Use of Agro-biomass for Preparation of Particle Board
Background

India is one of the key producers of food grain, oilseed, sugarcane, fibre crops and other agricultural products.

After crop harvesting, the left over plant material including straw, leaves, stalk, husk, shell, and roots is known as agriculture residues.

India generates around 500 Mt of crop residue annually (GOI, 2016),

From total crop-residues production - Wheat produces 20%, Rice-24% , Maize-12%, Millets- 5%, Sugarcane-26%, Fibre crops – 3%, and Pulses- 6%.

In India among all agro-residues cereals are the largest producer of crop residue followed by sugarcane. (Devi et al. 2017).
In recent years, across India the demands of crop residue for cattle feed and industrial purpose have increased due to excessive in-situ burning of it.

The four states viz. Uttar Pradesh, Maharastra, Madhya Pradesh and Punjab constitute 47% of total burnt crop residue.

These agro-residues can be used for different industrial purposes such as bio-energy generation, composite making, particle board preparation etc.

It can be a source of additional income generation for farmers.
### Table 1: Total crop residue generation (tonnes) in different states of India during 2014-15

<table>
<thead>
<tr>
<th>State/ UT</th>
<th>Rice</th>
<th>Wheat</th>
<th>Coarse Cereal</th>
<th>Pulse</th>
<th>Oilseed</th>
<th>Sugarcane</th>
<th>Cotton</th>
<th>Jute &amp; Mesta</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andhra Pradesh+</td>
<td>13.5</td>
<td>0.0</td>
<td>8.1</td>
<td>1.8</td>
<td>1.3</td>
<td>5.2</td>
<td>2.2</td>
<td>0.02</td>
<td>32.1</td>
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<tr>
<td>Telangana</td>
<td>5.7</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.2</td>
<td>0.4</td>
<td>0.0</td>
<td>0.27</td>
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<td>Assam</td>
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<td>3.8</td>
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<td>0.50</td>
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<td>Bihar</td>
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<td>0.0</td>
<td>0.00</td>
<td>8.9</td>
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<td>Chhattisgarh</td>
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<td>14.7</td>
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<td>0.8</td>
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<td>3.6</td>
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<td>0.1</td>
<td>0.0</td>
<td>0.00</td>
<td>0.7</td>
</tr>
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<td>Himachal Pradesh</td>
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<td>0.9</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
<td>2.5</td>
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<tr>
<td>Jammu &amp; Kashmir</td>
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<td>0.4</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.00</td>
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<td>0.0</td>
<td>0.00</td>
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<td>11.4</td>
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<td>1.1</td>
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<td>0.00</td>
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<td>Kerala</td>
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<td>0.1</td>
<td>0.0</td>
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<td>Madhya Pradesh</td>
<td>4.2</td>
<td>17.6</td>
<td>5.1</td>
<td>7.3</td>
<td>8.4</td>
<td>1.8</td>
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<td>0.00</td>
<td>45.0</td>
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<td>Maharashtra</td>
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<td>1.5</td>
<td>7.6</td>
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<td>3.1</td>
<td>32.1</td>
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<td>Orissa</td>
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<td>0.4</td>
<td>0.7</td>
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<td>0.3</td>
<td>0.1</td>
<td>0.02</td>
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<td>Punjab</td>
<td>13.0</td>
<td>19.6</td>
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<td>0.1</td>
<td>2.8</td>
<td>0.5</td>
<td>0.00</td>
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<td>Rajasthan</td>
<td>0.4</td>
<td>12.2</td>
<td>12.9</td>
<td>3.0</td>
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<td>0.5</td>
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<td>1.0</td>
<td>9.6</td>
<td>0.3</td>
<td>0.00</td>
<td>23.8</td>
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<td>Uttar Pradesh</td>
<td>14.3</td>
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<td>6.1</td>
<td>2.2</td>
<td>0.9</td>
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<td>Uttarakhand</td>
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<td>0.8</td>
<td>0.5</td>
<td>0.1</td>
<td>0.0</td>
<td>2.4</td>
<td>0.0</td>
<td>0.00</td>
<td>4.6</td>
</tr>
<tr>
<td>West Bengal</td>
<td>17.2</td>
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<td>1.1</td>
<td>0.3</td>
<td>1.0</td>
<td>0.8</td>
<td>0.0</td>
<td>3.00</td>
<td>24.6</td>
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<tr>
<td>Others</td>
<td>3.0</td>
<td>0.1</td>
<td>0.8</td>
<td>1.3</td>
<td>0.2</td>
<td>0.4</td>
<td>0.0</td>
<td>0.03</td>
<td>24.6</td>
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<td>All-India</td>
<td>122.6</td>
<td>110.3</td>
<td>71.3</td>
<td>26.7</td>
<td>28.9</td>
<td>141.1</td>
<td>11.6</td>
<td>3.85</td>
<td>516.3</td>
</tr>
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</table>

Source: Compiled by author. Data provided by Ministry of Statistics and Program Implementation (MOSPI, 2013-14).
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Crop</th>
<th>Residue Name</th>
<th>Residue Quantity</th>
<th>Major Producer States</th>
</tr>
</thead>
</table>
| 1.    | Rice | Straw & Husk | 1. Every ton of paddy produces 1.1–1.3 Mt of straw and 0.23 – 0.25 Mt of husk.  
2. India generates around 112 Mt of rice straw and 22 Mt of rice husk, respectively. | West Bengal, Uttar Pradesh and Andhra Pradesh |
| 2.    | Wheat | Straw | 1. Every ton produces 1.4 to 1.5 t of straw.  
2. India generates about 110 Mt of wheat straw. | Uttar Pradesh, Punjab & Haryana |
| 3.    | Maize | Stover, Cob & Silk | 1. Every ton of maize produces 1.5 Mt of stover, 0.25-0.30 Mt of husk, silk, etc.  
2. India generates over 23 Mt of stover, 4 Mt of cob and 3 Mt of husk, respectively. | Karnataka, Maharashtra, Rajasthan, Uttar Pradesh, Andhra Pradesh, Bihar |

**Source:** http://www.erewise.com/current-affairs/biomass-resources-inindia_art52cbb9bcd5df.html#.Vd9atPmqko
Agro-residues used as Domestic Fuel to Cook the Food.

Agrowaste stored near the Farmers Houses

Wall of a House made using Cotton Stalk
Problems due to On farm burning agro-residues

- Decreasing soil fertility,
- Affect soil structure and texture
- Loss of micro nutrients
- Distroy important micro-organisms
- Air pollution, and Health problem
- A source of greenhouse gases ($\text{CO}_2$, $\text{CO}$, $\text{CH}_4$, $\text{N}_2\text{O}$, $\text{SO}_2$), aerosols, smoke, volatile organic compound and radioactive gases
## Properties of Agro-residues

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Agro-wastes</th>
<th>Type</th>
<th>Volatile Matter, %</th>
<th>Ash %</th>
<th>Fixed C%</th>
<th>HHV, MJ/Kg</th>
<th>Briquette/PB/composting Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cotton</td>
<td>Stem</td>
<td>70.3</td>
<td>2.5</td>
<td>19.7</td>
<td>17.4</td>
<td>Very Good</td>
</tr>
<tr>
<td>2</td>
<td>Soya</td>
<td>Stem</td>
<td>76.9</td>
<td>6.6</td>
<td>16.4</td>
<td>16.4</td>
<td>Good</td>
</tr>
<tr>
<td>3</td>
<td>Groundnut</td>
<td>Shell</td>
<td>68.0</td>
<td>2.8</td>
<td>19.1</td>
<td>16.7</td>
<td>Good</td>
</tr>
<tr>
<td>4</td>
<td>Sorghum</td>
<td>Stem</td>
<td>69.4</td>
<td>6.4</td>
<td>18.82</td>
<td>16.6</td>
<td>Good</td>
</tr>
<tr>
<td>5</td>
<td>Mustard</td>
<td>Stem</td>
<td>71.2</td>
<td>5.2</td>
<td>19.38</td>
<td>17.3</td>
<td>Good</td>
</tr>
<tr>
<td>6</td>
<td>Black gram</td>
<td>Stem</td>
<td>68.2</td>
<td>3.5</td>
<td>23.4</td>
<td>16.3</td>
<td>Good</td>
</tr>
<tr>
<td>7</td>
<td>Wheat</td>
<td>Stem</td>
<td>72.1</td>
<td>3.4</td>
<td>23.9</td>
<td>15.4</td>
<td>Good</td>
</tr>
<tr>
<td>8</td>
<td>Bagasse</td>
<td>Stem</td>
<td>75.8</td>
<td>4.2</td>
<td>20.1</td>
<td>18.1</td>
<td>Very Good</td>
</tr>
<tr>
<td>9</td>
<td>Garden lawn</td>
<td>Leaves</td>
<td>72.6</td>
<td>3.2</td>
<td>17.3</td>
<td>15.2</td>
<td>Good</td>
</tr>
</tbody>
</table>
Different uses of Agro-residues

- Pellets preparation
- Briquettes
- Particle board
- Compost
- Mushroom production
- Charcoal
- Carton boxes
## Profit to the farmers by selling chipped stalks

<table>
<thead>
<tr>
<th>Operations</th>
<th>Operational Cost per ton (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uprooting cost</td>
<td>Rs. 700</td>
</tr>
<tr>
<td>Chipping cost</td>
<td>Rs. 200</td>
</tr>
<tr>
<td>Packing charges (Bagging, stitching, loading and cost of bags)</td>
<td>Rs. 200</td>
</tr>
<tr>
<td>Transportation charges within 100 km area</td>
<td>Rs. 400</td>
</tr>
<tr>
<td><strong>Total Operational cost</strong></td>
<td><strong>Rs. 1500</strong></td>
</tr>
<tr>
<td>Selling price</td>
<td>Rs. 2000</td>
</tr>
<tr>
<td><strong>Total Min. Profit</strong></td>
<td><strong>Rs. 500-1200</strong></td>
</tr>
</tbody>
</table>
USE OF AGRO-RESIDUES FOR PREPARATION OF PARTICLE BOARD

INTRODUCTION
The agro-residues like saw dust, bagasse, rice straw, wheat straw, ground nut husk, Cotton stalks etc. can be used for preparation of particle boards.
It is composed of distinct particle or chips of the wood or any other lignocellulosic fibrous substances which are bounded together using any organic binder or glue by the application of heat and pressure.

To make the end product water resistant, fire proof and/or insect-proof chemicals are used including wax, dyes, wetting agents, and release agents.

Particle boards can be made of different thickness like 8mm, 12mm, 19 mm 25mm etc.
**SOURCE OF RAW MATERIAL FOR PARTICLE BOARD PREPARATION**

**Bagasse**: is the dry pulpy fibrous residue that remains after sugarcane or sorghum stalks are crushed to extract their juice.

**Sawdust** is the by-product of woodworking operations such as sawing, milling, routing, drilling and sanding. It is composed of fine particle of wood. Sawdust is the main component of particle board.
**Rice Straw**: It is a rice by-product produced when harvesting paddy. Each kg of milled rice produced about 0.7-1.4 kg of rice straw.

**Wheat straw**: It is wheat by-product.

**Cotton Stalks**: Cotton stalks are produced after harvesting of seed cotton.
Basic steps involved in preparation process

- Raw material preparation
- Conversion into particles (chipping)
- Drying of Particles
- Classification of Particles
- Blend with a resin and additives
- Particle/resin/additive blend (“furnish”) is formed into a mattress
- Cold and Hot pressed to compact the particles together and cure the resin
- Cooled and finished
Raw material is chipped into sizes: 1.5 – 2.0 cm size,

Rechipped to: 20 mesh size to 8 mesh size

Dry the material brings its moisture content at 2-3% level

The dried material is taken to rotary screen unit where it is separated into coarser (\geq 2.5\text{mm}) and finer (\leq 2.5\text{mm}) material

Mix with synthetic binders such as urea formaldehyde and phenol formaldehyde.

Additives are used to make board water proof, fire proof, and termite resistant.

Prepared three layered mat (comprising coarser particles at core layer and finer at top and bottom respectively)

Press the mat between cold press and heated platens of a hydraulic press for specific time and pressure (at 18-20 kg/cm² pressure, 140-180°C temp.) to form board

cooled to attain dimensional stability and cut into desired shape and size

Thickness may vary from 2.5mm to 35mm.
Machinery involved in manufacturing of particle board
Mat forming Machine
Process flowchart of particle board preparation

- Raw Material Preparation
- Chipping & Flaking
- Drying & Screening
- Pre-Press
- Mat Forming
- Resin Mixing & Blending
- Trimming & Sizing
- Testing
- Hot Press
- Particle come out with different sizes by using screening machine
- Wood species is oil palm
- Particle sizes as a parameter:
  - 1.0 mm
  - 2.0 mm

- Resin that use in producing the particleboard is phenol formaldehyde.
- Using different concentration as a parameter:
  - 7%
  - 9%
  - 11%
Mixing process → Matt forming process → Cold press → Trimming process → particleboard → Hot press
Marking for testing → Cutting for testing → Measure the width

Thicknes swelling testing → Measure the length → Weight the particleboard
BENDING TESTING

- This testing is for measure the mechanical properties of the particle board.

- Usually, this testing is for measure the Modulus of Rupture (MOR) and Modulus of Elasticity (MOE)

- From this testing we can know the mode of failure from testing as well as for structural application requiring strength and rigidity

- For this particleboard, the testing for the sample is important to determine the characteristics for overall samples.
INTERNAL BONDING

- An overall measure of the board’s integrity that defines how well the core material is bonded together.

- In the standard test for IB, dimension of 50mm x 50mm piece of particleboard is pulled apart with tension applied perpendicularly to both faces.

- IB is influenced directly by board density, resin content, particle geometry and raw material type.
Material Balance

Stalks chips (10 % moisture) (1 tonne)

Rechipped Material (950 kg) 10% moisture

Dried Material (884 kg) 3 % moisture

Particle Separation Loss (813 kg) 3 % moisture

Furnish Material (959 kg) 12 % moisture

Mat Formation (911 kg)

Pressing of Board (856 kg) 6 % moisture

Finished Boards (674 kg) 6 % moisture
**Binder**
- Urea formaldehyde (UF)
- Phenol formaldehyde (PF)

**Other adhesives**
- Inorganic (cement bonded)
- Thermoplastics

**Renewable resource-based adhesives**
- Tannin-based adhesives
- Lignin-based adhesives
- Glues based on vegetable oils
- Soy flour-based adhesives
- Furan polymer-based adhesives

**Binderless boards** using “activated” chips/particles (enzymatic or chemical)

**Other Additives**
- Waxes (reduction in moisture uptake) (Typically, wax is added at around 0.5-1.0%)
- Fungicides
- Flame retardants
Forming

3 layer

Homogeneous

2 layer - unbalanced

Surface

Core

Surface

Forming
Pre-pressing & hot pressing

• Pre-pressing undertaken to:
  – Reduce the thickness of the mattress (i.e. increase the bulk density of the mattress)
  – Give the mattress some mechanical strength for handling
  – Speed up the hot press process

• Pre-pressing may be cold or hot,

• Hot-pressing:
  - Is used to finally consolidate the board and cure the adhesive.
  - Density profile generated during hot-pressing

• Various types of press, the most common being a continuous press
Properties of Particle Board

- Strength (bending, transverse tensile, shear)
- Stiffness (bending)
- Density
- Surface hardness
- Screw holding
- Colour
- Surface “finish” (roughness)
- Moisture resistance
- Creep (long term deformation under a sustained load)
Bending Strength
- This testing was basically used to measure the value of Modulus of Rupture (MOR) and Modulus of Elasticity (MOE).
- MOR was the measurement of the rate rupture particleboard specimen.
- MOE value was to measure the resistance to bending related to stiffness of a beam.
- This testing was most important to determine the strength of the particleboard.

Internal Bonding
- The Instron Model machine will give a pull from upper and below at the particleboard. Samples were tested until it crack and the graph that show drop.

Water Absorption
- The samples were soaked into the water for 24 hours. For every 2 hours, the samples are weighted and recorded until the value was constant at 24 hours.
- The formulae that is used in calculation to know the percentage of the water absorption as below:
  \[ WA = \frac{\text{Weight After} - \text{Weight Before}}{\text{Weight Before}} \times 100\% \]

Determination of Thickness Swelling
- Before soaked all the data must be recorded and then samples were soaked into water for 24 hours.
- Take the thickness of the samples for every 2 hours until reach 24 hours.
  \[ TS = \frac{\text{Thickness After} - \text{Thickness Before}}{\text{Thickness Before}} \times 100\% \]
Particle Boards are classified on the basis of density

1. Low Density Particle Board: 0.4 g/cc or below
2. Medium Density Particle Board: 0.4 – 0.9 g/cc
3. High Density Particle Board: Above 0.9 g/cc
Demand of Agro-based Particle board

- Bricks, Cement, sand, and wood are now becoming scarce materials.

- Due to growing deforestation there is a bright future of particle board.

- The market is driven by the increasing demand for furniture in office space and hospitality sectors.

- Upcoming construction and infrastructure projects will increase the demand for particle board.

- The hospitality sector (hotels, lodges, etc.) is growing rapidly and the number of tourists (both domestic and foreign combined) visiting all states in India.

- The requirement for furniture in the hotel rooms is increasing significantly owing to the rise in number of hotel rooms from the past decade.

- Thus, all the aforementioned factors are expected to drive the Indian particle board market’s growth during the forecast period.
Use of Agro-based Particle Board

PB can be used for interior decoration, false ceiling, partitioning, paneling etc.

Areas: include door panel inserts, partitions, wall panels, pelmets, furniture items, floor and ceiling tiles, etc. for residential houses, commercial buildings, schools, hotels, theatres, etc.
Advantages of particle board

- It is free from natural defects of wood, like warping.
- It is easier to fix. For instance, the factory made panel doors with particle board are available in ready-to-fix form.
- It is cheaper than substitute materials.
- With proper protective surface coating and edge covering, particle board can be made termite proof and fire resistant.
- It can take a variety of surface finishes, like laminations, veneers, paint, varnish polish, etc.
AGRO-BASED PARTICLE BOARD

Advantages

- Low Cost
- Light-Weight
- Perfect for Ready-Made Furniture

Disadvantages

- Low Strength - Cannot Support Heavy Loads
- Not as Eco-Friendly as Wood Furniture
- Expands or Discolors Due to Moisture
Video: Preparation of Agro-based Particle Board (Cotton Stalks)
At present, therefore, hardly 4800 tonnes of particleboard is produced based on non-wood sources, which is about 8% of the total.
One tonne of cleaned stalk chips with 10% moisture yields 0.7 tonne of plain boards with 6% moisture.

To prepare 1 tonne of plain boards with 6% moisture, about 1.4 tonnes of cleaned stalks chips with 10% moisture are required.
Few Indian Major Players are as under:

Archidply Industries Ltd.
Bajaj Eco-Tec Products Ltd.
Bajaj Hindustan Ltd.
Ecoboard Industries Ltd.
Feroke Boards Ltd.
Genus Paper Products Ltd.
Kitply Industries Ltd.
Novopan Industries Ltd.
Nuboard Manufacturing Co. Ltd.
Rushil Decor Ltd.
Shapoorji Pallonji & Co. Ltd.
Shirdi Industries Ltd.
Western India Plywoods Ltd.
## Present price level for Particle Board

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Price</th>
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<tbody>
<tr>
<td>12 mm Thick</td>
<td>Rs. 200 per sq.m</td>
</tr>
<tr>
<td>19 mm Thick</td>
<td>Rs. 280 per sq.m</td>
</tr>
<tr>
<td>25 mm Thick</td>
<td>Rs. 350 per sq.m</td>
</tr>
</tbody>
</table>

Taxes and Duties: Extra as applicable
DISCUSSIONS ON ECONOMIC CAPACITY, PROJECT COST AND PROFITABILITY PROJECTIONS

Economic Capacity :: 30000 sq.m. per annum

Project Cost :: Rs. 80 lakhs

Assessment of project cost

1. Land

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>Cost Rs.in lakhs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Cost of land of 0.5 acre at Rs.5.5 lakh per acre</td>
<td>2.75</td>
</tr>
<tr>
<td>1.2</td>
<td>Cost of levelling, laying internal roads/fencing and compound wall</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>3.03</td>
</tr>
</tbody>
</table>

2. Building

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>Cost Rs.in lakhs</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Factory building of area 210 sq.m. at Rs.3200/sq.m.</td>
<td>6.72</td>
</tr>
<tr>
<td>2.2</td>
<td>Non-factory building of area 60 sq.m. at Rs.4500/sq.m.</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>9.42</td>
</tr>
</tbody>
</table>

3. Cost of Plant & Machinery

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>Cost Rs.in lakhs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Cost of basic plant and machinery</td>
<td>23</td>
</tr>
<tr>
<td>3.2</td>
<td>Instrumentation and control</td>
<td>1.73</td>
</tr>
<tr>
<td>3.3</td>
<td>Pipelines and valves</td>
<td>2.3</td>
</tr>
<tr>
<td>3.4</td>
<td>STRUCTURALS FOR ERECTION</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>Subtotal</td>
<td>28.18</td>
</tr>
<tr>
<td>3.5</td>
<td>Octroi, excise duty, sales tax, etc.at 12%</td>
<td>3.30</td>
</tr>
<tr>
<td>3.6</td>
<td>Packaging and insurance charges (2%)</td>
<td>0.56</td>
</tr>
<tr>
<td>3.7</td>
<td>Transportation charges (2%)</td>
<td>0.56</td>
</tr>
<tr>
<td>3.8</td>
<td>Machinery stores and spares (2%)</td>
<td>0.56</td>
</tr>
<tr>
<td>3.9</td>
<td>Foundation charges (2%)</td>
<td>0.56</td>
</tr>
<tr>
<td>3.10</td>
<td>Installation charges (2%)</td>
<td>0.56</td>
</tr>
<tr>
<td></td>
<td>Total cost of plant and Machinery</td>
<td>34.57</td>
</tr>
</tbody>
</table>

4. Technical know-how fees :: Rs.2.00 lakhs

5. Miscellaneous fixed assets

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>Cost Rs.in lakhs</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Electrification</td>
<td>3</td>
</tr>
<tr>
<td>5.2</td>
<td>Steam boiler and auxiliaries</td>
<td>1.5</td>
</tr>
<tr>
<td>5.3</td>
<td>Water storage tank, borewell etc.</td>
<td>0.60</td>
</tr>
<tr>
<td>5.4</td>
<td>Fuel storage tank</td>
<td>0.50</td>
</tr>
<tr>
<td>5.5</td>
<td>Laboratory equipment</td>
<td>0.50</td>
</tr>
<tr>
<td>5.6</td>
<td>Office machinery &amp; equipment</td>
<td>0.80</td>
</tr>
<tr>
<td>5.7</td>
<td>Material handling equipment, packaging machinery, weigh balance, etc.</td>
<td>0.6</td>
</tr>
<tr>
<td>5.8</td>
<td>Diesel generator</td>
<td>4.4</td>
</tr>
<tr>
<td>5.9</td>
<td>Effluent treatment</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>13.2</td>
</tr>
</tbody>
</table>

6. Preliminary & Pre-operative expenses:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Description</th>
<th>Cost Rs.in lakhs</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Preliminary expenses</td>
<td>0.80</td>
</tr>
<tr>
<td>6.2</td>
<td>Pre-operative expenses:-</td>
<td></td>
</tr>
<tr>
<td>6.2.1</td>
<td>Establishment</td>
<td>0.80</td>
</tr>
<tr>
<td>6.2.2</td>
<td>Rent rates and taxes</td>
<td>0.80</td>
</tr>
<tr>
<td>6.2.3</td>
<td>Travelling expenses</td>
<td>0.70</td>
</tr>
<tr>
<td>6.2.4</td>
<td>Interest and commitment charges on borrowings</td>
<td>3.50</td>
</tr>
<tr>
<td>6.2.5</td>
<td>Insurance during construction period</td>
<td>1.40</td>
</tr>
<tr>
<td>6.2.6</td>
<td>Other preoperative expenses and deposits</td>
<td>-</td>
</tr>
<tr>
<td>6.2.7</td>
<td>Interest on deferred payment</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>8.00</td>
</tr>
</tbody>
</table>

7. Provision for contingency :: Rs.4.32 lakhs

8. Working capital margin :: Rs. 5.81 lakhs

9. Total project cost :: Rs.80 lakhs

10. Means of Finance

Promoter's contribution :: Rs.32 lakhs
Term loan from financing institutions :: Rs.48 lakhs
Total project cost :: Rs.80 lakhs

11. Financial statements
## Cost of production

<table>
<thead>
<tr>
<th>A</th>
<th>Variable cost</th>
<th>Rs. in lakhs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw material and utilities</td>
<td>29.72</td>
<td></td>
</tr>
<tr>
<td>Spares and maintenance</td>
<td>2.06</td>
<td></td>
</tr>
<tr>
<td>Selling expenses</td>
<td>4.15</td>
<td></td>
</tr>
<tr>
<td>Total variable cost (A)</td>
<td>35.93</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B</th>
<th>Fixed cost</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Salaries and wages</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Interest on term loan and working capital loan</td>
<td>11.79</td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>4.88</td>
<td></td>
</tr>
<tr>
<td>Administrative expenses</td>
<td>2.49</td>
<td></td>
</tr>
<tr>
<td>Total fixed cost (B)</td>
<td>28.16</td>
<td></td>
</tr>
</tbody>
</table>

| C | Total cost of production (A+B) | 64.09 |

<table>
<thead>
<tr>
<th>D</th>
<th>Selling price per kg. (in Rupees)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>12 mm thick</td>
<td>Rs.200 per msq.m</td>
<td></td>
</tr>
<tr>
<td>19 mm thick</td>
<td>Rs.280 per sq.m</td>
<td></td>
</tr>
<tr>
<td>25 mm thick</td>
<td>Rs.350 per sq.m</td>
<td></td>
</tr>
</tbody>
</table>

| E | Annual sales turnover | 83 |

| F | Net profit before tax (E-C) | 18.91 |

| G | Breakeven point in % | 60% |
Problems in Utilization of Agro-residues by Industries

❖ Absence of an Established Supply Chain (weakest link)
❖ Industry’s hesitation to use any new Raw Material
❖ Dependence on Forest Based Material (Timber)
❖ Lack of Legislation on Ecological Considerations
❖ Uncertainties in Dry Land Agriculture leading to inconsistent supply of Raw Material
❖ Lack of Awareness about Market Acceptability of Composite Boards from Cotton Stalks
Conclusion

- Crop residues has a great economic value as industrial raw material.
- It is a sustainable alternative sources that can replace the use of wood to a large extent.
- Particle boards from agro-residues could be a great substitute of wood.
- It can improve the soil health and environment by preventing the burning of biomass in the field.
- It generates employment in rural areas and income enhancement among the rural masses.
- There is a need of some kind of extension activity (talks, speeches, presentations etc.) to disseminate the knowledge of usefulness of crop residues.
THANK YOU
Forming of particle board

• Laying up the “furnish” prior to pre-pressing and hot pressing (consolidation)
  – Improved bending properties
  – Good surface finish
  – Optimized density

• Boards may be “single layer”, “multi-layer” (3,5), or “graduated”

• Surface layers of “fine” particles, “core” of coarser particles

• MC of surface layers 8-15%; core 4-8%

• Resin content of surface layers may also be higher to give improved strength
Particle boards can be prepared of different sizes

Thickness:
- 3/8”
- ½”
- 5/8”
- 11/16”

Size:
- 4’ x 8’
- 5’ x 12’
- 4’x 12’
- 4’ x 10’
- 30” x 97 “
- 36” x 145”

etc.…. 
USES OF PARTICLE BOARD

It is used in the construction industry as prefabricated houses or as ceiling materials in monolithic structure.

Particle boards have numerous uses in the furniture industry, which experienced high demand from residential and commercial sectors.

Plain particle boards can be used in interior applications, such as beds, storage units, wardrobes, computer tables, bookshelves, shoe racks, and television cabinets.

It is also used in kitchen cabinets, storage units, tabletops, countertops, wardrobes, and dressing units etc.