Machinery for Processing and Value Addition of Small Millets

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Millets Classification

Major millets

- Sorghum (jowar)
- Pearl millet (bajra)

Small (minor) millets

- Finger millet (ragi) (*Eleusine coracana*),
- Foxtail millet (*Setaria italica*)
- Little millet (*Panicum miliare* Lamk.)
- Proso millet (*Panicum milliaceam*)
- Barnyard millet (*Echichola frumentacra* Link)
- Kodo millet (*Paspalum scobiculatum*)
- Brown-Top Millet (}
Small Millets

Popular Varieties

Ragi: Indaf Series, GPU 28, GPU 26, MR 1, MR 911, etc., all from UAS(B)

Other millets: Information can be obtained from Project Coordinator (Millets), GKV, UAS(B)
Introduction

- Total area under millets 23-24 million hectares (Mha), small millets are cultivated in about 3.5 Mha which include 2 Mha under ragi and 1.5 Mha under other small millets (little, foxtail, kodo, proso and banyard millets).

- Small millets are grown in different states of India; Total production - 1.78 Mt; Indian Govt. has initiated huge project “INSIMP” to increase the area.

- Centre of Excellence on Millets created @ UAS(B) with funding from GoI to promote processing & value addition.

- Small millets are considered as nutri-cereals because of their low glycemic index, high fibre content, etc.


- Consumed by rural and tribal people as traditional foods.
Post-Harvest Processing of Millets

Post-Harvest Technologies

Primary PH Operations

Secondary PH Operations
Primary Post-Harvest Operations

Unit operations carried out on the grains at producers’ level or in the vicinity of farm which improves grain quality / transforms the grain into more useful form

- Cleaning
- Dehulling
- Sorting
- Polishing / Pearling
- Grading
- Size reduction / Grinding
- Drying
- Storage
Secondary Post-Harvest Operations

Unit operations that are carried out on grains either directly or after primary processing, that transform the grain into products generally for direct consumption.

They are done usually away from farm either in unorganized or in organized sectors.

- Puffing
- Baking
- Milling
- Flaking
Importance of Primary Processing

Cost of ragi at village level = Rs. 1100/qtl
Cleaning/pearling loss = 5 kg
Cleaned ragi = 95 kg
Cost of pearling = Rs. 25/qtl
Transportation & handling = Rs. 50/qtl.

Total Cost / Qtl. = Rs. 1175
Revenue = 95 x 15 = Rs. 1425
Profit by primary processing = 1425 - 1175 = Rs. 250
Profit from crop production = -ve (for ragi)

In terms of investment = 250 / 1175 x100 = 21.28%
PRIMARY PROCESSING MACHINERY FOR MILLETS

Grain Pre-Cleaners

Destoner – Grain Cleaner
SCREENING

It is the method of separating grain / seed into two or more fractions according to the size alone using screens or sieves.

Factors Affecting Screening Operation

- Screen aperture size / shape / arrangement
- Effective opening area
- Screen motion
- Feeding arrangement
- Sieve arrangement
- Type of product
- Type of screen
<table>
<thead>
<tr>
<th><strong>Microperforated</strong></th>
<th><strong>Round holes 60°</strong></th>
<th><strong>Rounds at 45° &amp; 90°</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Low thickness sheets where holes diameter and thickness value are the same</td>
<td>Round hole staggered 60° pattern from Ø of 0.3 mm on 0.3 mm thickness above</td>
<td>Sheets with other perforations at 45° or 90° are also available on demand</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Oblongs/slots</strong></th>
<th><strong>Square holes</strong></th>
<th><strong>Hexagonal holes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Perforated sheets with oblong holes, straight, staggered parallel long/short side</td>
<td>Square holes sheets disposition straight, staggered, diagonal, etc.</td>
<td>Hexagonal holes with high OA%, even at zones, small mid series and prototype</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Flared &amp; milled</strong></th>
<th><strong>Zone perforations</strong></th>
<th><strong>Special holes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Perforated sheets with flared holes, milled holes sheets, sheets for staircases</td>
<td>Perforated sheets at zone, as drawing, in large and small series or even single</td>
<td>Pocket holes, triangle, octagon, rhomb, half moon, round slot, and many more</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Sectors &amp; seaves</strong></th>
<th><strong>Perforated disks</strong></th>
<th><strong>Embossed sheets</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sectors, seaves, trunks of cone as drawing, at measure even small quantity</td>
<td>Perforated disks with decreasing perforation and borders also with blind center</td>
<td>Embossed sheets of round type, square, lozenge, rhomb and stick shape</td>
</tr>
</tbody>
</table>
INDIAN STANDARD SIEVES

Standards and specific requirements of IS : 460 (Part I) 1976 for the wire cloth test sieves and IS : 460 (Part II) 1978 for perforated plate test sieves with respect to widths of aperture, permissible variations in aperture, wire diameter and screening areas.

The sieves from 22 micron to 3.5 mm size are available in 200 mm diameter and have woven wire cloth fixed in spun brass frames, from 40 mm to 5.5 mm size are available in 300 mm size and from 63 mm to 125 mm size in 450 mm diameter.

The sieves of size 5.6 mm and above in 300 mm or 450 mm dia, are either of woven wire or perforated sheet and are fitted in G.I. Frames as per the requirement.

**HS32.35**

200 mm diameter, (Spun Brass Frame)

<table>
<thead>
<tr>
<th>Aperture Size</th>
<th>Aperture Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.15 mm</td>
<td>850 µm</td>
</tr>
<tr>
<td>2.80 mm</td>
<td>710 µm</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>600 µm</td>
</tr>
<tr>
<td>2.00 mm</td>
<td>500 µm</td>
</tr>
<tr>
<td>1.70 mm</td>
<td>425 µm</td>
</tr>
<tr>
<td>1.40 mm</td>
<td>355 µm</td>
</tr>
<tr>
<td>1.10 mm</td>
<td>250 µm</td>
</tr>
<tr>
<td>1.00 mm</td>
<td>181 µm</td>
</tr>
<tr>
<td>0.90 mm</td>
<td>150 µm</td>
</tr>
<tr>
<td>0.80 mm</td>
<td>100 µm</td>
</tr>
<tr>
<td>0.75 mm</td>
<td>63 µm</td>
</tr>
<tr>
<td>0.60 mm</td>
<td>45 µm</td>
</tr>
<tr>
<td>0.50 mm</td>
<td>32 µm</td>
</tr>
<tr>
<td>0.45 mm</td>
<td>26 µm</td>
</tr>
<tr>
<td>0.40 mm</td>
<td>90 µm</td>
</tr>
</tbody>
</table>

**ACCESSORIES:**

HS32.40: Lid and Receiver for 300 mm dia sieves, made of brass.

**HS32.45**

300 mm diameter (G.I. Sheet Frames)

<table>
<thead>
<tr>
<th>Aperture Size</th>
<th>Aperture Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.3 mm</td>
<td>16.0 mm</td>
</tr>
<tr>
<td>4.5 mm</td>
<td>13.2 mm</td>
</tr>
<tr>
<td>3.75 mm</td>
<td>11.2 mm</td>
</tr>
<tr>
<td>3.15 mm</td>
<td>9.5 mm</td>
</tr>
<tr>
<td>2.65 mm</td>
<td>8.0 mm</td>
</tr>
<tr>
<td>2.24 mm</td>
<td>6.7 mm</td>
</tr>
<tr>
<td>1.90 mm</td>
<td>5.6 mm</td>
</tr>
<tr>
<td>1.46 mm</td>
<td>4.0 mm</td>
</tr>
</tbody>
</table>

**ACCESSORIES:**

HS32.50: Lid and Receiver for 450 mm diameter sieves made of G.I. Sheet.

**CONVERSION TABLE FOR STANDARD TEST SIEVES**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5.60 mm</td>
<td>5.60</td>
<td>-</td>
<td>3.5</td>
</tr>
<tr>
<td>4.75 mm</td>
<td>4.75</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>4.00 mm</td>
<td>4.00</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>3.35 mm</td>
<td>3.35</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>2.80 mm</td>
<td>2.80</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>2.36</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>2.00 mm</td>
<td>2.00</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>1.70 mm</td>
<td>1.70</td>
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<td>12</td>
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<tr>
<td>1.40 mm</td>
<td>1.40</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>1.18</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td>1.00 mm</td>
<td>1.00</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>0.850 micron</td>
<td>0.850</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>710 micron</td>
<td>0.710</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>600 micron</td>
<td>0.600</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>500 micron</td>
<td>0.500</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>425 micron</td>
<td>0.425</td>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>350 micron</td>
<td>0.355</td>
<td>44</td>
<td>45</td>
</tr>
<tr>
<td>300 micron</td>
<td>0.300</td>
<td>52</td>
<td>50</td>
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<tr>
<td>250 micron</td>
<td>0.250</td>
<td>60</td>
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<tr>
<td>212 micron</td>
<td>0.212</td>
<td>72</td>
<td>70</td>
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<tr>
<td>180 micron</td>
<td>0.180</td>
<td>85</td>
<td>80</td>
</tr>
<tr>
<td>150 micron</td>
<td>0.150</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>125 micron</td>
<td>0.125</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>106 micron</td>
<td>0.106</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>90.9 micron</td>
<td>0.090</td>
<td>170</td>
<td>170</td>
</tr>
<tr>
<td>75.0 micron</td>
<td>0.075</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>63.0 micron</td>
<td>0.063</td>
<td>240</td>
<td>230</td>
</tr>
<tr>
<td>53.0 micron</td>
<td>0.053</td>
<td>300</td>
<td>270</td>
</tr>
<tr>
<td>45.0 micron</td>
<td>0.045</td>
<td>350</td>
<td>325</td>
</tr>
</tbody>
</table>
PRIMARY PROCESSING MACHINERY FOR MILLETS

Jowar Polisher

Ragi Pearler

Millet Rice Polisher
PRIMARY PROCESSING MACHINERY FOR MILLETS

Flour Mills

Pulverizer, MS

Stone Type (Mini)

Plate Type

Pulverizer, SS (Mini)

Cutting

Stone Type

Pulverizer Double
Dehulling Machinery for Small Millets

Kodo Dehuller

Foxtail / Little/Proso Dehuller

Foxtail / Little/Proso Dehuller

All Millets

Victor Machines, Salem
Dehulling Machinery for Small Millets

Kodo Dehuller

Foxtail / Little/ Proso Dehuller

Foxtail / Little/ Proso Dehuller

All Millets

Victor Machines, Salem
Dehulling Machinery for Small Millets

Multi Millet Dehuller / Polisher

Kodo / Barnyard Dehuller

Double Stage Dehuller

AVM Engineering Works, Salem
Dehulling Machinery for Small Millets

TNAU Multi Millet Double Stage Dehuller

ICAR-CIAE, Bhopal Multi Millet Dehuller

Bhavani Millet Dehuller, Mysuru

Borne Technologies, CBE

ICAR-CIPHET, Ludhiana Millet Mill
PROCESSING MACHINERY FOR MILLETS

Rubber Roll Sheller

Rice Huller

Vertical Abrasion Polisher
High Capacity Grain Cleaners

AIR SCREEN GRAIN CLEANER/ SEED CLEANER MODEL-PC-5

Suitable for cleaning of almost all types of cereals, Pulses, Spices, Oil Seeds, Vegetable Seeds, Coffee Beans etc.

No. of Screen : 2
Size of each screen : 122 x 180 cms (W x L)
Screen Inclination : Fixed
Screen Perforation Cleaning Device : Nylon Brush
No. of Aspiration : One
Fan Capacity : 3500 CFM at 75 mm WGSP
Fan Speed : 1400 RPM
Electric Motor Blower : 4 HP, 3 Phase, 380-440 V

Screen Cradle, Feed & Nylon Brush Drum : 1.5 HP, 3 Phase, 380-440 V
O.A. Size (LxWxH) : 225 x 180 x 235 cms

LINK
Specific Gravity Separator

**Application**
The Machine is specifically meant for removing impurities and achieving very high grading quality in any free flowing granular material, grains all types of seeds, spices, etc. It removes the impurities and upgrades the material on the principal of specific weight.

**Technical Specifications**

<table>
<thead>
<tr>
<th></th>
<th>G2</th>
<th>G4</th>
<th>G6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cap. (based on Wheat)</td>
<td>1.5 to 2 TPH</td>
<td>3 to 4 TPH</td>
<td>5 to 6 TPH</td>
</tr>
<tr>
<td>No. of Fans</td>
<td>3</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Size of Deck (mm)xWxL</td>
<td>600x159</td>
<td>1040x2340</td>
<td>1190x310X</td>
</tr>
<tr>
<td>Type of Deck</td>
<td>Rectangular Type</td>
<td>Rectangular Type</td>
<td>Rectangular Type</td>
</tr>
<tr>
<td>Electric Drive: Fan</td>
<td>4</td>
<td>7.5</td>
<td>10</td>
</tr>
<tr>
<td>HP: Deck</td>
<td>1.5</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Rotary Reel Separator

Rotary sieves

Vibratory Grader
Auxillary Systems for Cleaning / Grading

DUST ASPIRATION SYSTEM

AGROSAW 13 3 2007
Flour Sifter

Plansifters
Millets Product Processing Machinery

Foxtail Kurkure

Twin Screw Extruder Machine

Kurkure + Masala
Millets Product Processing Machinery

- Pasta Machine
- Grain Roaster
- Flaking Machine
- Food Blender
- FFS Packaging Machine
Millets Product Processing Machinery

Roti Machine

Biscuit Machine

Edge Runner

Grain Roaster
Thank You
Performance Evaluation of Different Dehusking Machines for Kodo Millet

- To evaluate four different machines namely, burr mill, rubber roll sheller, Victor millet mill model-I and Victor millet mill model-II for dehulling raw kodo millet
- To study milling characteristics of kodo millet at different moisture contents
Material & Methods

- Four machines used for dehusking –
  - Burr mill, Rubber roll sheller, Victor millet mill model-I and Victor millet mill model-II
- Kodo millet at three different initial moisture contents used – 9.0, 9.5 & 10.0 % (wb)
- Milling characteristics studied were:
  - Dehusking characteristics
  - Milling recovery
  - Head rice yield
  - Brokens yield
Fig. 1: Dehulling efficiency of four different millet mills for kodo millet at different moisture levels
Milling Characteristics

Fig. 3: Head yield in four different millet mills for kodo millet at different moisture levels
Fig. 2: Milling recovery in four different millet mills for kodo millet at different moisture levels
Fig. 4: Broken rice yield in four different millet mills for kodo millet at different moisture levels.
Conclusion

- Among the four different dehulling equipments namely, burr mill, Victor millet mill model-I, Victor millet mill model-II and rubber roll sheller that were tested for hulling kodo millet, the Victor millet mill model -II was found to be best based on dehusking efficiency, milling recovery, head rice yield and broken yield.