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Utilization of rice husk and poultry wastes for renewable energy potential in Pakistan: An economic perspective

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ABSTRACT

The present work reports the potential of rice husk mixed with poultry waste as an alternative source to generate energy. The rice husk and poultry waste have substantial potential for the production of power and energy. The energy obtained from this process is renewable energy which is considered environment-friendly. Using this technology, the timber used as fuel in the power plants can also be saved from its depletion. The studies show that two types of benefits can be obtained from such technology that is power generation and cleanliness of the environment. Benefit gains in the first year are less due to the fixed installation cost of the biogas plant but afterwards the benefit gains are larger. The benefit-cost analysis shows that the installation of biogas plant using rice husk with poultry waste is feasible in Pakistan. In anaerobic fermentation process biogas is produced in the absence of oxygen. The by-products such as bio-slurry produced during the anaerobic fermentation process can be utilized as fertilizer to enhance the soil fertility and reduce the import bills of synthetic fertilizers. The generation of renewable energy by using rice husk and poultry waste is economically feasible, socially sound and environment-friendly.

Contents

1. Introduction

Energy is one of the essential components of life but the crumbling of environment not just makes unsteadiness between the harmony of human anthropogenic framework and the green range additionally makes deficiency of ecological assets [1]. The environmental resources are ordered in two sorts; renewable and non-renewable [2,3]. There are numerous harmful elements that influence the environment in the form of greenhouse effects. A greenhouse gas (GHG) ingests and emits radiation within the warm infrared range [4]. Recently, the advancement of renewable

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Table 1
Resource availability of agriculture field residues in Pakistan [33].

Crops	Production (million tons)	R/P ratio (fraction)	Total residue	Residue collected (million tons)	Energy content (PJ/million tons)	Potential (PJ)
Cotton	2.21	2.76	6.10	2.14	14.65	31.28
Rice	5.56	1.76	9.76	3.42	13.80	47.15
Maize	3.11	2.00	6.22	2.18	17.20	37.44
Gram	0.48	1.60	0.77	0.27	15.91	4.27
Total	11.36	8.12	**22.85**	**8.00**	61.56	**120.15**

energy resources has been accelerated in response of environmental issues, and energy safety. The use of renewable energy does not cause any addition of carbon dioxide in the climate rather than the fossil fuels [5]. The fundamental methods through which energy can be got from biomass consists of trans-esterification, pyrolysis, liquefaction, gasification, hydrogasification, anaerobic and alcoholic fermentation and immediate burning. The advantages of every technique depend on the required type and the source of energy [6,7].

The history of biomass potential for biogas plants belongs to old Persia and China. It was noted that spoiling vegetables produce combustible gas. During thirteenth century the Chinese were utilizing covered sewage tanks to generate power. In 1859, the first biogas plant was assembled at Bombay in the Indian Sub-Continent to process the sewage [8]. Biogas refers to the gas processed by the organic breakdown of organic matter without oxygen (anaerobic fermentation). Biogas is the result of food chain in which the sun's energy is trapped by green plants that are consumed by the domesticated animals as fodder to generate energy, fats, carbohydrates and proteins that the animals' body uses [9]. The waste-items that are discarded hold a mess of carbohydrates and other food supplements and fibers, which are the major source of methane produced during the process of dung-fermentation by anaerobic fermentation of microorganisms [10].

In developing countries, cookers/stoves, lamps, refrigerators and engines are appliances commonly fueled by biogas [11]. Biogas can be converted into electricity using a fuel cell, though this is still considered a research area due to the need for very clean gas and the cost of fuel cells [12]. In contrast, using biogas to fuel a combustion engine and in turn an electric generator is a proven means of producing electricity, given the wide availability of suitable generators. For example, in Pura, India a well-studied community biogas digester was used to fuel a modified diesel engine and run an electrical generator [13]. Renewable energy (RE) sources are the fastest growing energy source in the world and various projections indicate that these resources will have huge contribution in the future [14,15]. Pakistan mainly depends upon the conventional energy resources and there is not much effort for the utilization of RE resources for electricity generation. Due to over dependence on fossil fuel, presently more than 60% of the foreign exchange is spent for the import of energy [16,17].

Fig. 2 presents the historical trend of rice production for the last 45 years. As it can be seen clearly, an increasing production trend that can be correlated with the world's increasing population is depicted in the graph. The calculated trend for quantity of rice husk represents an increase of around 1.5% per annum [18,19].

Pakistan has enormous biomass resources such as crop remains, dung and feces, poultry waste, sugarcane bagasse and wood that have health and other ecological risks [20]. Being the source of energy, the potential of rice husk might be measured as follows: 1 ton of rice paddy produces 220 kg of rice husk; 1 ton of rice husk is equivalent to 410–570 kW h electricity; Calorific value is 3000 kilocalories per kilogram; moisture content is 5–12%.

Currently in Pakistan, rice husk is specifically burnt in plants in the boilers making the air contaminated [21]. There are numerous

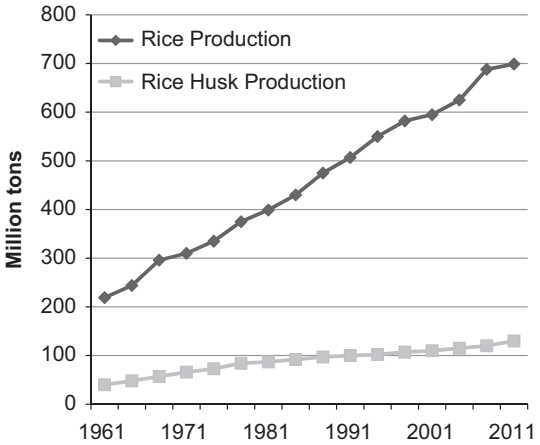

Fig. 1. Historic trend of the world rice production and the calculated rice husk output graphed based on [18,19].

issues while utilizing rice husk as it is exceptionally troublesome to store it and handle it. It has vast volume, so there is need to compact rice husk and then to use it [22]. Several researchers studied the renewable energy and power generations for example see [23–30], all of them discussed and resulted renewable energy potential, opportunities and usage in one or another way. Poultry waste is a perfect subtract to prepare biogas. Poultry farms produce significant amount of poultry-waste that is dumped out in the open, initiating contamination in the environment [31]. Keeping in view the critical situation of energy shortage worldwide, there is need to explore renewable energy sources to utilize waste disposal by using 3Rs mechanism (reduce, reuse and recycle) [32]. For the estimation of future potential of field residues, the average yield and area under crops in case of rice, maize and cotton for the period 2009–2025 has been projected based on available data [33–37]. For the remaining period, these values have been projected on the basis of 15 years (2010–2025) average annual growth rates of yield and area under crops of these respective crops. In case of gram, the area and yield has been projected on the basis of average annual growth rates of the 10 years (1998–2007). The projected area for the different crops and the average yield for the period (2005–2050) are given in Table 1. Moreover, rice production and rice husk production of world is shown in Fig. 1. This also confirms that rice husk production is significantly more than other crop's residues and hence, it must be utilized in order to generate renewable energy to cope with energy crisis.

This paper presents the feasibility of proper use of rice husk mixed with poultry waste. Rice husk mingled with poultry waste to generate energy are used not only to generate sufficient power but also used to conserve the environment as well by conserving non-renewable fossil fuel resources and reducing the environmental impacts of trash disposals. The main objective of this study is to investigate the potential of biomass (rice husk and poultry waste) as a source of renewable energy and to estimate the