# Energy from Agricultural Waste
# R & D suggestions

**By**

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# The present status

- India generates annually 800 million tons agricultural waste having >2.5 times as much energy as imported petroleum.
- No extra land, efforts or inputs needed for generating agricultural waste.
- It is light, bulky and spread out in millions of farms.
- How to collect it ?  Who bears the  cost?

# Mobilizing agri-waste

- If a fair price is offered, farmers bring A.W. to the processing factory at their own cost.
- Currently, 100 factories in Maharashtra convert A.W. into fuel briquettes.
- 2.5kg briquettes costing Rs.15, have the same energy as 1 litre fuel oil @ Rs. 40/litre.

# Research Needs

- Machines for making  fuel briquettes at farm level for value addition and ease of transport.
- Standardise quality norms of briquettes.
- Design furnaces, cookstoves, kilns etc. for using biomass briquettes.
- Briquettes also ideal fuel for steam- and Sterling engines.
- Commercialize Sterling Engine.

# Charcoal from agri-waste

- Pyrolysis of biomass yields 30% charcoal.
- Charcoal has no volatiles.  Can replace coke in metallurgy. Heating charcoal mixed with iron ore yields sponge iron.
- Minerals in charcoal contribute to quality of steel. E.g. rust free iron column in Delhi, Damascus swords and chain mails from Indian steel.

# Charcoal briquettes from light biomass

# Research Needs

- Recover tar and waste heat during charcoal production.
- Iron smelting as cottage industry, using charcoal from agri-waste.
- Ash from grasses, added to Portland cement or lime mortar, yields Pozzolana cement. Revive technology.

# Fuels for i. c. engines

- India imports annually 120 million tons, or about 80% of the Country's requirement of petroleum.
- Largest item of import, causing annual outflow of about US$112,000 million.
- Can we replace petroleum with agri-waste based fuels?

# 1. Producer Gas

- **70% of plant biomass volatilizes at temp. above 300C. High temp. generally achieved by burning biomass to be gasified.**
- **Producer gas, formed at 700C, contains CO, $H_2$, $CH_4$, $N_2$ & some tar. Can be used as fuel in i. c. engines after filtering out tar.**
- **Presence of 50% $N_2$ in producer gas reduces calorific value.**

# Research Needs

- **Generation of nitrogen-free producer gas by using oven-and-retort system or nitrogen-free air for burning biomass.**
- **Catalysts needed for reducing tar and increasing proportion of combustible gas.**
- **Improved internal combustion engines using producer gas as fuel.**
- **Process for obtaining oil instead of gas for ease of storage and transport.**

# 2. coal gas

- Burning charcoal + steam gives coal gas $C+H_2O= CO + H_2$.
- Does not have tar, but has nitrogen.
- **Research needs**
- Produce coal gas without $N_2$ .
- Develop coal gas for use in i.c. engines.
- Develop coal gas as new industrial fuel.

# 3. Biogas

- **Anaerobic micro-organisms and methanogens convert digestible org. waste into biogas $C_6H_{12}O_6=3CH_4+3CO_2$ (60% $CH_4$, 40% $CO_2$ and traces of $H_2S$ and $NH_3$).**
- **Lignin not digested in this process.**
- **Technology simple and well developed; used both in households & industries.**
- **Biogas can serve as fuel in i. c. engines without any processing.**

# ARTI biogas plant

# Research needs

- I.c. engines and household appliances using biogas as fuel.
- Reduce size and cost of biogas plants.
- Produce pure methane from biogas.
- Fuel cells based on methane.
- Use of effluent from biogas plant.
- Develop methanogens with tolerance to cold, to low and high pH; ability to digest organic substances like lignin, plastics, petroleum products etc.

# General research needs

- **Small, off-the-shelf devices for converting waste biomass into high quality fuel and appropriate appliances for using these fuels.**
- **Filling wood gas, biogas and coal gas into cylinders for ease of storage and transport.**
- **Conversion of above gases to liquid fuel.**
- **Develop hybrid systems**
- **Develop supply chains and delivery mechanisms for commercialising these fuels.**

# Decentralized Electricity Generation

- **Sugar factories use steam turbines to generate their own electricity. Bagasse serves as fuel.**
- **Generate electricity using ag-waste collected from 10 to 20 villages.**
- **Availability of electricity would increase rural business opportunities and employment.**
- **Battery powered vehicles would offer freedom from petroleum.**

# Shouldn’t agri-waste go back to soil?

- **<u>Textbook opinion:</u> Agriculture removes minerals from the soil. Return agri-waste to the field to give minerals back to the soil.**
- **<u>Fact:</u> soil has unlimited supply of minerals.**
- **Molecules removed from soil solution get replaced by new ones from undisolved pool of minerals in the soil.**
- **1m layer of soil can support agriculture for 25000 years and new soil is continuously being formed from earth’s crust, which is 30 km thick.**

# Pros and cons of chemical fertilizers

- Soil minerals have low water solubility, measurable only in PPM or PPB units.
- Uptake of minerals from such dilute solution is difficult for plants.
- Chemical fertilizers, being water soluble, are readily taken up by plants.
- But chemical fertilizer industry is the world's highest energy consuming industry.
- Soil fatigue due to chemical fertilizers.

# Agriculture without chemical fertilizers

- **Soil microbes more efficient than plants in absorbing soil minerals.**
- **Provided with any organic carbon source, soil microbes multiply, taking up minerals directly from soil, and converting them into water soluble cellular components.**
- **After exhausting the carbon source, microbes die of starvation to release minerals from their cells. These minerals are taken up by plants.**

# Suggested research

- **Sugar is a high calorie organic material devoid of minerals.**
- **Estimate content of water soluble minerals in soil.**
- **Incubate soil with sugar for some period.**
- **Estimate water soluble mineral content after incubation.**
- **Study plant growth in soil treated and not treated with sugar.**

# Thank you

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