Case 5 - Utilization Of Banana Waste  
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Introduction:

Banana is a type of fruit from herbaceous plants of the genus Musa. It is known as pseudo stem plant, since its leaves behave as stem. These stems are full of best fibres. Banana tree is also known as kalpa-vruksha, and with good reason. Every part of the tree can be used for our benefit. It’s fruits are eaten, leaves used as plates and to produce banana alkali, its stem sap contains N, P, K (fertiliser nutrients), and there are many other uses are there for each part.

The Challenge:

Currently the challenges or problem identified by the team is that each banana tree gives the bunch of fruit only once in its lifetime. After that, it becomes waste, and hence is cut down. This leads to huge amount of banana tree waste generation which includes the stem, leaves, and rotten fruit. The problems faced farmers are disposing of these waste. Apart from stem of the tree all the waste decompose easily but stem took 3-4 to decompose. The banana stem took 3-4 month to become compost which farmer don’t want to invest their time throw it on the road. And, it costs around Rs 12000 - 15000 per hectare to cut and dispose of banana stems. Team identified the present gap and analyze the situation so, they come up with an idea to help the farmers supplement their income by using waste of the banana tree. All this practices affect the farmer by investing their money on cutting the stem without adding any value or income and lots of waste generation on roads and highways etc.

Questionnaire prepared:

General Farming:
1. What is the farming process that you use on the banana farm? (timeline, sowing, harvesting, lifecycle, working hours)  
2. What is the spacing between each tree. (layout)  
3. What are the tools, pesticides and fertilisers that are used?  
4. What is the average output(yearly)? What is the size of the farm?  
5. How are bananas graded?  
6. Where/to whom do you sell the bananas (export? traders? direct market?)? What is the estimated price for them? (both the market price and the price that the trader gives)  
7. What are the problems that you are facing?
Banana waste:
1. What do you currently do with the waste banana trees? (leaves, stem, juice, flower, fruit)
2. If you sell the waste, whom do you sell it to? How much do you get? If you don't, why not?
   Any problems faced?
3. How do you cut them?
4. Where do you store them? (if applicable)
5. What is the extra value that you get from the plant waste?
6. Do you do your own processing for the banana tree waste?
7. If we came up with a solution to help you get more value from this waste, what kind of
   solution do you expect from us? (something that you would like to use, or whether you have
   some constraints etc)

About the banana liquid:
1. Do you use this liquid? If so, for what purposes?
2. How do you collect it?
3. What are the properties of the liquid (smell, sticky, cooling, taste etc)
4. Is there any way to tell which trees give a better type of liquid (for example. from our
   experience, some liquid is very stinky, some isn't)

About possible solutions:
1. How much labour are you willing to do for a little more of income
2. Would you be willing to use any machinery that we provide you with?
3. Are you willing to learn new technology?
4. Will you be willing to form a cluster or a chain to work together?

Pulp/Fibre Manufacturers:
1. 1. How do you collect banana stems? (sources and transport)
2. 2. How do you store them?
3. 3. What are the backward linkages for this industry?
4. 4. What is the machinery that is used?
5. 5. Could you explain the entire process to us? Are there any problems that you are facing?
6. 6. Whom do you sell it to? What are the markets you are focusing on?
7. 7. What type of solutions are you looking for? Are there any specific problems that should be
6. 8. Addressed to improve production/ increase the market?

Field Trip:
1. Navsari Agricultural Institute, Navsari
2. Mr. Kalidas Movalia’s House, Baroda
3. Gujarat State Fertiliser and Chemicals Ltd, Baroda
4. Sejal Bhai’s Banana Plantation Farm, Anand
At 5am the team started their journey to Navsari Agricultural Institute. Team met Mr Kanu Bhai Patel at the Banana Pseudostem Processing Unit. Before he arrived they took a look around at the display room.

They saw all the different types of products that were being made by the institute:
- Banana pseudo stem fiber
- carded banana fiber
- banana fiber yarn
- banana fiber non-woven
- banana fiber fabrics
- handmade articles: bags, mats, dolls
- banana fiber based paper products (files, envelopes)
- Micro-crystalline cellulose powder
- Banana fiber paper
- Vermi-compost
- particle board made from scutching waste
- dye mordant from banana sap
- Organic fertiliser liquid from banana stem sap
- Candy from the core part of them stem
- Ready to serve drink from the banana central core

Then a video was shown to them which had all the details of the processes followed. The notes are written below:
- 62000 hectares of banana farms in Baroda
- world banks gave a loan to start this project
- JK papers is their partner, CIRCOT Mumbai is their research partner. MANTRA, Surat is their textiles partner. Surat also has a similar research center
- There are 4 parts of the banana stem that can be processed to give useful products: fiber, scutcher, liquid, central core
- Farmers used to spend 12000-15000 Rs to remove the banana stems per hectare of land.
- The stems are removed free of cost for the farmers (they don't pay them for the stems)

**Process:**

Fiber:
1. Stems are brought to the unit in trucks
2. They split it into 2 halves using a splitting machine
3. Then the parts (layers) of the stems are separated by hand
4. Then they use the fiber separator machine to remove fibers. This machine was made by CIRCOT Mumbai (farmers advice was also taken into account when making the machine)
5. The fibers that are removed are cleaned in water and dried in the Sun. (takes 2 days to dry)
6. They are stored in a place without moisture.
7. All these fibers are processed in the factory. If this machinery is rented out to the farmers, they buy a kg of fiber at a cost of around 80-100Rs.
8. A single hectare of land can give 700-800 kg of fibers. 5 average length stems give 1 kg fiber.
9. The quality of fabric made from the banana fiber is being tested at CIRCOT Mumbai and Mantra Surat. they make different types of things: like sofas, seat covers (cars)

Papers:
1. The fibers are boiled to make a slurry/pulp
2. Then it is put into a paper making machine which will make paper out it of different thickness
3. It is put into a cutting machine to make different products such as files, boxes, envelope etc

Central core:
1. Microcrystalline cellulose powder is made from this. It is used for filler part of medicines/capsules. (process not specified)
2. It is made into a candy, it is actually tasteless so additional flavouring has to be added
3. It is also made into Ready to serve drinks (again additional flavouring required)
4. jam is also made

Scutcher:
1. The waste that is collected from fibre removal is called scutcher
2. They squeeze it using a screw press to remove the liquid. This liquid is fermented to give organic liquid fertiliser
3. Its composition is high in Potash(highest), nitrogen, phosphorous (NPK)
4. The liquid can also be used as a dye mordant to ensure the colour stays.
5. The residue is decomposed to make vermicompost. 30 percent cow dung is mixed and earthworms and ants are added to aid the process. This process takes 45 days, while other organic waste takes 60-70 days
6. Fish food can also be made from this. 30% of the fish food is vermicompost
7. 8-10 tonnes of fertiliser is got from 1 hectare. Sold at 5/- per kg
8. Navroji is the name of the brand of fertilisers. It is very useful in farming of sugarcane, onion and bananas)
9. Cardboard is also made from the scutcher
10. Navsari farming centre processes the liquid to make Naoroji
Questions:

1. What are the Process Costs for the different products?
- 60-70/- per liter for fertiliser
- 45-50 per kg for fiber
- 500/- per kg candy
- 130-140/- per kg for paper
Cost of labour is around 178/- per day.

2. What are the specifications of the machine? Raspador
It costs around 1 lakh. Now it may cost around 70-80k the motor horsepower is 3-5. Motor rpm is 1430, wheel rpm might be around 900-1000rpm. It has a grooved rod and rotating shaft with fins on it. When the wheel turned it would be subjected to a rubbing action that would remove the scutcher. The gap between the fin and grooved rod is between 1-1.5mm. Material is high carbon steel for the rotor blade, while rest of the body was made by cast iron. A single labourer working for 8 hours can get around 25kg of fibres. Capacity of 300-400kg of stems per day.

3. Is the market for banana based products good?
The organic fertiliser market is very good. We have signed MoUs with 12-13 companies in Maharastra and Gujarat who have bought our technology. It costs 20 lakhs to set up the entire plant. Out of which 4 lakhs is our cost for the technology.
The other markets are not so good. We currently have 20 tonnes of fabric sitting idly in our storage. That is why we have stopped running the machines.

4. **Do you approach the farmers or do the farmers approach you to buy the stems?**
We generally use the stems within the agricultural institute. If our need is more, then we approach outside farmers. We currently do not pay the farmers for the stems.

5. **Why is the market for banana waste based products not so good? Why isn’t more marketing being done?**
Firstly there is not too much awareness about these products. Earlier we had received grant from the central government for this project. But now those grants have stopped. Further, as a government company, we cannot do any marketing. But the companies which bought these patents from us, they are doing good marketing and are also selling the fertilisers at around 3000-4000 repose per litre. We sell it for only 130/- per litre.

Also, these products are very expensive because of the processing costs involved, which are very high. For example, there are bags made of jute also, which are much cheaper than banana fibre bags. But quality wise, the banana products are superior. For example the files made from banana paper are much more durable than the ones currently used. The high processing costs is mainly due to machinery and labour costs.

As for creating awareness amongst farmers, we do conduct workshops with farmers. ATMA is also working in this area. But it is proving to be expensive for farmers also. Further lot of labour is involved. Nowadays, instead of throwing stems away, farmers are burying it in the soil.

6. **Are there any problems faced in cutting, transportation or storage of stems?**
No. These stems have lot of water content so they are easy to cut. Transportation is simple, there is no damage that the stems face during transportation. Stems can be used within 10-15 days of cutting before the quality of fibre goes down. Maybe by
storing it in a cold storage they can last longer, but the quality will still go down after sometime.

7. When do you get banana waste? Throughout the year or seasonally?
A single tree will only give one loom in its lifetime. Once a loom is cut, they cut the tree and it becomes waste. This process happens throughout the year. Around 6-7 trees are cut at a time, with maybe around a week’s gap between them. It is not seasonal. But during monsoon season, they do not cut the stems because the high moisture content will spoil the fibres.

8. Do you know anything about biofuel/biogas uses for banana waste?
No, I do not know.

10. What else can banana fibre be used for?
The non-woven banana fibre can be used in coolers, it has good thermal insulation properties. (in fact, sir’s cabin had covered his windows using a mat of non-woven fibre) It also has sound absorbing properties. Car companies like BMW and audi have used this for sound absorption. It has also been used in car bodies for thermal insulation, for protection from the sun’s heat.

Inferences
- Technology to process banana waste already exists but the end products are expensive because of high machine, labour and transportation cost
- The market demand for such products can be expanded. (he mentioned that had excess of 20 tonnes of fibre lying unused) This can happen by
  - increasing awareness
  - reducing process costs

24th May 2018

Gujrat State Fertilizers and Chemical Limited
We met the Ms. Shivani Hora, Biotechnologist at GSFC. She explained the production of “Banana Plant” by way of “Tissue Culture.”
Interview session:

1. **What is actually tissue culture and how it is helping the farmer on the field?**

   The tissue culture is the process to extract the tissue from the good plant which is also considered as a kind of “Clone Farming.” This help the farmer to get the output as similar as the plant from which that tissue belongs i.e. duration of fruit growth, the quality of the fruit, and it holds the similarity as the mother plant from which the tissue extracted that is known as “Sucker.”

2. **How tissue grows the plant?**

   The tissue is Sucker, for this it requires the base of the plant. The tissue should be cut in the cross sectional ways. After 25 days it will appears in the form of “Indution.” This will put in the artificial sunlight and wind, to provide them surrounding which that will have to surround in future. The induction will put in the laboratory for around 90 to 120 days. Then it will send it to net house after that green house.

3. **Which part of the year does the sappling or seedling?**

   In the month of June the plant will give the bunches of banana. In the month of May the remove the bunches of the banana and extract the succer in the rainy season or after rainy season. If they want to keep the plant then they will continue to keep the plant either they will uproot the plant.
4. **What were the earlier practices for growing the banana?**

   Earlier the banana contains the seeds which will sow in the field but these were of different varieties and sizes. So the after the lot of research they came up with an idea of tissue culture farming. Currently there is a seedless banana.

5. **What are the content used for the sucker?**

   They put few chemical i.e. organic and inorganic (calicum phosphade, urea and etc) in the water then agar(Gelly kind of powder) and then boil the water at 100 celcius so that the sucker can easily fits in the bottles and the consistency will be thick and put at the room temperature to cool it down and the agar converts into a gel.

6. **Which season contains maximum waste of banana?**

   April to May/June there is a maximum waste generation from the banana plants.
Sejal Bhai Farm:

1. **What is the life cycle of the banana tree?**
The average lifespan is around 12-13 months. After I sow the seedlings, it takes about 9 months for them to mature into adult trees. After that, Banana looms start growing for about 2-3 months time.

2. **What is the average size of the tree?**
The average height of tree is 10-12 feet.

3. **What variety do you grow?**
I grow the Grand Naine variety on my farm.

4. **What farming practices do you follow?**
We have both organic and inorganic farms on my plantation. I do not use any types of chemicals in my organic farm. Each of my trees are spaced at a distance of 4 feet.

5. **What problems do you face in farming?**
Weeding in the organic farming is a very time-consuming process since we do not use chemical weedicides to kill them. We also have pigs who come into our farm and dig up the soil, causing the trees to overturn. Apart from that, in summer, the heat is too much and destroys our crops.

6. **How do you currently dispose your tree waste?**
We cut the banana stems at their base and then push the tree over so that it falls. After that we run over the stems using a small tractor with a rotary tiller attached to it. This chops the tree into small pieces and mixes it into the soil. If we have too many trees, we throw the excess stems onto the roadside.
i. What machinery do you use for this process?
We use a normal rougher, and for disposal, a rotary tiller which is attached to our small tractor.

ii. What problems do you face in disposing?
We cut a lot of trees at once, so disposing all of them is very hard.

iii. How many trees do you cut at once?
Around 500-600.

iv. What do you do after this?
We plant our next crop, which is potato plant.

7. Do you know that you can get fibres from banana stems? Do you know how to get them?
Yes, I do. We can get them by drying the stems in the sun, and then stretching the fired stems so that we can get the fibres out by hand. There is a farmer I know in Baroda who has machinery and uses that to get the fibres on a large-scale.

Ghyammsham Bhai Desai Farm:
(farmer who practices fiber extraction)

1. What machines do you use for fiber extraction?
I use raspador machines, which I bought second-hand from Mumbai.

   i. How many machines do you have?
   I have 3 machines right now, but I have ordered 4 more which should be arriving soon

   ii. What is the cost of these machines?
   I bought them second-hand for about 70-80k.

2. What do you do with the scutcher waste that is generated from fibre extraction process?
We use this as fertiliser in our fields. We do not subject it to further processing to make other products.

3. **We had heard that the market for this fibers is not very big. Do you agree? if so, why?**
   The quality of the fibers that we produce is of less quality than that produced in South India, where banana fiber extraction is more widely practiced. It has both high production and better quality.

   i. **Why is the quality here worse?**
   In South, the banana tree stems have a higher moisture content and the soil quality is better.

   ii. **How exactly do you compare and measure the quality of banana fibers?**
   The quality of a banana fiber is measured by the whiteness of the fiber and its smoothness.

   iii. **How does your fiber reach the market? Which industries use banana fiber?**
   I sell all my fiber to a broker or a middle man. He is the one who does all the dealings, and only he knows which markets buy it.

4. **What is the main expenditure for the fiber extraction**
   The major part of expenditure is the labour cost and wages. Also, the cost of processing a single tree is around 22-25 rupees.

5. **How much fiber is extracted from 1 tree?**
   Around 150 -200 grams of fiber is extracted.

6. **What problems do you face in the extraction?**
   The lack of high quality machine is major problem faced by the farmer.

7. **What amount of fiber is produced monthly?**
   1200-1300 kg of fiber is produced.

8. **Where do you store the fiber?**
   They do not need high tech storage, so they can be kept anywhere.

9. **Does anyone else you know follow this practice?**
No. They are not interested.

i. Why?
Because they are not ready to invest so much in this. Also, you do not immediately get returns in this business.

**Story of a Banana Farmer: (one who doesn’t practice fibre extraction)**
I currently own 2 types of banana plantations: I practice inorganic farming in one, and organic farming in another. The farming cycle starts around August, when I get a batch of fresh seedlings from the GSFC. The land would have been freshly ploughed, and each seedling will be planted with a distance of 4 feet between them. In the inorganic farm, I spray weedicide which quite effectively removes all the weed. But in the organic farm, I do not use any chemicals and hence employ manual labour to remove weeds. This costs thousands of rupees in labour. But though it is laborious, I have seen that the quality of bananas is far superior since the soil quality is better. It takes roughly 10 months for the trees to bear fruit (though it depends on the species of the fruit) I take good care of each loom, I treat them like children. When they are young, I ensure that they are shaded from the sun under the leaves of the banana tree. As they grow bigger and heavier, I use sticks to prop them up so that the tree does not bend and break under its weight. When it is finally time to harvest, I identify the ripe fruit and cut them off. I cut around 8-10 looms at a time. When all the trees are harvested, it is time to plant new crop. I first get my labourers to cut down the stems of every tree and push the stems onto the floor. I then attach a rotary tiller to the tractor and go over the farm so that the stems get chopped and mixed into the soil. This increases the fertility of the soil, and I can plant potatoes in it. But I have to wait close to 2 months for all the stems to decompose.

**Story of a Banana Farmer: (one who does practice fiber extraction)**
I know I have taken a risk by investing in this fiber processing machinery. Not only was the machinery expensive despite being second-hand, I have to spend so much more money on labour, close to 70% of my money is spent on it. I did not foresee this. Also, I have to spend so much time on this. The machines are constantly running for close to 8 hours per day. When the 4 more machines that I
have ordered arrive, I know that machines will be running for almost 16 hours. Though I was very scared that I had taken the wrong decision in the first few months, now I am feeling more assured since the profits have started coming in. However, I still face competition from the South, where the fibers are softer and of better quality. At least I have lessened the trouble I had earlier faced in getting rid of the stems, and am managing to earn some income from it. But I am unable to convince my other farmer friends to take this risk as well. They are unwilling to invest so much.

On the basis of the field visit and the observations made from the visit, problem statement was taken into consideration and the team started working towards the prototype design for extracting banana fiber from the banana waste.

**Problems Identified**
From the field visits and research, the team identified the following problems regarding the banana fiber products industry.

- Technology to process banana waste already exists but the end products are expensive because of high machine, labour and transportation cost
- The market demand for such products is quite small. This is due to:
  - less awareness
  - high product costs
Existing Banana Fiber extractor machine - raspador. Costs 1,00,000

They spoke to a farmer who told them that farmers were reluctant to enter into the banana waste product sector because of the high investment involved versus the late returns. Thus, they realised that the lack of technology wasn’t a problem, rather the lack of affordable technology. The fibre processing practice should become more lucrative to farmers such that they have less risk & investment, but can get more value out of it. Proper marketing channel for the processed product is also required, so that awareness about the end product increases.
**Solution**

After thinking about how the team could tackle the above problems, they decided that they could try to make a low cost fiber extracting machine. This would make the technology more accessible to the smaller scale farmers since less investment will be required, resulting in a smaller break-even period.

**Final Design**

Having decided what they would make, they had to ideate on how they would make it. So the team first studied the mechanisms involved in the existing machines. Building upon the mechanism of existing fiber extractors, they came up with the final design. The major change involved was in the shape of the rotor. They changed it from a round rotor to a square shaped rotor that enabled us to reduce the size and number of the high speed steel blades that would be required (reduction of high cost material requirement) they also reduced size of rotor which meant that a smaller motor would be sufficient to provide the 180N force that is required to separate the fibers.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Material</th>
<th>Specification</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rectangular cross-section bar, Mild Steel</td>
<td>4cm<em>8cm</em>20cm, thickness: 2mm</td>
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<td>2</td>
<td>Rectangular cross-section bar, Mild Steel</td>
<td>4cm<em>8cm</em>34cm, thickness: 2mm</td>
<td>2</td>
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<td>3</td>
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<td>4cm<em>8cm</em>80cm, thickness: 2mm</td>
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<tr>
<td>4</td>
<td>Sq Solid Bar, Mild Steel</td>
<td>8cm<em>8cm</em>60cm</td>
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<tr>
<td>5</td>
<td>Threaded Cylinder (if possible, else get a</td>
<td>diameter: 5cm, length 50cm, pitch: 0.5mm, depth of thread ~ 0.5mm</td>
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<tr>
<td></td>
<td>normal one), Mild Steel</td>
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<td></td>
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<tr>
<td>6</td>
<td>Rectangular Solid bar, <strong>High Carbon Steel</strong></td>
<td>1cm<em>3cm</em>30cm</td>
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<tr>
<td>7</td>
<td>Pedestal Bearing</td>
<td>Inner Diameter: 3cm</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>V-belt Pulleys, double groove</td>
<td>Hole Diameter: 3cm</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Motor</td>
<td>2 HP, 1400rpm</td>
<td>1</td>
</tr>
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Costing
As mentioned earlier, the existing raspador machines cost close to 1 lakh. The machine can be manufactured for less than 25% of the cost. The details are provided in the table below:

<table>
<thead>
<tr>
<th>FABRICATION</th>
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<tbody>
<tr>
<td></td>
<td>Welding</td>
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<td></td>
<td>Drilling</td>
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<td></td>
<td>Milling</td>
<td>100</td>
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<tr>
<td>Lathe Operation (Turning, Facing, Threading)</td>
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<tr>
<td></td>
<td>Grinding</td>
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<td>Cutting</td>
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<td>Assembly Labour</td>
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<td>Total</td>
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<td>Normal Loss</td>
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<td>Grand Total</td>
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<tr>
<td>Overall Total</td>
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<tr>
<td>Name of Part</td>
<td>Material</td>
<td>Quantity</td>
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</tr>
<tr>
<td><strong>Frame</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 L - Section (5cm*5cm, thickness: 5mm) - Length: 100cm</td>
<td>Mild Steel</td>
<td>2</td>
</tr>
<tr>
<td>2 L - Section (5cm*5cm, thickness: 5mm) - Length: 42cm</td>
<td>Mild Steel</td>
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</tr>
<tr>
<td>3 Square Section (4cm*4cm, thickness: 3mm) - Length: 80cm</td>
<td>Mild Steel</td>
<td>4</td>
</tr>
<tr>
<td>4 L - Section (5cm*5cm, thickness: 5mm) - Length: 50cm</td>
<td>Mild Steel</td>
<td>2</td>
</tr>
<tr>
<td>5 L - Section (5cm*5cm, thickness: 5mm) - Length: 17cm</td>
<td>Mild Steel</td>
<td>2</td>
</tr>
<tr>
<td>6 L - Section (5cm*5cm, thickness: 5mm) - Length: 7cm</td>
<td>Mild Steel</td>
<td>2</td>
</tr>
<tr>
<td><strong>Rotor</strong></td>
<td></td>
<td></td>
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<tr>
<td>7 Solid Shaft, Diameter: 30mm, Length: 60cm</td>
<td>Mild Steel</td>
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</tr>
<tr>
<td>8 Square Section (5cm*5cm, thickness: 2mm) - Length: 30cm</td>
<td>Mild Steel</td>
<td>1</td>
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<tr>
<td>9 Square Plate - 5cm*5cm, Thickness: 3mm, with 30mm hole in the centre</td>
<td>Mild Steel</td>
<td>2</td>
</tr>
<tr>
<td>10 Blades - 3.8cm<em>30cm</em>3mm</td>
<td>High Speed Steel</td>
<td>4</td>
</tr>
<tr>
<td>11 Pedestal Bearings - Inner Diameter: 30mm</td>
<td>MS, HSS</td>
<td>2</td>
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<tr>
<td>12 Bolts - Outer Diameter: 10mm</td>
<td>Mild Steel</td>
<td>4</td>
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<tr>
<td>13 Nuts - Diameter: 10mm</td>
<td>Mild Steel</td>
<td>4</td>
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<tr>
<td>14 Washers- 10mm, 32mm</td>
<td>Mild Steel</td>
<td>4</td>
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<td><strong>Grooved Rod</strong></td>
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<td>15 Solid shaft - Diameter: 35mm</td>
<td>Mild Steel</td>
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</tr>
<tr>
<td>16 Nuts - Diameter: 20cm</td>
<td>Mild Steel</td>
<td>2</td>
</tr>
<tr>
<td><strong>Motor - Pulley System</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 Induction Motor - 2HP, 1440 rpm, 3 phase connection</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>18 V Belt Pulley - Groove Diameter: 3 inches, Hole Diameter: 20mm</td>
<td>Mild Steel</td>
<td>1</td>
</tr>
<tr>
<td>19 V Belt Pulley - Groove Diameter: 4.5 inches, Hole Diameter: 30mm</td>
<td>Mild Steel</td>
<td>1</td>
</tr>
<tr>
<td>20 V Belt - 5 feet</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>21 Bolts - Outer Diameter: 8mm</td>
<td>Mild Steel</td>
<td>7</td>
</tr>
<tr>
<td>22 Nuts - Diameter: 8mm</td>
<td>Mild Steel</td>
<td>4</td>
</tr>
<tr>
<td><strong>Casing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23 Metal Sheet - 40cm*60cm, Thickness: 1mm</td>
<td>Mild Steel</td>
<td>1</td>
</tr>
<tr>
<td>24 Bucket - TBD</td>
<td>Plastic</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>11976</td>
</tr>
<tr>
<td>Normal Loss</td>
<td></td>
<td>2395</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>14371</td>
</tr>
</tbody>
</table>

* The costs were calculated on a per kg basis
Prototype is almost completely assembled. Preliminary tests have been done where team members rotated the rotor manually. There is a good percentage of the pulp was removed in very few rotations itself. However, fibres had got only partially separated.
Tests with the motor are yet to be done.