</tr>
</tbody>
</table>

Fig. 6. Percentage of cleaned pods and foreign material for GG-22 and GG-20 varieties

3.4 Determination of Threshing Parameters

The threshing parameters such as crop feed rate, pod output capacity, percentage of blown pods, percentage of unthreshed pods, percentage of broken pods, percentage of spilled pods, threshing efficiency and cleaning efficiency were determined during the study.

3.4.1 Threshing efficiency

Threshing efficiency was varied from 79.3% to 82.38% with an average value of 81.08% for the variety GG-22. It was varied from 83.61% to 86.48% with an average value of 85.41% for the variety GG-20. Thus higher threshing efficiency was observed in GG-20 (85.41%) as compared to GG-22 (81.08%).

3.4.2 Cleaning efficiency

Cleaning efficiency varied from 85.89% to 90.80% with an average value of 88.19% for the variety GG-22. It was varied from 88.39% to 89.35% with an average value of 88.74% for the variety GG-20. It was observed that due to sufficient drying of the crop the groundnut was separated easily and efficiently from the foreign materials (stone, soil and plant stem). Thus higher cleaning efficiency was obtained for both the varieties.

3.5 Cost of Operation

Cost of groundnut threshing was calculated in terms of fixed cost and Operating costs:

3.5.1 Cost calculation for thresher

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars</th>
<th>Thresher</th>
<th>Tractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Fixed cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Depreciation, Rs/hr</td>
<td>57.75</td>
<td>67.50</td>
</tr>
<tr>
<td>b.</td>
<td>Interest, Rs/hr</td>
<td>28.23</td>
<td>41.25</td>
</tr>
<tr>
<td>c.</td>
<td>Housing, Rs/hr</td>
<td>7.70</td>
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</tr>
<tr>
<td>d.</td>
<td>Insuarance and taxes, Rs/hr</td>
<td>10.27</td>
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</tr>
<tr>
<td></td>
<td>Total fixed cost, Rs/hr</td>
<td>103.95</td>
<td>135.00</td>
</tr>
<tr>
<td>2.</td>
<td>Variable cost</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Fuel cost, Rs/hr</td>
<td>-</td>
<td>160.00</td>
</tr>
<tr>
<td>b.</td>
<td>Oil cost, Rs/hr</td>
<td>-</td>
<td>4.8</td>
</tr>
<tr>
<td>c.</td>
<td>Repair and maintenance cost, Rs./hr</td>
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<tr>
<td>d.</td>
<td>Wages, Rs/hr</td>
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<tr>
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<td>Total variable cost, Rs/hr</td>
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<td></td>
<td>Total (Fixed + variable) cost, Rs/hr</td>
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<td>4</td>
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<td>5</td>
<td>Average cost of groundnut threshing, Rs/kg</td>
<td>1.56</td>
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</tbody>
</table>
4. CONCLUSION

The average pod-vine ratio for groundnut variety GG-22 was observed as 0.3353 having moisture content of pods and vine as 11.73 and 11.53% (d.b.) respectively. The average pod-vine ratio for groundnut variety GG-20 was observed as 0.5836 having moisture content of pods and vine as 6.81 and 12.92% (d.b.) respectively. The crop feed rate for groundnut variety GG-22 was varied from 2033.89 kg/h to 2117.65 kg/h with an average value of 2115.55 kg/h at a threshing cylinder speed of 292 rpm. The crop feed rate for groundnut variety GG-20 was varied from 1282.05 kg/h to 1298.70 kg/h with an average value of 1304.69 kg/h at a threshing cylinder speed of 421 rpm. The average pod output capacity for groundnut variety GG-22 was observed as 524.66 kg/h and it was varied from 518.63 kg/h to 531.97 kg/h. The average pods output capacity for groundnut variety GG-20 was observed as 407.60 kg/h and it was varied from 375.41 kg/h to 454.79 kg/h. The average percentage of blown pods, un threshed average pods output capacity for groundnut variety varied from 518.63 kg/h to 531.97 kg/h. The crop feed rate for groundnut variety GG-22 was varied from 1282.05 kg/h to 1298.70 kg/h with an average value of 1304.69 kg/h at a threshing cylinder speed of 421 rpm. The average pod output capacity for groundnut variety GG-22 was observed as 524.66 kg/h and it was varied from 518.63 kg/h to 531.97 kg/h. The average pods output capacity for groundnut variety GG-20 was observed as 407.60 kg/h and it was varied from 375.41 kg/h to 454.79 kg/h. The average percentage of blown pods, un threshed pods, broken pods and spilled pods were observed as 14.51, 18.92, 0.126, 1.04% and 6.07, 14.59, 0.361, 0.99% for GG-22 and GG-20 varieties, respectively.

ACKNOWLEDGEMENT

The groundnut thrresher was tested at Cotton Research Centre and Instructional Farm of College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh for groundnut varieties GG-20 and GG-22, respectively.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES


**APPENDIX I**

Size of Groundnut Pods for GG-22 and GG-20 varieties

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<tr>
<th>Sr. No.</th>
<th>Length, mm</th>
<th>Width, mm</th>
<th>Length, mm</th>
<th>Width, mm</th>
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<tr>
<td>GG-22</td>
<td></td>
<td>GG-20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>29.55</td>
<td>13.10</td>
<td>25.89</td>
<td>11.44</td>
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<tr>
<td>2</td>
<td>37.37</td>
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<td>3</td>
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<td>4</td>
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<td>8.98</td>
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<td>11.38</td>
<td>27.34</td>
<td>14.20</td>
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<tr>
<td>7</td>
<td>16.95</td>
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<td>24.44</td>
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<td>17.44</td>
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<td>26.80</td>
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<td>21.18</td>
<td>8.36</td>
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<td>22.34</td>
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<td>28.95</td>
<td>12.97</td>
</tr>
<tr>
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<td>31.04</td>
<td>12.66</td>
<td>27.34</td>
<td>10.55</td>
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<td>16.46</td>
<td>9.84</td>
<td>26.80</td>
<td>14.88</td>
</tr>
<tr>
<td>14</td>
<td>35.41</td>
<td>13.45</td>
<td>28.03</td>
<td>12.46</td>
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<td>29.98</td>
<td>12.01</td>
<td>28.02</td>
<td>12.76</td>
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<tr>
<td>16</td>
<td>17.26</td>
<td>11.42</td>
<td>28.42</td>
<td>13.00</td>
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<td>28.70</td>
<td>12.15</td>
<td>29.48</td>
<td>13.34</td>
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<tr>
<td>18</td>
<td>35.41</td>
<td>13.45</td>
<td>28.03</td>
<td>12.46</td>
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<tr>
<td>19</td>
<td>36.85</td>
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<td>29.26</td>
<td>12.95</td>
</tr>
<tr>
<td>20</td>
<td>25.16</td>
<td>11.33</td>
<td>25.16</td>
<td>12.97</td>
</tr>
<tr>
<td>21</td>
<td>34.48</td>
<td>13.44</td>
<td>20.32</td>
<td>10.41</td>
</tr>
<tr>
<td>22</td>
<td>19.16</td>
<td>10.76</td>
<td>26.73</td>
<td>11.25</td>
</tr>
<tr>
<td>23</td>
<td>26.61</td>
<td>12.90</td>
<td>32.06</td>
<td>13.41</td>
</tr>
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<td>29.84</td>
<td>13.67</td>
<td>26.51</td>
<td>15.93</td>
</tr>
<tr>
<td>25</td>
<td>30.46</td>
<td>12.69</td>
<td>34.82</td>
<td>13.53</td>
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<td>26</td>
<td>25.79</td>
<td>10.37</td>
<td>25.58</td>
<td>13.07</td>
</tr>
<tr>
<td>27</td>
<td>24.83</td>
<td>11.68</td>
<td>24.91</td>
<td>13.82</td>
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<td>28</td>
<td>26.54</td>
<td>12.48</td>
<td>31.75</td>
<td>14.11</td>
</tr>
<tr>
<td>29</td>
<td>22.18</td>
<td>11.62</td>
<td>32.48</td>
<td>15.08</td>
</tr>
</tbody>
</table>

**APPENDIX II**

Determination of Pod-vine Ratio for GG-22 and GG-20 varieties

The determination of pod and vine ratio was calculated by taking 4 samples of crop at random. Then, the bold pods where separated from the vines manually for each sample and weighed.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Sample No.</th>
<th>Total weight (g)</th>
<th>Weight of pods (g)</th>
<th>Weight of vines (g)</th>
<th>Pod-vine ratio (E)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GG-22</td>
<td>1</td>
<td>975.5</td>
<td>249.0</td>
<td>726.5</td>
<td>34.27</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1034.0</td>
<td>234.0</td>
<td>800.0</td>
<td>29.25</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>831.5</td>
<td>196.5</td>
<td>635.0</td>
<td>30.94</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>906.0</td>
<td>252.0</td>
<td>654.0</td>
<td>38.53</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>1117</td>
<td>287.5</td>
<td>829.5</td>
<td>34.66</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>33.53</td>
</tr>
<tr>
<td>GG-20</td>
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<td>440</td>
<td>770</td>
<td>57.14</td>
</tr>
<tr>
<td></td>
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<td>1153</td>
<td>451</td>
<td>702</td>
<td>64.24</td>
</tr>
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<td>1189</td>
<td>460</td>
<td>729</td>
<td>63.10</td>
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<tr>
<td></td>
<td>4</td>
<td>1247</td>
<td>425</td>
<td>822</td>
<td>51.70</td>
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<tr>
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<td>395</td>
<td>710</td>
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</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>58.36</td>
</tr>
</tbody>
</table>

**APPENDIX III**

Determination of Moisture Content of Pod and Vine for GG-22 & GG-20 varieties

The moisture content of groundnut pods and vine was determined on dry basis. The oven dry method was used for determination of moisture content by taking five samples randomly. The samples were weighed and kept in oven for 24 hours at 105°C. The samples were weighed after drying. The moisture content was calculated by using the following formula:
**MC % (d.b.) = \frac{W_1 - W_2}{W_1 - W}**

Where:

- \(W_1\) = Mass of material and dish before drying (g)
- \(W_2\) = Mass of dish with dried material (g)
- \(W\) = Mass of empty dish (g)

### Table: Test results of the groundnut thresher performance

#### Observations for groundnut variety GG-22

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Parameters</th>
<th>Test Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>1</td>
<td>Duration of test, hr</td>
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<tr>
<td>2</td>
<td>Variety of groundnut crop</td>
<td>GG-22</td>
</tr>
<tr>
<td>3</td>
<td>Feeding rate, kg/hr</td>
<td>2117.65</td>
</tr>
<tr>
<td>4</td>
<td>Pod output, kg/hr</td>
<td>518.63</td>
</tr>
<tr>
<td>5</td>
<td>Fuel consumption, lit/hr</td>
<td>2.44</td>
</tr>
<tr>
<td>6</td>
<td>Capacity, kg/lit</td>
<td>867.89</td>
</tr>
<tr>
<td></td>
<td>Input</td>
<td>212.55</td>
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<tr>
<td>7</td>
<td>Losses on the basis of total pod output (%)</td>
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</tr>
<tr>
<td></td>
<td>Broken</td>
<td>0.088</td>
</tr>
<tr>
<td></td>
<td>Blown</td>
<td>15.31</td>
</tr>
<tr>
<td></td>
<td>Un-threshed</td>
<td>18.44</td>
</tr>
<tr>
<td></td>
<td>Sieve overflow</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>Total loss</td>
<td>33.84</td>
</tr>
<tr>
<td>8</td>
<td>Efficiency (%)</td>
<td>87.95</td>
</tr>
<tr>
<td>9</td>
<td>Machine parameters</td>
<td>81.56</td>
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#### Test results of the groundnut thresher performance

**APPENDIX IV**

### Table: Test results of the groundnut thresher performance

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<td></td>
</tr>
<tr>
<td>1</td>
<td>Duration of test, hr</td>
</tr>
<tr>
<td>2</td>
<td>Variety of groundnut crop</td>
</tr>
<tr>
<td>3</td>
<td>Feeding rate, kg/hr</td>
</tr>
<tr>
<td>4</td>
<td>Pod output, kg/hr</td>
</tr>
<tr>
<td>5</td>
<td>Fuel consumption, lit/hr</td>
</tr>
<tr>
<td>6</td>
<td>Capacity, kg/lit</td>
</tr>
<tr>
<td></td>
<td>Input</td>
</tr>
<tr>
<td>7</td>
<td>Losses on the basis of total pod output (%)</td>
</tr>
<tr>
<td></td>
<td>Broken</td>
</tr>
<tr>
<td></td>
<td>Blown</td>
</tr>
<tr>
<td></td>
<td>Un-threshed</td>
</tr>
<tr>
<td></td>
<td>Sieve overflow</td>
</tr>
<tr>
<td></td>
<td>Total loss</td>
</tr>
<tr>
<td>8</td>
<td>Efficiency (%)</td>
</tr>
<tr>
<td>9</td>
<td>Machine parameters</td>
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<table>
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<td></td>
</tr>
<tr>
<td>1</td>
<td>Duration of test, hr</td>
</tr>
<tr>
<td>2</td>
<td>Variety of groundnut crop</td>
</tr>
<tr>
<td>3</td>
<td>Feeding rate, kg/hr</td>
</tr>
<tr>
<td>4</td>
<td>Pod output, kg/hr</td>
</tr>
<tr>
<td>5</td>
<td>Fuel consumption, lit/hr</td>
</tr>
<tr>
<td>6</td>
<td>Capacity, kg/lit</td>
</tr>
<tr>
<td></td>
<td>Input</td>
</tr>
<tr>
<td>7</td>
<td>Losses on the basis of total pod output (%)</td>
</tr>
<tr>
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<td>Broken</td>
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<td></td>
<td>Blown</td>
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<td></td>
<td>Un-threshed</td>
</tr>
<tr>
<td></td>
<td>Sieve overflow</td>
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<td>Total loss</td>
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<tr>
<td>8</td>
<td>Efficiency (%)</td>
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<td>Machine parameters</td>
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Observations for groundnut variety GG-20

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APPENDIX V

Calculation of cost of operation by Straight-Line Method

Assumptions:

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<td>10% of initial cost</td>
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<td>300 hours</td>
<td>1000 hours</td>
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<tr>
<td>Interest rate</td>
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<td>10%</td>
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<tr>
<td>Housing cost</td>
<td>1.5% of initial cost</td>
<td>1.5% of initial cost</td>
</tr>
<tr>
<td>Insurance cost</td>
<td>2.0% of initial cost</td>
<td>2.0% of initial cost</td>
</tr>
<tr>
<td>Repair &amp; maintenance</td>
<td>5.0% of initial cost</td>
<td>5.0% of initial cost</td>
</tr>
<tr>
<td>Fuel cost</td>
<td>-</td>
<td>64 Rs. / lit</td>
</tr>
<tr>
<td>Labour cost</td>
<td>300 Rs. Per day of 8 hr.</td>
<td>-</td>
</tr>
</tbody>
</table>

Calculations:

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Thresher</td>
</tr>
<tr>
<td></td>
<td>1. Fixed cost</td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Depreciation, Rs/hr</td>
<td>57.75</td>
</tr>
<tr>
<td>b.</td>
<td>Interest, Rs/hr</td>
<td>28.23</td>
</tr>
<tr>
<td>c.</td>
<td>Housing, Rs/hr</td>
<td>7.70</td>
</tr>
<tr>
<td>d.</td>
<td>Insurance and taxes, Rs/hr</td>
<td>10.27</td>
</tr>
<tr>
<td></td>
<td>Total fixed cost, Rs/hr</td>
<td>103.95</td>
</tr>
<tr>
<td></td>
<td>2. Variable cost</td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Fuel cost, Rs/hr</td>
<td>-</td>
</tr>
<tr>
<td>b.</td>
<td>Oil cost, Rs/hr</td>
<td>-</td>
</tr>
<tr>
<td>c.</td>
<td>Repair and maintenance cost, Rs./hr</td>
<td>25.67</td>
</tr>
<tr>
<td>d.</td>
<td>Wages, Rs/hr</td>
<td>225</td>
</tr>
<tr>
<td></td>
<td>Total variable cost, Rs/hr</td>
<td>250.67</td>
</tr>
<tr>
<td></td>
<td>3 Total (Fixed + variable) cost, Rs/hr</td>
<td>354.62</td>
</tr>
<tr>
<td></td>
<td>4 Total threshing cost, Rs/hr</td>
<td>729.42</td>
</tr>
<tr>
<td></td>
<td>5 Average cost of groundnut threshing, Rs/kg</td>
<td>1.56</td>
</tr>
</tbody>
</table>

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