TECHNOLOGY FOR SMOKE FREE BRIQUETTES FROM AGRICULTURE WASTE--- SUITABLE FOR COTTAGE INDUSTRY

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Introduction

- **The depletion of fossil fuels and the need to reduce greenhouse gas emissions has resulted in a strong growth of biomass utilization for heat and power production. Attempts to overcome the poor handling properties of biomass, i.e. its low bulk density and inhomogeneous structure, have resulted in an increasing interest in biomass densification technologies, such as pelletization and briquetting.**

AVAILABLITY OF SURPLUS CROP AND AGRO - PROCESSING RESIDUES AND THEIR USES

- **Annually about 477.46 millions tonnes of crop residues including about 100 milliontonnes of agro-processing residues/ wastes are produced in India.**
- **• Substantial quantities of these residues are used as cattle feed/fodder, domestic fuel for cooking, construction material for rural housing (thatch), for paper industry and as packing material.**
- **• About 100-125 million tonnes, are not used properly and are available as surplus.**
- **• Part of this surplus, specially the rice straw, some quantities of wheat straw and cotton stalks are burnt in the states of Punjab, Haryana, Western Uttar Pradesh, Uttarakhand, Madhya Pradesh, Gujarat and Maharashtra.** Cont.

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- • With the increase in productivity of crops, on one hand and
- reduction in animal population, and environmental concerns regarding burning of straw on the other hand, the availability of biomass for briquetting will be much more from the present position.
- By the year 2015 about 700 million tonnes of crop and agro processing.
- residues/wastes are likely to be available annually out of which about 300 million tonnes would be surplus.
- • If the surplus biomass is briquetted as such or after fortification (for animal feed), its handling, storage and transport becomes economical and much easier and the briquettes can be used as feed and fodder for animals or as domestic and industrial fuel for energy.

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- **• High density briquettes are used in boilers, gasifiers, furnaces and domestic cook stoves.**
- **• The calorific value of crop/agro-processing residues vary between 3100 - 4500 kcal/kg.**
- **If used for power generation 1 kg of such residues can give about 1 kWh of electrical energy.**
- **• It is visualized that in future there will be greater demand for briquetting of surplus biomass in India**

TOTAL ANNUAL AVAILABILITY OF AGRICULURAL WASTEIN INDIA

(Source In Million Tonnes)

1. Crop and agro-processing residues	**577.46**
2. Road side waste	**10.74**
3 Waste from Waste lands	**27.12**
4. Forest waste	**157.18**
5. Dung – livestock	**267.76**
6. Poultry droppings	**4.81**
7. Fisheries waste	**5.00**

Total	**1050.07**

- **Out of the annual production of about 577.46 MT crop and agro-processing residues about 100-125 MT are available as surplus.**

BRIQUETTING TECHNOLOGY

- **Briquetting is a technology for densification of biomass /crop residues to increase its bulk density, lower moisture contents, make briquettes of uniform size and shape for easy handling, transport and storage. It also helps in uniform burning when used as fuel.**
- **The briquetting does not add any calorific value to the base biomass. In order to upgrade the specific heating value and combustibility of the briquette, certain additives like charcoal and coal powder in very fine form can be added.**
- **Briquettes have high specific density, about 1100-1200kg/m3 and bulk density about 600-800 kg/m3 as compared to loose biomass which have bulk density in the range of 80-200 kg/m3.**

Briquetting can be done with and without binder.

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- **The compaction of biomass into briquettes and pellets is an old process that has been known for more then 130 years.(William H. Smith) registered the first patent for biomass, dendification in 1880 in Chicago.**

- **Bailing, briquetting, extrusion and pelletization are the different types of biomass densification.**

- **Biomass densification first became a commercial large scale process in the second half of the last century.**

ISSUES INVOLVED IN PROMOTION OF BRIQUETTING TECHNOLOGY

- ¬ Need for reliable assessment of annual availability of crop
- and agro-processing waste in different regions and seasons.
- ¬ Need of efficient machines for harvesting, retrieval,
- densification, fortification, handling, transport and storage
- of crop and agro-processing residues.
- ¬ Reliable assessment of availability of surpluses in different
- regions and seasons.
- ¬ Efficient machines for briquetting of low density (0.4–0.7
- gm/cm3) and high density (1–1.2 gm/cm3) briquettes, with
- and without binder.
- - High density, binder less briquetting/ pelleting for energy
- purposes 20 mm–90 mm diameter for boilers, gasifiers
- - Low density briquetting with and without binder for cook
- stoves, animal feed

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- **Transport of crop and agro-processing residue to the briquetting plant, in loose form is expensive. Preparation of feedstock should be done in production catchments.**
- **Raw material cost is about 40–75% of the cost of briquettes and hence availability of raw material at cheaper cost will bring down the selling cost of briquettes.**
- **For operation of a briquetting machine of 500 kg/h capacity running in 2shifts (16 h/day) and operating for about 300 days/year, about 2400 tones of raw material will be required.**
- **If the briquetting plant is installed in production catchments and collection centers are established in a cluster of few villages, the farmers/ landless laborers are expected to supply biomass in small quantities, which will ensure regular supplyof different types of biomass to the briquetting plant.**

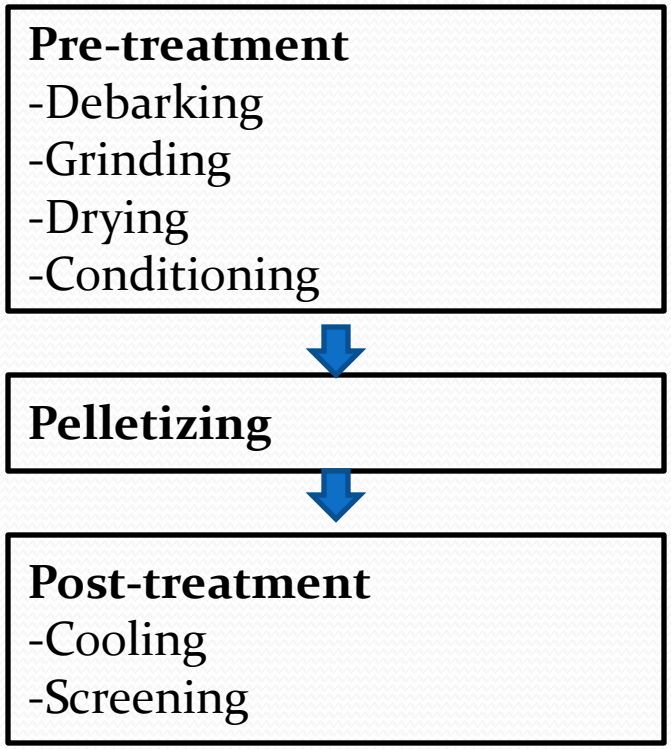
WHAT CAN BE BRIQUETTED?

- **All crop and agro-processing residues, woody biomass, saw dust from timber mills, dried leaves from orchards, shrubs and grasses along the road sides can be used for briquetting.**
- **The problem lies in their collection, drying, handling and transport.**
- **Crop residues like rice and wheat straw, cotton stalks and many agro-processing residues are not presently being briquetted and substantial quantities are being burnt in the field for quick disposal in different parts of the country.**

AIM

- Karkania et al.(2012) studied the market for agricultural pellets in Greece. The concluded the studies that densification of biomass is an opportunity to make biomass easier to handle, but the cost factor remains a challenge.
- Therefore, this present investigation aimed to develop an easy and efficient technology to convert agriculture waste into briquettes and popularize the technology to the target groups.

A typical overview of the biomass densification process



METHODOLOGY

- Collection of raw materials
- Soaking in tap water
- Boiling for 30 minutes
- Air dry the substrate with 50%moisture
- Spawning
- Solid state fermentation for 40—50days
- Fermented substrate
- Mix with charcoal powder
- Mould in to pellets
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METHODS (Solid State Fermentation)

- **Agriculture waste is collected, soaked, boiled and filled in poly bag fermenter along with fungal inoculum.**
- **The fermenters will be kept in fermentation room at 21 + or – 3° C for a period of time (until the uniform coverage of fungi mycelium on the substrate which resulted appearance of fugal fruit body , after harvesting the fruit bodies).**

SS FERMENTED STRAW

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- the bags will be shifted to ordinary room temperature where it is kept for a period of time.
- Here, the fungal mycelia which grown on the substrate will die and decomposed, due to this the fermented substrate will turn into brownish black in color and have a texture like clay. In this condition the fermented substrates are called “Bioclay.”

BIOCLAY

Carbon mobilization from raw substrates to fungal fruit body during SS Fermentation

SL.NO	Parameters	PS	ED	CW
1.	Amount of carbon in raw substrate	54	45	39
2.	Amount of carbon in fermented substrate	33	27	21
3.	Amount of carbon accumulated in fungal fruit body	18	15	12
4.	% of carbon accumulated in fruit body	33.3	33.3	30.8
5.	% of carbon in fermented substrate	61.1	60.0	53.8
6.	% of carbon released	5.6	5.7	15.4
7.	% of carbon removed from the raw substrate	38.9	39.0	46.2

Fungal fruit body yield from paddy straw at various occasions

SL. NO	Paddy straw samples	Dry weight of paddy straw(g)		Reduction of dry Wt. during SSF (%)	Amount of fermented straw(%)	Fresh mushroom yield (g)	Biological efficiency (%)
		Before SSF	After SSF				
1	I	483	343	28.9	70	403	83.43
2	II	445	229	50.6	49	357	80.2
3	III	582	377	35.2	64.5	320	54.9
4	IV	750	627	21.7	78	182	30.2

Briquettes from fermented paddy straw with various concentrations of agar waste

S.No	Treatments PS: AW (g)	Initial fresh weight of fermented substrate (g)	Initial dry weight of fermented substrate (g)	Amount of dry charcoal (g)	Total dry weight of Briquettes (g)	No.of briquette pieces	Individual briquette weight (g)	No.of days fermented	Amount of mushroom harvested (g)
1.	900:100 PsAw-100	563	112.6	169	279	20	14.2	56	265
2.	800:200 PsAw-200	677	135.4	203	312	23	13.8	62	250
3.	700:300 PsAw-300	527	105.4	158	258	17	15.1	47	275
4.	600:400 PsAw-400	498	99.6	149	234	17	14.1	38	328
5.	500:500 PsAw-500	543	108.6	163	258	18	14.3	48	336

BIOCHARCOAL BRIQUETTES

BRIQUETTES IN VARIOUS SHAPES AND SIZE

PACKED BIOCOAL BRIQUETTES

cost analysis

- The following is the cost analysis for mini briquette units which can handle about 100kg of dry paddy straw per day through our technology
- **Fixed Capital:**
- **Cost of land of five cent**
- **(Rs 30000/cent) 1, 50,000**
- **2.Erectionof thatched shed 3nos 16x20ft 45,000**
- **3. Mini briquette press 1,00,000**
- **4. Boilers 2nos 10,000**
- **5. Straw cutter 10,000**
- **6. Other equipment 40,000**

Total Rs 3,55,000

=Euro 5180.9

Daily Expenditure:

• Cost of 100kg paddy straw Rs 3/kg	300.00
• Cost of fungal spawn 15kg (Rs 70/kg)	1050.00
• Cost for processing/maintain paddy straw	
• during SSF Rs 2/kg of paddy straw	200.00
• Labor 3x200	600.00
• Cost of wood charcoal 15x10	150.00
• Other expenses	100.00
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Total	2400.00

Expected Income:

Fungal fruit body yield from 100kg paddy straw (50%) Biological Efficiency (BE).	50kg
Fungal fruit yield if biological efficiency 80%	80kg
Fungal fruit body yield if biological efficiency 30%	30kg
Amount of fermented substrate	50kg
Amount of charcoal added with fermented substrate to prepare briquette	15kg

If fruit body yield	30kg	50kg	80kg
Income from sale of Fungal fruit body Rs120/kg(Rs)	3600	6000	9600
Add Income from sale of Briquettes(Rs)	975	975	975
Estimated Income per day(Rs)	**4575**	**6975**	**10575**
Less estimated expenditure(Rs)	2400	2400	2400
Estimated Profit per day (Rs)	**2175**	**4575**	**8175**
Expected profit per month(Euro)	1017.9	1922.7S	3644.9

Cost analysis of briquettes preparation from 100kg of paddy straw under Traditional method.

Cost raw material 100kg paddy straw Rs 3/kg	Rs 300
Processing cost Rs 1.50/kg of straw	Rs 150
Wastage 5%	Rs 15-

Total	Rs 465

Amount of biomass briquette produced 95kg	
Cost of briquettes Rs 10/ kg	950
Less Expenses	465

Daily income	485

Monthly income 485x30	Rs 14550
	(or) Euro 212.35

Thank you for your patience