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Sustainable Energy Resources from Chicken

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ABSTRACT

The energy sector is one of the most important sectors in the nation. This sector has contributed to the development and economic well being of the country. But power generation is a difficult task without causing environment pollution. Non-renewable energies like coal, atomic energy and hydrothermal are the current scenario in power generation. Even, when fossil fuels burn they leave by-products that damage both the environment and health, causing misery for millions of people. Currently, science and technology establish novel methods on waste recycling, which provides the way to study the utilization of animal wastes for biogas with low level emission of carbon pollutants and energy production. It putforth some novel ideas on the production of electric energy from chicken litter and biodiesel production from its feathers which has high impact value on renewable bioresource management. This segment of the energy market is likely to grow rapidly and utilities will adapt to the opportunity with challenges. The future of day-lighting as a renewable energy resource applied in buildings is, therefore, very promising and eventually, it assures 100% energy production process with less expensive and helps in high environmental protection.

Key words: Renewable energy resource, chicken litter, biogas and energy production, environment protection

INTRODUCTION

Energy sector is a vital sector for the economic and social development of a country. The Central Electricity Authority has estimated that India would need a total installed capacity of 212000 MW by 2012 (Eleventh National Power Survey) i.e., the need for creating additional capacity of 1,00,000 MW by 2012. But now we are facing lack of non-renewable resources like coal, petroleum reserves. Renewable energy sources offer viable option to address the energy security concerns of a country. There is a significant potential in India for the generation of power from renewable energy sources like wind, small hydro project, biomass and solar energy. But we should keen about its adverse effect on environment when used as renewable sources. Greater reliance on renewable energy sources offers enormous economic, social and environmental benefits (Joseph and Selvanayagam, 2001). Over the last four decades there has been rapid growth in livestock production in India as shown in Fig. 1 and a rapid change in how animal products are consumed as in Fig. 2.

Growth in livestock production in both developed and developing countries has been led by poultry (Clare *et al.*, 2007). This results in the increase in the production of poultry wastes like

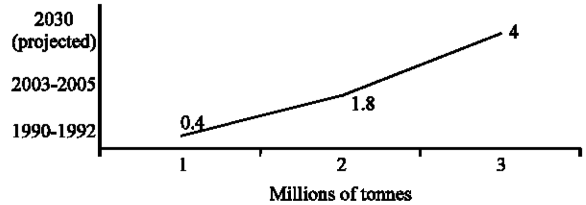

Fig. 1: Poultry meat production from 1990-2030 (projected)

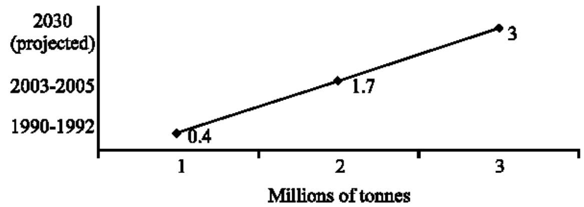

Fig. 2: Poultry meat consumption in India. Source: Figure 1 and 2- FAOSTAT accessed on October 2007. Projections to 2030 are from IFPRI's International Model for Policy Analysis of Agricultural Commodities and Trade (IMPCT) model projections, October 2007

chicken litter and feathers. It may results in air pollution, soil pollution and pollution of water (Joseph *et al.*, 2010). This study is looking for energy production from pollutants based on ecofriendly manner.

POULTRY LITTER

Poultry litter consists of bedding material mixed with manure, feathers, spilled water and waste feed accumulated during the production cycle. The bedding material, primarily have high carbon content biomass and this contributes to the energy content of litter (Reardon *et al.*, 2001). Materials used include straw, sawdust, wood shavings, shredded paper and peanut or rice hulls (Kelleher *et al.*, 2002). Because of its high plant nutrient levels, it is a valuable organic fertilizer providing plant nutrients such as nitrogen (N), phosphorus (P) and potassium (K). Applying poultry litter residues to crop soil will increase organic matter and as a result the soil's water-holding capacity and improve soil tilth. However, one of the main risks related to agricultural field is the imbalance of N and P in poultry manure. These two nutrients in poultry litter are not in the same proportion as needed by crops (Edwards and Daniel, 1992). A soil analysis is important to determine the appropriate balance of N-P-K and Ca for the desired crop and although poultry litter contains many of the valuable macronutrients found in expensive commercial fertilizers, the NPK ratios may not be ideally suited to the soil nutrient needs (Reardon *et al.*, 2001). Chemical and physiochemical characterization of poultry manure are summarized in Table 1 (Guerra-Rodriguez *et al.*, 2001).

ENERGY GENERATION FROM POULTRY LITTER

Biogas production: The anaerobic digestion of organic wastes leads in the generation of biogas, which contains of approximately 60% CH_4 and 38% carbon dioxide (CO_2) (Smith, 1980). The remaining 2% is water vapor, NH_3 and hydrogen sulfide. CH_4 has a range of possible uses as an energy source, but it has primarily been used by direct burning for heat or as fuel for internal combustion engines (Hashimoto *et al.*, 1980). Possible uses for the digester effluent include fertilizer

Table 1: Chemical and physiochemical characterization of poultry manure.

Solid poultry manure	Value
Organic matter content (% dry matter)	85.38
Moisture (% Wet wt)	48.69
Total nitrogen (% dry wt)	3.56
Inorganic nitrogen (% dry wt)	1.74
Ammonia nitrogen (% dry wt)	1.76
pH	8.8
P_2O_5 (% dry wt)	0.71
K_2O_5 (% dry wt)	3.79

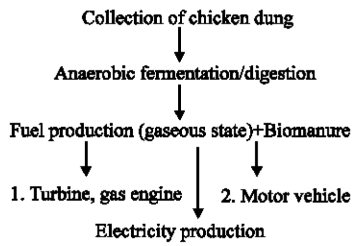

Fig. 3: Chicken waste to fuel conversion system

and feed supplement for animals, although the nutritive value of the effluent is dependent on the digestion system and operation method (Lacey *et al*., 1980) as well as the method of collection (Hashimoto *et al*., 1980). Studies of biogas generation by anaerobic digestion of a number of animal wastes, including poultry waste, points that several variables influence biogas generation. A number of researchers have described the method of digestion systems for poultry manure (Converse *et al*., 1977, 1980; Yang and Chan, 1977; Rockey *et al*., 1978; Jantrania and White, 1985; Safley *et al*., 1985; Mahadevaswamy and Venkataraman, 1986; Shih, 1988). Most of these systems were designed to operate in the mesophilic range (approximately 35°C), as recommended by Smith (1980) for on-farm systems (Fig. 3).

Net energy produced during digestion has been reported to range from approximately 60% (Converse *et al*., 1980) to 75% (Morrison *et al*., 1980) of gross output. While the theory of biogas generation is well established, there have been several reports of operational difficulties accompanying anaerobic digestion of poultry manure, which must be diluted for hydraulic transport. The major problems include mechanical aspects such as mixing, screening, pumping and plumbing (Sweeten, 1978), formation of scum (Converse *et al*., 1977; Rockey *et al*., 1978), grit accumulation (Safley *et al*., 1985) and others. In addition, the equipment is not simple (Fontenot *et al*., 1983) and the digesters must often be operated without skilled technicians (Smith, 1980). These problems may influence the economic feasibility of biogas generation. Barth and Hegg (1979) state that biogas production is economically justifiable when the digestion systems operate at design capacity, but found that none of eight plants they visited was operating at capacity. The primary reason cited was operators' lack of familiarity with the technology; when confronted with a problem, the digestion system was simply shut down (Edwards and Daniel, 1992).

Mass burn combustion: Chicken litter is one of the wastes comes from the Chicken poultry farms (Zaigham and Nayyer, 2005) that constitute a complex source of organic nutritive ingredients with

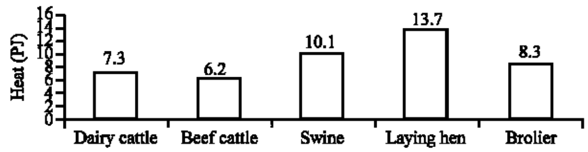

Fig. 4: Comparison of heat energy production of different animal wastes with Chicken wastes(Junichi, 2005)

environmental effects. These wastes can be used to make the energy generation. Percentage of heat energy of produced by the Laying hen and Broilers are more than other farm cattles (Fig. 4).

The most effective and successful conversion of poultry litter to energy involves the use of mass burn combustion and, in particular, step-grate combustion systems (Kelleher *et al.*, 2002). The wastes can be burnt in purpose-built incinerators. The heat can then be used to produce electricity, or to provide heating for the buildings. Advanced technologies can be employed to ensure that the waste gases emitted from these facilities will reduce the environmental risk.

In Britain, the Thetford Power Station in Norfolk utilizes the chicken litter waste from local chicken farms. This usefully disposes of about 400,000 tonnes/year of poultry litter to produce 38.5 MW of electricity (Zaigham and Nayyer, 2005). Fibropower officially opened their poultry litter- fired power plant, thought to be the first commercial plant of its type in the world, at Eye in Suffolk UK in November 1993. The plant generates a gross output of 14 MWe. After in-house use of electricity, a net output of 12.5 MWe is supplied to a 33 kV power line for distribution through local electricity networks. The poultry litter itself comes from barn reared broiler hens and is a mixture of wood shavings, straw and chicken droppings. The wood shavings and straw improves the burning process and permits control of the moisture content. The high calcium content of the litter produces a self-cleansing effect and reduces the need to introduce calcium as a cleaning agent for gaseous emissions. The release of odours from the storage facility is minimized by the use of negative pressure. Fuel is fed into a boiler through a stepped-grate system, which ensures that the material has a residence time of 2 sec at 850°C there by killing pathogens and preventing the emission of odour. The system is operated by automatic cranes that mix the Chicken litter and load to elevators. The fuel is then pumped through the furnace by the step-grate system. Then, the Electrostatic precipitator used to minimize the dust emissions (Staff, 2000).

Fluidised bed combustion: In fluidized bed combustion is devise contains three main types of fluidised beds, bubbling, turbulent or circulating bed types. All designs consist of a bed of sand in a refractory-lined chamber through which primary combustion air is blown from below. Adjusting the airflow fluidises the sand particles. Cyclones are placed within the freeboard to re-circulate the sand to the bed. Annamalai *et al.* (1985) investigated the direct combustion of poultry litter in a fluidised bed combustor. The fluidised bed reactor facilitates the dispersion of incoming fuel, where it is quickly heated to ignition temperature and provides sufficient residence time in the reactor for complete combustion. Fluidised beds are compact and have high heat-storage and heat transfer rates and thus allow faster ignition of low combustible waste to recover the heat (Williams, 1999). Using poultry litter as an energy resource (combined heat and power), combustion studies of poultry litter on its own or mixed 1:1 with peat were carried out in an atmospheric bubbling fluidised bed (Abelha *et al.*, 2002). The high moisture content of chicken litter provided uncertainty as to whether combustion could be sustained on 100% chicken litter therefore, a mixture with peat was considered to help improve combustion. The study found that as long as the moisture content of chicken litter is kept below 25%, the combustion will not need the addition of peat. Leachability tests were carried out with the ashes collected to verify whether or not they could safely be used in agricultural lands. The results showed little tendency to leach. These studies illustrate that fluidised bed technology can be used for the direct combustion of poultry litter. The minimization of moisture content at low cost is obviously desirable and worthy of investigation for all combustion techniques. The manipulation of diet to lower the moisture content of poultry litter may be an approach worth considering. One such investigation was carried out by Svihus *et al.* (1995). High moisture barley, which is sometimes included in the feed given to broiler chickens in Norway, was stored under different conditions to study the effect on the digestive tract and, consequently, the moisture content of the poultry manure. The barley was preserved anaerobically by ensiling using different additives, aerobically with propionic acid, or by drying (Kelleher *et al.*, 2002).

BIODIESEL

Chicken feather meal, a mix of processed chicken feathers, blood and innards, is one of the nastiest by products of the poultry processing industry. A new study from scientists at the University of Nevada indicates that the feather, blood, innard might be better suited as a non-food based feedstock for biofuels. The biodiesel process, which involves extracting fat from feather meal with boiling water, has the potential to generate 153 million gallons of biofuel in the US and 593 million gallons of biodiesel worldwide based on the amount of poultry waste produced each year. According to the researchers, feather meal biofuel is of comparable quality to other popular biofuel feed stocks (Biodiesel on the Wing, 2009).

BENEFITS

Poultry litter is a renewable energy resource. Displacement of fossil fuels used in heating, lighting and ventilation of poultry houses with gas and electricity of poultry litter from an on-farm litter-to-energy scheme have a great impact on environmental, societal and economic benefits. This farm-scale litter to energy scheme, would give poultry growers an alternative litter management with favorable economics.

The current utility grid mix in Arkansas has less than 2.7% non-hydroelectric renewable energy and more than 78% of the grid mix is supplied by fossil energy. Implementation of a farm scale litter-to-energy scheme in Missouri could result in more than 80% increase in the renewable energy fraction of this state. The total annual energy supplied to 9600 broiler houses and 2700 market turkey houses in Arkansas was 253,000 MWhe (0.6% of the utility grid energy) and ~62 Million gallons of LPG equivalent (assuming 5,000 gallons/house). Supplying all the poultry houses with litter-derived renewable energy would result in a 20% growth in (nonhydro) renewable energy forhe state and result in a conservation of 62 million gallons of fossil derived LPG fuel (Reardon *et al.*, 2001). Bitzer and Sims (1988) reported that excessive application of poultry litter in cropping systems can result in nitrate (NO_3) contamination of groundwater. High levels of NO_3 in drinking water can cause methaemoglobinaemia (blue baby syndrome), cancer and respiratory illness in humans and fetal abortions in livestock (Stevenson, 1986). These all can be reduced by this application.

CONCLUSION

Chicken litter have a great capacity to pollute water, land and air and also helps in the production of green house gases (CH_4 and N_2O) leading to global warming (Monteny *et al.*, 2006).

So in order to reduce these issues we should adopt some novel techniques which is ecofriendly. Energy production from litter has great importance in this. By practicing this technique we could reduce green house gas emission from chicken litter which will give benefits to environment and the power generation will help us to maintain economic stability and the reduction of odour will gave benefits to society too.

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