Foundation for MSME Clusters (FMC)

CEMCA

REPORT OF BAMBOO GASIFICATION

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Introduction

Foundation for MSME Cluster along with Copenhagen Business School (CBS), SIDBI (Small Industries Development Bank of India) and CEMCA (Commonwealth Educational Media Centre for Asia) under European Union Switch Asia funded project, “Promote Bamboo MSME Clusters for Sustainable Development”. The objective of this project was to promote bamboo as sustainable resource and boost entrepreneurship with emphasis on women, leading green jobs.

Bamboo stands as a prime exemplar of a sustainable resource, embodying the principles of environmental consciousness and responsible utilization. With its rapid growth cycle and ability to mature within just a few years, bamboo emerges as a renewable asset, contrasting starkly with traditional hardwood trees that require decades to reach maturity. This exceptional growth rate ensures a consistent and abundant supply without depleting ecosystems. Additionally, bamboo's capacity to sequester carbon dioxide, coupled with its minimal need for fertilizers and pesticides, contributes to its environmentally friendly profile. The plant's versatility, as it finds purpose in construction, textiles, paper, and more, accentuates its value as a multifaceted resource. In choosing bamboo over conventional materials, we embrace a pathway to sustainable production, reduced deforestation, and a harmonious coexistence with our planet's finite resources. There are various possible uses for energy production from bamboo and their corresponding effects on farmers' income:

- Bamboo can be used as a source of biomass for energy production through processes like combustion, gasification, and anaerobic digestion. Farmers can cultivate bamboo specifically for energy purposes, creating an additional revenue stream. This can help diversify their income and reduce dependence on traditional crops.
- Bamboo can be processed to produce biofuels like bioethanol and bio gasoline. Farmers could potentially set up small-scale biofuel production facilities, creating jobs and increasing their income. However, the technology and infrastructure required for biofuel production might be more advanced and costly compared to other options.
- Every part of the plant, that comes out as process waste, can be directly converted in to Bamboo charcoal is a high-quality and sustainable alternative to traditional charcoal. One need not use good bamboo for this purpose. It has various applications, including cooking, heating, and industrial processes. Farmers could engage in bamboo charcoal production, which has a relatively high market value and can contribute to their income.
- Bamboo can be used to generate electricity through various means, such as direct combustion or gasification to produce steam for turbines. Farmers can sell surplus electricity to the grid, providing them with a continuous income stream. However, this would require more substantial infrastructure and regulatory support.
- Bamboo can be used in biogas production along with organic waste through anaerobic digestion. The produced biogas can be used for cooking and lighting. This can help farmers save money on energy expenses and potentially generate surplus biogas for sale.
- In areas with limited access to electricity, bamboo-based energy solutions can help bring power to rural communities. Farmers can benefit from improved living conditions,

enhanced productivity, and potential income generation through small businesses that rely on electricity.

- Bamboo plantations used for energy production can sequester carbon dioxide from the atmosphere. Farmers might be able to participate in carbon credit trading schemes, generating income by selling carbon credits to industries looking to offset their emissions.
- Beyond energy production, farmers can create value-added products from bamboo, such as bamboo-based textiles, construction materials, and handicrafts. These products can have a higher market value and contribute to increased income.

Implications on Income Levels of Farmers:

- Diversification: Bamboo energy production can provide an additional income source, reducing farmers' dependence on a single crop and mitigating risks associated with crop failures or price fluctuations.
- Employment Opportunities: Bamboo energy projects can create local jobs, such as in cultivation, harvesting, processing, and maintenance of energy production facilities.
- Technology and Skills Development: Farmers may need training and technical support to engage in bamboo energy production effectively. This could lead to skill development and increased employability.
- Environmental Impact: Sustainable bamboo cultivation for energy can have positive environmental impacts, such as reforestation, erosion control, and carbon sequestration, contributing to long-term income sustainability.
- Market Access: Farmers' income potential would depend on factors like market demand, pricing, infrastructure, and government policies supporting renewable energy and bamboo industries.

However, challenges such as initial investment costs, infrastructure development, access to markets, and policy support need to be considered to ensure that the adoption of bamboo energy production translates into improved income levels for farmers.

Bamboo possesses potential as a fuel source, and there exists a variety of fuels, including CNG, bio natural gas, and charcoal. Bamboo is particularly applicable for gasification, primarily for local energy needs. Our aim was to ascertain the feasibility of bamboo as a viable fuel for gasification. The objective was to determine the viability of utilizing bamboo in this capacity, leading to possible expansion and dissemination of this business application.

Professor K. R. Chari was associated
with this part of project related to use of bamboo for energy generation. The objective was to establish the feasibility, Potential for adding to energy pool of India and the Technoeconomic feasibility of the option.

Technical and scientific testing help was provided by M/s Chanderpur Industries, Yamuna Nagar, Haryana State, India. This report serves as a concise summary of the outcomes derived from this experimentation.

Our findings demonstrate the following points about bamboo gasification:

- Bamboo can indeed be utilized for gasification, with attention to managing its relatively high moisture content.
- Gasification processes are best conducted in locations where bamboo is locally abundant to minimize transportation costs associated with raw bamboo.
- The calorific value of bamboo aligns closely with that of coal.

We firmly believe that the insights and outcomes detailed in this report from our experimentation could provide valuable guidance for further exploration and development within this field.

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Dated 16/01/2023

PROXIMATION AND CALORIFIC VALUE OF BAMBOO CHIPS SAMPLE:-

1.	MOISTURE CONTENT	31.93 %
2.	VOLATILE MATTER	59.92 %
3.	FIXED CARBON	6.79 %
4.	ASH CONTENT	1.34 %
5.	CALORIFIC VALUE	3728.14 kcal/kg (Dry Bamboo basis)

Total Bamboo chips consume during 7 hr. process:	**324 kg**
Moisture in Bamboo:	**31.93 %**
Dry Bamboo chips:	**220 kg**
CV of Gas:	**980 Kcal/Nm3** (Less CV of gas due to high moisture in feed stock)
Volume of gas:	**630 Nm3/hr.**
Efficiency of the Gasifier:	**75.27%**
Total charcoal discharged during this process:	**30.6 kg** (approximate 14% of feed)
Total power generation during 7 hr. process:	**180 KWH**
Overall efficiency of the gasifier/engine:	**18.8%** for power generation
Bamboo consumption:	**1.22 kg/kW** (Dry Bamboo basis)

During a 7-hour process, a total of 324 kg of bamboo chips were consumed. These bamboo chips had an initial moisture content of 31.93%, resulting in the production of 220 kg of dry bamboo chips. The gas generated from these chips had a lower calorific value (CV) of 980 Kcal/Nm3 due to the high moisture content in the feedstock. The gas volume produced was 630 Nm3 per hour, and the gasifier's efficiency was calculated to be 75.27%.

From this process, approximately 30.6 kg of charcoal were discharged, representing around 14% of the initial feedstock. The power generation during the 7-hour operation amounted to 180 KWH.

Considering both the gasifier and engine, the overall efficiency for power generation was found to be 18.8%. The consumption rate of bamboo was estimated to be 1.22 kg per kilowatt (kW) of power generated on a dry bamboo basis.

Experiment Analysis

Sl. No.	Particulars	Unit	Value
	IF BAMBOO		
1	Biomass Consumed	kg	324
2	Moisture in Biomass	%	31.93
3	Dry Biomass Weight	Kg	221
4	Price of Biomass	INR/kg	4
5	**Costing of Biomass consumed**	**INR**	**1296**
6	GCV of Gas produced	Kcal/Nm3	980
7	Charcoal Produced	Kg	30.6
8	Price of Charcoal	INR/Kg	35.00
9	Electricity Generated	Kwh	180
10	Price of Electricity	INR/Kwh	8
11	**Total Value of Produce (Electricity plus Charcoal)**	**INR**	**2511**
12	**1 INR of Bamboo offer produce of cost of**	**INR**	**1.94**
	IF COAL		
12	Efficiency of Thermal Power Plant in India	%	42
13	GCV of coal used in Thermal power plant	Kcal/Kg	3000
14	Coal Used for 180 KW electricity generation	Kg	123
15	Unit price of coal	INR/kg	8
16	**Price of coal for 180 KW electricity generations**	**INR**	**983**
17	**1 INR of coal offer electricity of cost of**	**INR**	**1.47**
18	Emissions per kwh by Coal	Kg	0.82
19	Emissions per kwh by Biomass	Kg	0.23
20	Emissions reduction per kwh of electricity	kg	0.59
21	**Emissions reduction per kwh of electricity**	**%**	**71.95**

The anticipated cost for the trial bamboo is roughly 4 INR per kilogram. When utilizing 324 kg of bamboo priced at 1290 INR per tonne, accounting for a 32% moisture content, the generated return amounts to 2,510 INR. Conversely, utilizing one tonne of bamboo priced at 4000 INR yields a return of 7,740 INR.

Based on the aforementioned outcomes, it can be inferred that one unit of bamboo's cost will yield electricity and charcoal production equivalent to 1.93 INR, while the return on one INR spent on coal is 1.47, additionally resulting in a reduction of approximately 72% in emissions when employing biomass for electricity generation.

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