RJPSSs June 2019, Vol. XLV, No.1, ISSN: (P)0048-7325 (e) 2454-7026 Impact Factor 6.763 (SJIF)

Importance of Rural Bioenergy for Developing Countries

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Abstract:

Bioenergy is a recent type of renewable energy derived from living organic matter called biomass that can be used to produce transportation fuels, heat, electricity and byproducts. Biomass is any organic matter that has absorbed sunlight and stored it as energy. Biomass has great potential and can be burned directly for heat or electricity, or it is often converted into alternatives to oil or gas. Liquid biofuel, a practical renewable substitute for gasoline, is mainly used in the transportation sector. We need to assess and evaluate bioenergy and its impacts in the context of the particular system of which it is a part and its direct impacts on the environment, economy, and society. This knowledge will provide a critical step to drive a sustainable biofuel and bio-economy around the globe. This topic will gather current knowledge and pressing questions about the significance of bioenergy and biofuels. This knowledge will provide a critical step to drive a sustainable bioenergy and bio-economy around the globe.

Keywords*: Bioenergy, Biomass, Biofuels, renewable energy, sustainable fuel.*

Reference to this paper should be made as follows:

Received: 30.05.2019
Approved: 16.06.2019

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RJPSSs 2019, Vol. XLV, No. 1, pp. 233-241

Article No.32
Online available at:
http://
rjpsss.anubooks.com/

Introduction

Bioenergy is obtained from biological sources. Some additional bioenergy sources are coal, petroleum and natural gases which are classified as fossil fuels. It can be broadly classified into animal energy and biofuel. Bioenergy is derived directly or indirectly from about 0.2% of the solar energy transmitted to the earth's surface and is converted into biomass by photosynthetic organisms. This is equivalent to more than ten times our biomass energy used by everyone in the world. The main use of bioenergy is man-made in rural areas of developing countries.

Generating Heat and Electricity

The fuels of biological origin are renewable and if used properly and efficiently, they can solve the problem of energy crisis in developing countries. Present-day technology can be used to replace the use of fossil fuels with biofuels. We can make use of bioenergy for generating electricity and producer gas to run tube wells, to obtain alcohol and other products of fermentation to generate biogas for cooking, and lighting.

Animal Energy

It is classified into two types: (i) HMP (Human Muscle Power); and (u) DAP (Draught-pronounced as Draft Animal Power). The housewives, marginal farmers, artisans, and non-agricultural laborers make use of HMP which is equivalent to one-fifth of the total electricity generated annually in India.

The animals act as the sources of food, hides, and bones. They are employed for agriculture and for transport. The full potential of DAP can be realized effectively by (a) improving the carts; (b) breeding the animals for improvement in their quality regarding the yield of the product, their mechanical strength, and the ability for the resistance to diseases; (c) developing methods for better management of grazing lands; and (d) production of nutritious feed.

The energy potential of DAP is alarming. There are 84 million work animals, 70 million bullocks, 8 million buffaloes, one million horses, one million camels, and a large number of mules, donkeys, elephants, and yaks in India. If each animal produces 0.5 horsepower of energy then the total energy produced by animals would exceed 42 million H.P. or 30,500 MW which is equal to the total electric power generated annually by our country. DAP is highly significant in rural areas where transport is dependent on animal-drawn carts (our country has about 15 million animal-drawn carts). The advantage lies in the fact that carts can be used in all types of terrains as well Biofuels

Sources of Biofuels

Wood is used by man for direct burning to produce heat: by gasification to produce gas; by carbonization to produce charcoal; by pyrolysis to produce charcoal, gas, and oil; by hydrolysis and fermentation to produce ethanol, and by gasification and synthesis to produce methanol.

Many industries depend on wood for fuel. More than 50% of the human population uses wood for cooking and heating. The extensive use of wood for fuel is the basis of environmental degradation as a sequel to the removal of forests, The advantages of using wood for producing fire are:

(i) It is renewable and is available everywhere.

(ii) It can be easily harvested by unskilled labor.

(iii) 99% of it is combustible in the dry state.

(iv) It helps in the heating of large surfaces.

(v) It can be obtained from a wide range of species.

Good firewood should be highly combustible, have a high calorific value, be easy to dry, not split when ignited, be non-smoky, and be free from offensive odors. The hardwood (angiosperm wood) is generally better than softwood (gymnosperm wood). Hardwood produces uniform heat over a long period of time. However, softwood burns rapidly only for short periods producing intense heat momentarily.

Some good sources of firewood are Acacia nilotica (babul). A. senegal: Adina cordifolia (haldu), Albizia (siris). Anogeissus latifolia, Azadirachta indica (neem), Casuarina equisetifolia, Ceriops egal, Dalbergia sissoo (Sheesham), Gmelina Arborea, Heritiera minor (sundry), Hopea sp., Lagerstroemia speciosa sp., (jarul), Mesua ferrea, Quercus sp. (oak), Prosopis cineraria (Mukherji), Syzygium cumini (Jamun) and Terminalia tomentose. Some plants, though widely distributed but are not fit for fuel are Bauhinia (kachnar), Bombax ceiba (email), Mangifera indica (mango). Madhuca Indica (mahua), Michelia excelsa (champak), and Pinus roxburghii (Chir).

In addition to the use of firewood for cooking, it is also used for tea and snack stalls, restaurants, bakeries, cottage industries, and cremation. About 300 kg of firewood is required to cremate one dead body. According to one estimate, if 20,000 corpses are cremated each year in Delhi, about 6000 tonnes of firewood shall be burnt. The only way to reduce this loss of firewood is to use an electric crematory which is more efficient and reduces the extent of pollution in the environment.

Firewood Crisis

With the increase in human population, there is a rise in demand for fuelwood as well as additional land for agriculture to grow food. As a result, increased

deforestation causes soil erosion and silting up of dams. Thus, the power supply is also affected. To meet the shortage of firewood, people start using animal dung for fuel, which otherwise would have served as a good fertilizer for agriculture. Thus, food shortage becomes aggravated due to the poor fertility of soils.

Some major steps to meet the energy crisis are: (i) to grow more trees for fuelwood fi.e., to raise energy plantations, (ii) to increase the efficiency of wood-stoves through socially acceptable design., and (iii) to extract wood energy more efficiently through processes such as carbonization, pyrolysis, and gasification.

Energy Plantation

Energy plantation means plantation of trees which leads to the production of commercial fuel. The commercial trees help to increase the energy production and also raise the economy of the country.

The growing of trees for firewood is advantageous because solar energy can be stored continuously; minimum technology is required for raising trees; they are renewable, economical, and ecologically safe, and minimum manpower is needed to raise them.

The following precautions shall be taken to raise energy plantations:

i) To avoid the danger of loss of agricultural land for growing fuelwood, attempts should be made to grow trees for fuel on (a) farmer's land, (b) village common lands, (c) along both sides of roads, canals and railway tracks, (d) in degraded forests, and (e) on wastelands. By following these precautions, more than 30 m hectares of land can be made available in India without utilizing the land for agriculture and industries.

ii) The selection of tree species should follow the rule of social forestry wherein the forests are to be raised by communities of people based on multipurpose use of the plant such as for firewood, fodder, food, green manure, medicinal utility, and for food. Thus, we can say that forests are by the people and for the people.

iii) Attempts should be made to ensure maximum land use by cultivating fodder grasses mixed with food crops and fuelwood species. The potentiality of different species to grow in a specific habitat should be worked out before planting the species.

Some criteria for selecting species to be used for energy plantation are:

1) It should be a local one so that it would be better adapted to that environment.

2) It should be fast-growing and its samplings should get established easily on a certain piece of land.

3) It should have a high coppicing ability of regenerative potential. Coppicing refers to the thick growth of branches from the stump after the aerial branches are removed. Coppiced growth is generally faster than raising plants through seeds because the root system of the stump is well established.

4) The plant should be able to grow with minimum water and fertilizer requirement.

5) It should require minimum requirements from the soil, instead, it should add some nutrients back to the soil raising the soil fertility.

6) Attempts should be made to plant such saplings which can fix atmospheric nitrogen recycling.

7) The species grown in deserts should have lower rates of transpiration.

8) It should be resistant to pests and diseases.

9) Its wood should have a high calorific value and burn without adding harmful gaseous pollutants into the atmosphere.

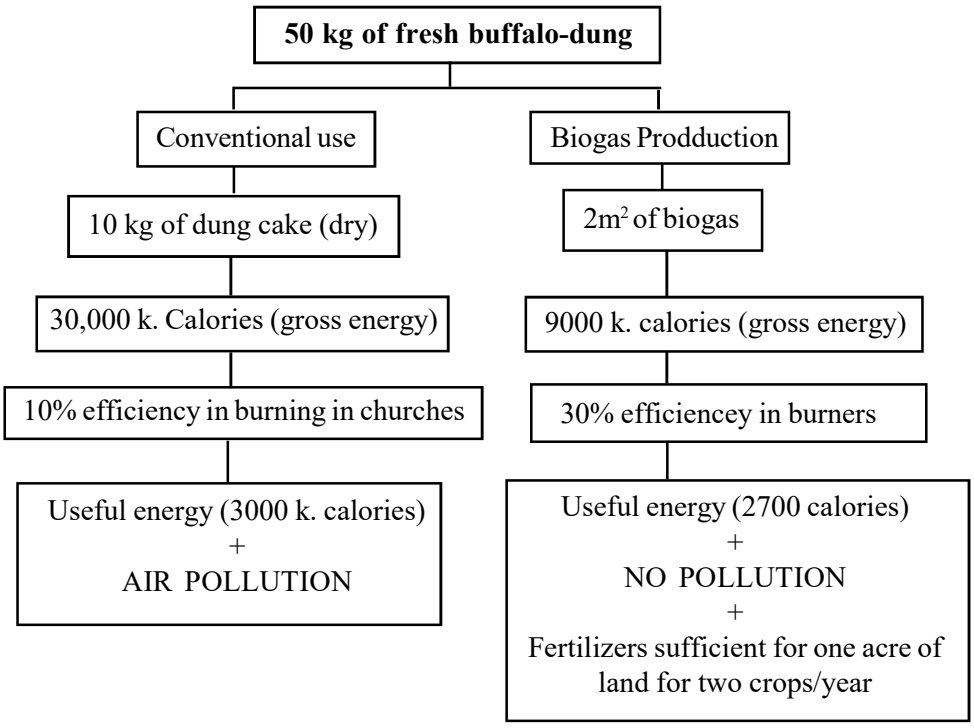
Annual waste biomass production in India

S. No.	Nature and source of waste	Estimated amount in Metric tonnes
1	Buffalo dung and urine	437.0
2	Cattle dung and urine	1225.0
3	Goat/sheep and urine	28.0
4	Human facces and urine (Night-soil)	304.4
5	City refuse	15.0
6	Other animal wastes	22.7

Waste materials can serve as a source of Bioenergy: Human activities related to agriculture, industries, and households lead to the production of large amounts of waste biomass.

Regional and Rural Economic Development

In rural areas of developing countries, it is a common practice to use animal dung for making dung cakes which are used for fuel. The dung can be put to better use if it is used to generate biogas (gobar gas and side by side a stabilized residue to serve as the fertilizer. The energy yield of biogas is lower than that of dung cakes but the efficiency of biogas burners is very high.



Biogas

The gas produced by the anaerobic fermentation of waste biomass is called biomass. It consists of methane (50-70 %), Co2, (30-40%), and traces of hydrogen, nitrogen, and hydrogen sulfide. The waste biomass to be used for biogas production may be represented by animal waste (dung and urine), poultry litter, sheep and goat droppings, slaughterhouse wastes, fishery and wool waste, crop residues (crop stubble, straw, fodder waste, cotton, and jute sticks, and weeds); human feces and urine; forest residues (twigs, bark, branches, leaves, and undergrowth); wastes from agro-industries (bagasse, bran, tobacco waste, seeds, wastes from vegetables and fruit processing, oil cakes, waste from sugar industry, tea and coffee wastes); aquatic plants e.g, water-hyacinth and algae; and urban solid wastes (paper, household residues and trash).

Anaerobic fermentation of residual biomass can be visualized in three stages: First, the complex polymers are broken down into simple monomers by the enzymatic action of the facultative anaerobic micro-organisms. Cellulose, hemicellulose, proteins, and lipids are degraded, but lignin and inorganic salts remain as residues. In the second step, the monomers are converted to organic acids by microbial activity under

partially aerobic conditions and finally to acetic acid. In the final stage, anaerobic methanogens oxidize the acetic acid to methane. Cellulose degradation is the slowest process and if the waste is rich in cellulose then the biogas production rate becomes very low. In the final stage, anaerobic methanogens oxidize the acetic acid to methane. Cellulose degradation is the slowest process and if the waste is rich in cellulose then the biogas production rate becomes very low. Using waste biomass for biogas production is more beneficial than using it directly as fuel or fertilizer for the following reasons:

1. Biogas can be easily stored to provide an energy source. quantity more efficiently.
2. Besides cooking it can be used for many different purposes.
3. The by-product of this process is a stabilized residue that is used as a good fertilizer.
4. It reduces the growth of pathogens in feces due to the absence of contact waste. Therefore, it is important to improve sanitary conditions.
5. It also reduces the risk of pathogen spread in field conditions, thereby minimizing disease incidence year after year.

Substitutes of Petroleum and Oil

As we face the threat of depletion of petroleum products, we must seriously look for alternative energy sources. Forest biomass also is an important resource for producing bioenergy and reducing greenhouse gas (GHG) emissions. The GHG savings potential of ethanol over gasoline was also modeled (Zhang, et al., 2018). M. Calvin was the first to recognize a group of petroleum plants (whose products can be used in place of petrol and oil). Most of these plants belong to the families Euphorbiaceae, Asclepiadaceae, and Apocynaceae. These plants convert a significant amount of photosynthates into latex. The liquid hydrocarbons in the latex can be used to serve as a liquid fuel that can replace the fuel needs of automobiles either mixed with petrol or as entire fuel.

Alcohol as Fuel

Petroleum-based fuels and petrochemicals can be harmful to the environment and are major surface and groundwater pollutants. Biofuels such as ethanol and biodiesel, are less toxic and are biodegradable. In many of the country, alcohol is being used as automobile fuel. The petrol engines burn the gasohol to generate power to run the automobiles. Crops that can be used to produce ethanol are called energy crops. Some of them are potatoes, sugarcane, sugarbeet, corn, tapioca, and molasses.

The Alcohol Yield of Energy Crops

S. No.	Energy crop	Average Yield of Economic Product tonnes/hectare	Alcohol Production	
			Litres/tonne	Liters/hectare
1	Maize	03.50	350	1225
2	Molasses	02.50	565	60
3	Potato	15.00	15.00	1650
4	Sugarbeet	20.00	90.00	1800
5	Sugarcane	56.00	70.00	4000

Conclusion

The use of bioenergy has the potential to significantly reduce our greenhouse gas emissions. The replacement of fossil fuels with energy from biomass has a number of obvious environmental impacts. If biomass is harvested at a sustainable rate, using it for energy will not lead to a net increase in atmospheric carbon dioxide, a greenhouse gas. Raw materials for biomass production, biomass conversion, biofuel transport and biofuel use are essential steps in the biofuels and bioenergy industries and each step still requires many efforts. As a widely available clean and renewable energy source, biofuels and bioenergy are expected to play an important role in achieving the targets of reducing demand for petroleum products. mine as a viable alternative and reduce greenhouse gas emissions in the long term. Countries have played a leading role in protecting the environment by reducing greenhouse gas (GHG) emissions, and states' emissions are substantial globally. CO_2 and CO are the main greenhouse gases associated with global warnings. Today, coal is responsible for 30-40% of global CO_2 emissions from fossil fuels. SO_2 and NO_2 contribute to acid rain. Carbon footprints can play an important role in strategies to control carbon dioxide emissions while increasing incomes.

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