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ASSESSMENT OF TECHNO-ECONOMIC FEASIBILITY OF A SOLAR-POWERED SHREDDER FOR AGRICULTURAL WASTE

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Abstract

This study evaluated the techno-economic feasibility of a solar biomass shredder and determined its capacity, shredding efficiency, and power consumption. Agricultural waste (wheat and paddy straw) were selected and shredded at three rotational speeds (RPM) (1500, 2500, 3500) and five moisture contents (MC) (6%, 8%, 10%, 12%, 14%) to evaluate shredding efficiency. Wheat was shredded at additional MCs of 16% and 18%. Optimum shredding efficiencies were achieved, with values exceeding 95%, and maximum capacities of 60.39 kg/h and 55.61 kg/h were obtained at 6% MC and 3500 RPM for both waste. The highest power consumption was found to be 1.86 kWh and 2.2 kWh/h at 18% MC and 3500 RPM for wheat straw and at 14% MC with 3500 RPM for paddy straw, respectively. Maximum bulk density was observed at 18% MC and 3500 RPM for wheat straw (47.3 kg/m^3) and 14% MC and 3500 RPM for paddy straw (53.14 kg/m^3). Particle size distribution was also studied for shredded crop waste through sieve analysis. Maximum average lengths were recorded at 1500 RPM, measuring 76.73 mm at 18% MC for wheat and 71.78 mm at 14% MC for paddy straw. The payback period and benefit-cost ratio of the shredder were found to be 2.86 years and 7.0, respectively. The solar biomass shredder offers a promising solution for the sustainable management of agricultural waste, as it is considered the main step for benefiting from crop waste for purposes such as feeding livestock, composting, and biofuel production. It not only promotes eco-friendly and efficient farming but also supports farmers in achieving economic stability.

Key words: agricultural waste, cost-economics, shredding efficiency, solar-biomass shredder

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