Sher-e-Bangla Agricultural University

SDG Activity Report
on

SDG 7:
Affordable and Clean Energy

Contents

Thermochemical and physical characterization of agricultural biomass for sustainable energy in Bangladesh

Author: Debu Kumar Bhattacharjya,

Year: 2024

Abstract: The United Nations Sustainable Development Goals (SDGs) prioritize affordable, clean energy solutions to tackle global issues like poverty, climate change, and environmental degradation. In Bangladesh, agricultural biomass residues present a renewable and underutilized alternative to fossil fuels. This study systematically characterizes the thermochemical and physical properties of key agricultural residues—rice husk, rice straw, wheat straw, sugarcane bagasse, jute stick, dhaincha, and water hyacinth—to assess their potential for sustainable energy production. Key analyses include higher heating value (HHV), proximate composition (volatile matter, fixed carbon, ash), and elemental makeup. Volatile matter content ranged from 71.52 % in rice husk to 90.83 % in sugarcane bagasse, while fixed carbon varied between 7.00 % in sugarcane bagasse and 16.45 % in dhaincha. Ash content was highest in rice straw (15.05 %) and lowest in sugarcane bagasse (2.17 %). The HHV ranged from 19.65 MJ/kg for dahincha to 11.95 MJ/kg for water hyacinth, highlighting dahincha's high energy potential. However, elevated potassium in rice straw (1.62 %) and water hyacinth (2.84 %) suggests risks of slagging in thermal conversion systems. These findings underscore the value of region-specific biomass data in informing energy policy and advancing renewable energy initiatives. By identifying high-potential feedstocks and conversion needs, this study supports targeted biomass applications, contributing to cleaner energy solutions and reduced dependency on fossil fuels. Advanced conversion technologies and ash management strategies are recommended to optimize the energy efficiency of these residues, particularly in regions with abundant agricultural waste. The insights provided serve as a foundation for sustainable biomass utilization in Bangladesh, with potential replicability in other agrarian countries facing similar energy and environmental challenges.

Determinants of household adoption of clean energy with its rural–urban disparities in Bangladesh

Author: Iqramul Haq, Maruf Khan, Sharanon Chakma, Md. Rayhan Ali Rejvi, Md Mizanur Rahman Sarker

Year: 2024

Abstract:
This study aims to investigate factors influencing the adoption of clean energy among households in Bangladesh, using Blinder-Oaxaca decomposition and extended probit regression model with data from the 2019 Bangladesh multiple indicator cluster survey. Small households, primarily Muslim and urban dwellers, who speak the Bengali language and are Internet and mobile users, were likelier to adopt cleaner fuels than their counterparts. On the contrary, households residing in the Barisal, Khulna, Rajshahi, and Rangpur divisions, belonging to poor and middle-class

households, with household heads aged 15–64 and without formal education, were less likely to adopt cleaner fuels than their counterparts. The concentration curve revealed socioeconomic inequality in the adoption of clean energy, particularly favouring richer households in urban and rural areas. Further analysis using the Blinder-Oaxaca decomposition showed that urban residents showed a higher probability of adopting clean energy, with a significant difference of 0.508 compared to rural areas. Regarding the endowment effect, poor wealth quintile contributed the most, followed by the ownership of rented dwellings and the middle wealth quintile. The Bengali differential effect made the largest contribution to this aspect of the disparity, followed by the exposure of the Internet and the influence of the Dhaka and Chattogram divisions. The detailed analysis provides valuable insights for policymakers and practitioners on the issue of disparities in the adoption of clean energy between urban and rural areas in Bangladesh.

Impact of contemporary management practices in pond fish farming on the socio-economic condition of fish farmers in north-central Bangladesh

Author: Koushik Chakroborty, Jahid Hasan

Year: 2024

Abstract:
Aquaculture in Bangladesh has greatly improved diet structure, ensured food safety, and facilitated the transformation of fisheries growth mode. The study aimed to investigate the existingmanagement techniques of fish farming in ponds and assess its impact on the socioeconomic status of fish farmers in the Trishal upazila (sub-district), Mymensingh, a region in north-central Bangladesh, from January to June 2023. Data were collected using a well-structured questionnaire. The majority of farmers (62.50%) had ponds that were 0.5-1.0 ha in size. Over half of the farmers (52.50%) practiced monoculture, with catfish comprising 37.13%. The average stocking density was 50,000-65,000 fry ha-1 With conventional post-stocking management, the majority of farmers (90%) utilized probiotics, and 87.50% used vitamins and minerals. Around 90% had formal education, and most individuals resided in standard housing. All participants had access to electricity and potable water, 96% had adequate sanitary facilities, and 95% of the farmers had proper healthcare facilities. Half of the farmers (50%)
were involved in fish farming as their primary occupation. Most farmers (75%) earned an annual income ranging from 700 to 1,300 USD, and a significant 90% invested their own funds into fish farming. More than half of the farmers (55%) received technical assistance from their neighbors. Fish farming in the region has intensified, and the existing management practices have led to enhanced production, thus benefiting the livelihoods of the fish farmers. However, achieving long-term sustainability necessitates a supply of high-quality fry, cost-effective and high-quality feed, comprehensive training, and effective marketing strategies.

Actualizing the worldwide distribution and main uses of Parkinsonia aculeata L., Sp. Pl

Author: Mirza Hasanuzzaman

Year: 2024

Abstract: The palo verde (Parkinsonia aculeata L. Sp. Pl.) (Ulibarri 2008), although it is native to a semidesert region, it has been distributed throughout various regions worldwide, adapting to favorable and unfavorable environmental conditions. Starting from isolated, although abundant, studies on this species and its uses, an investigation was carried out with the aim of actualizing the international distribution and its main uses. The findings showed that palo verde is distributed on all continents, with a greater presence in America, Africa, and Australia. The palo verde can be found above sea level from 8.6 to 1310 m. Palo verde adapts to heat, drought, salinity, and waterlogging but is sensitive to cold conditions. There is only a single find from its habitat in North Asia. The main international uses of palo verde are natural reserve, medicinal, industrial, biocontrol and biofuel applications. Only in India and Mexico are these six uses given, together with their use as biocontrol agents of plant diseases, in Mexico. Most countries use verde nuts as natural reserves and medicinal and biofuel fines. Among the uses for medicinal purposes, the most diverse is to reduce diabetes mellitus.

Unlocking high-value products from diatoms via biorefinery processes for a sustainable biocircular economy

Author: Antara Ghosh, Roksana Jahan

Year: 2024

Abstract: As a repository of valuable pigments, fatty acids, and proteins, microalgae, particularly diatoms, make promising foundations for bioprospecting of biomedical, nutraceuticals, biofuel, feed, and food. Therefore, they are considered as next generation biomass. The necessity to valorize these biomasses is essential to bolster the economic feasibility of their industrial production through diverse biorefinery processes. The capacity for conducting multiple extractions concurrently offers prospects for obtaining various metabolites, biogas, and biofertilizers from diatom biomass. This unique feature significantly enhances the economic sustainability of diatom-based biorefineries. An effective biorefinery approach is highly desirable as it has the capability to fully capitalize the potential of diatoms. This chapter offers insights into the inherent value of diatoms and outlines the scenario of biorefinery processes aimed at realizing a sustainable biocircular economy. This information could serve as a solid foundation for making well-informed and profitable decisions in the realm of diatombased bioproducts, thereby contributing to both economic success and sustainability.

Energy potential of biomass from rice husks in bangladesh: An experimental study for thermochemical and physical characterization

Author: Debu Kumar Bhattacharjya

Year: 2024

Abstract: Rice husks, abundant leftovers from rice production, offer immense potential as a renewable energy source through thermochemical conversion processes. However, their efficient utilization hinges on understanding their unique thermal properties and reaction kinetics. This study addresses a critical gap by meticulously analyzing four prominent Bangladeshi rice husk varieties: BR22, BRRI Dhan46, BRRI Dhan47, and BRRI Dhan49. Through rigorous experimentation, we unveil a comprehensive dataset encompassing their physical, chemical, and thermochemical characteristics. Our investigation reveals favorable alignment of moisture content with various conversion technologies, alongside suitable bulk density for efficient handling. Proximate analysis sheds light on crucial components like ash, volatile matter, and fixed carbon, vital for optimizing combustion efficiency. Furthermore, elemental analysis not only highlights the presence of ash-forming elements but also assures low nitrogen and sulfur content, suggesting potential environmental benefits compared to conventional fuels. Delving into thermochemical characteristics, we measured higher heating values ranging from 13.31 MJ/kg to 14.42 MJ/kg, confirming the viability of these rice husk varieties for energy conversion. Thermogravimetric and kinetic analyses further illuminate their unique decomposition behavior, with BRRI Dhan47 exhibiting the highest decomposition rate, emphasizing the distinct reactivity profiles of different varieties. This extensive dataset empowers researchers and industry professionals with valuable insights for informed decision-making. By understanding the unique attributes of each rice husk variety and their behavior during conversion, we can optimize operational parameters for various thermochemical methods. Ultimately, this study bridges a critical research gap and paves the way for more efficient and sustainable utilization of rice husks as a renewable energy source, contributing to a greener future.

Techno-economics and environmental sustainability of agricultural biomass-based energy potential

Author: Nazmin Sultana,

Year: 2024

Abstract: This paper explores the viability of utilizing agricultural biomass-based energy potential, employing mathematical, engineering, and economic modeling techniques. Moreover, the potential of a biogas-based co-digestion (CD) system, integrating its techno-economic performance and environmental sustainability in terms of electricity generation, has also been studied. In this investigation, the categorization of 25 different plant species into two groups: arable field crops (AFCs) and horticultural plants (HPs), was performed. Data was collected during the 2021-–2022 cropping season in Bangladesh from various sources, including literature reviews, governmental, and non-governmental organizations. The findings revealed that the available agricultural biomass residues, totaling 1,02,585.75 KT, have the capacity to generate 1,33,815 million m3/year of biogas. This energy potential corresponds to 291,125.85 TJ/year or 9231.60 MW of electricity, which can fulfill 88% of the national total energy demand. In terms of levelized cost, the proposed approach is more competitive and shows a greater promise compared to other technologies. Furthermore, it demonstrates environmental friendliness by reducing CO2 emissions by 156 tons at a cost of $7/ton while earning $1092 annually from the potential carbon-credit market. This approach presents a potential solution to address Bangladesh's energy crisis. The payback period of the system ranged from 2.93 to 3.75 years, with and without the inclusion of a slurry, respectively. The recommended methods hold significant promise for meeting national energy demands. A case study was provided as a proof-of-concept (PoC) to validate the approach. This study is the first of its kind, providing valuable insights into the renewable energy potential in Bangladesh. The results will assist policymakers in formulating sustainable energy policies.

Managing Natural Resources Through Innovation: The Importance of Sustainable IoT-Based Models—The Smart Solar Dryer

Author: Md. Masud Rana

Year: 2024

Abstract: Many developing countries are use traditional methods of fish drying, which might lead to inferior quality products because of unsanitary conditions and environmental concerns. By using IoT and solar energy to create a regulated drying environment, the smart solar dryer solves these problems. By controlling temperature and airflow, an Internet of Things controller maximizes drying process effectiveness and quality. The smart solar dryer is a flexible solution for a range of situations and needs since it can be adjusted to operate at varying scales, from bigger commercial facilities to small-scale artisanal fish drying. According to preliminary findings, fish can successfully have their moisture content reduced by the smart solar dryer, producing dried goods of superior quality. 500 kg of fish must be dried in 30 h in order to lower the moisture content from 88%. Products are of far higher quality in terms of color, flavor, and texture than the traditional ones. According to preliminary results, this recently created environmentally friendly technique may greatly enhance the quality of dried fish while upholding the principles of sustainable energy. The regulated drying environment lowers the possibility of contamination and enhances overall product safety by assisting in the creation of hygienic conditions that meet food safety regulations. With potential uses in the global food processing industries, the smart solar dryer is a viable option for the sustainable manufacturing of dried fish.

Clean energy transition in rural Bangladesh: Challenges in adoption and impact

Author: Md. Sadique Rahman, Md. Hayder Khan Sujan

Year: 2024

Abstract: At the household level, the solar photovoltaic (PV) system is an off-grid clean energy source with significant poverty reduction potential, thereby contributing to the attainment of several sustainable development goals. Nevertheless, there has been limited adoption of renewable or clean energy technologies in Bangladesh. At present, renewable energy sources account for only 3% of the country’s electricity generation. This study thus investigates the drivers of solar PV adoption and the impact of this on household income and poverty in

Bangladesh. We present an econometric analysis of data from the International Food Policy Research Institute's Bangladesh Integrated Household Survey, 2020. Our findings indicate that only 5.51% of the sample households adopted solar PV, with the likelihood of adoption 3.8% higher in households with a mobile phone, 1.7% higher in households with internet access, and 2.8% higher among homeowners. However, the government's programs to expand the electricity grid made the delivery of solar PV by partner organizations less competitive. Our analysis reveals that the adoption of solar PV has a positive effect on household income of between 9.31% and 13.50%. The poverty gap is likely to decrease by around 20% to 26% due to adoption. These findings are pertinent to ongoing policy development efforts targeted at increasing the adoption of renewable energy to meet the sustainable development goals. Solar PV information could be potentially disseminated through mass media and modern communication technologies that require internet access. Furthermore, increasing the installation of solar PV systems in rented houses may promote the adoption of solar PV. It is imperative to implement policies that provide incentives for the installation and utilization of solar PV.

Thermochemical conversion of microalgae into biofuels

Author: Syfullah Shahriar
Year: 2024

Abstract: This chapter provides an overview of the thermochemical conversion techniques for transforming microalgae into biofuels. Microalgae are a promising source of renewable biomass for biofuel production due to their high lipid and carbohydrate content, fast growth rate, and ability to grow in diverse environmental conditions. However, the extraction and conversion of microalgae biomass into biofuels present significant technical and economic challenges. Thermochemical conversion techniques, such as pyrolysis, gasification, combustion, and liquefaction, offer a potential solution to overcome these challenges by converting microalgae biomass into liquid, gaseous, or solid biofuels. This paper discusses the principles and advantages of each thermochemical conversion technique, the factors that affect the conversion efficiency, and the current research progress and challenges in this field. The insights provided in this paper will assist researchers and stakeholders in developing sustainable and economically viable biofuel production processes from microalgae biomass. Analysis of data from the International Food Policy Research Institute's Bangladesh Integrated Household Survey, 2020. Our findings indicate that only 5.51% of the sample households adopted solar PV, with the likelihood of adoption 3.8% higher in households with a mobile phone, 1.7% higher in households with internet access, and 2.8% higher among homeowners. However, the government's programs to expand the electricity grid made the delivery of solar PV by partner organizations less competitive. Our analysis reveals that the adoption of solar PV has a positive effect on household income of between 9.31% and 13.50%. The poverty gap is likely to decrease by around 20% to 26% due to adoption. These findings are pertinent to ongoing policy development efforts targeted at increasing the adoption of renewable energy to meet the sustainable development goals. Solar PV information could be potentially disseminated through mass media and modern communication technologies that require internet access. Furthermore, increasing the installation of solar PV systems in rented houses may promote the adoption of solar PV. It is imperative to implement policies that provide incentives for the installation and utilization of solar PV.