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Utilization Opportunities of Agricultural Biomass in Iraq

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Abstract

Investing in renewable energies, including biomass, is an important topic in Iraq. Research indicates that there is great potential for renewable energy in Iraq, including biomass, but achieving this great potential requires clear strategies and significant investments. This research sought to determine the amount of biomass energy that can be produced by the residues of eight Iraqi crops: wheat, barley, oats, corn, rice (straw), rice (husk), cotton, and sugar beets. could produce. Calorific value and accessible residue amount were considered to determine the residue's potential for energy. Estimates for 2021 showed that 1,308,516 tons of agricultural residue would be available overall for the eight crops. The two crops with the highest residue percentages were wheat at 52.31% and rice (straw), at 19.98%. The total calorific value of the residue was also obtained at 20,744,442 GJ. Wheat and rice (straw) also gave the highest calorific value at 52.79% and 18.81%, respectively. Therefore, according to the results obtained in this study, a portion of the country's energy consumption can be saved in this way given the abundance of agricultural resources in Iraq and the appropriate climate. Implementing residue-to-energy projects will help Iraq harness these resources and contribute to sustainable energy development.

Irak'ta Tarımsal Biyokütlenin Değerlendirilebilme Olanakları

Özet

Biyokütle de dahil olmak üzere yenilenebilir enerjilere yatırım yapmak Irak'ta önemli bir konudur. Araştırmalar Irak'ta biyokütle de dahil olmak üzere yenilenebilir enerji konusunda büyük bir potansiyel bulunduğunu ancak bu büyük potansiyele ulaşmanın net stratejiler ve önemli yatırımlar gerektirdiğini göstermektedir. Bu araştırma, Irak'ta yetiştirilen sekiz tarım ürününün kalıntıları tarafından üretilebilecek biyokütle enerjisi miktarını belirlemeyi amaçlamıştır: buğday, arpa, yulaf, mısır, pirinç (saman), pirinç (kabuk), pamuk ve şeker pancarı. Kalıntının enerji potansiyelini belirlemek için kalorifik değeri ve erişilebilir kalıntı miktarı dikkate alınmıştır. 2021 yılı tahminleri, sekiz ürün için toplam 1.308.516 ton tarımsal artığın mevcut olacağını göstermiştir. Kalıntı yüzdesi en yüksek olan iki ürün %52,31 ile buğday ve %19,98 ile pirinç (saman) olmuştur. Artığın toplam kalorifik değeri de 20.744.442 GJ olarak elde edilmiştir. Buğday ve pirinç (saman) de sırasıyla %52,79 ve %18,81 ile en yüksek kalorifik değeri vermiştir. Dolayısıyla bu çalışmada elde edilen sonuçlara göre Irak'ta tarımsal kaynakların bolluğu ve iklimin uygun olması dikkate alındığında ülkenin enerji tüketiminin bir kısmından bu şekilde tasarruf edilebilecektir. Kalıntıdan enerjiye dönüştürme projelerinin uygulanması, Irak'ın bu kaynaklardan yararlanmasına ve sürdürülebilir enerji gelişimine katkıda bulunmasına yardımcı olacaktır.

1. INTRODUCTION

The world's population has grown, and so has the amount of energy consumed. Although they are scarce, coal, oil, and natural gas are the world's primary energy sources. Crude oil, coal, and natural gas make up 81% of the world's principal energy source (Riazi et al., 2013). Demand for all other fuels fell in 2020, but usage of renewable energy rose by 3%. Solar, wind, hydro, biomass, geothermal and other technologies provided two-thirds of renewable energy growth in 2021 (Renewable Global Energy Review). These days, climate change is the most significant environmental concern. Among renewable energy sources, biomass will be crucial in helping to meet human energy needs. The two primary strategies are to replace fossil fuels with clean energy sources and to increase energy efficiency. Remainders from plants and animals are sources of biomass that can be used to produce fuel. The International Energy Agency (IEA) estimates that the burning of gas alone releases an estimated 30 million tons of carbon dioxide (CO_2) into the atmosphere, making the Iraqi energy sector a direct contributor to the environmental issue (Alhassany et al., 2022).

In Iraq, oil fuel exports generally drive economic trends. The production of electricity is mostly dependent on fossil fuels. Iraq's energy system is weak due to a heavy reliance on traditional generation. Outages have become more common in recent years, particularly during the summer. The Iraqi energy industry produced 21,145 megawatts in 2021, the most amount the national electrical system has ever produced, according to a statement from the Ministry of Electricity (Iraqi Ministry of Electricity and Sustainable Energy). Iraq can rely on fossil fuels because of its large deposits of gas and oil, but it also has a lot of solar potential, which will contribute less than 5% of the country's producing capacity by the early 2030s (Renewable Global Energy Review). Academic attention to biomass energy and its application in integrated heating and power facilities has been scant, despite Iraq's abundant biomass energy resources. The strategy calls for advancing electrical connection and renewable energy projects, as well as implementing the combined cycle for all power plants, to obtain economic and development returns. Every year, Iraq produces enormous amounts of solid residue. There were just 12 million tons of municipal residue produced in 2020. According to Yemshanov and McKenney (2008), solid residue does not need to be burned or disposed of in landfills; instead, it can be recycled and used as a source of energy. Iraq has access to biomass energy resources, but there hasn't been much discussion about bioenergy and its application in combined heat and power plants.

Biomass energy production in Iraq has the potential to contribute significantly to the energy mix. Iraq has a high solar energy density and a climate suitable for renewable energy resources, including biomass (Kazem and Chaichan, 2012). The country also has extensive marine and agricultural areas cultivated for biomass energy (Naji et al., 2023). According to recent studies, Iraq has great potential for producing energy from agricultural residue. One study evaluated the theoretical energy potential of agricultural residue in Iraq and concluded that 10 million tons of dry biomass could be produced annually (Alhassany et al., 2022). The study was conducted on the characterization and assessment of five distinct kinds of Iraqi biomass agricultural leftovers. The biomass materials comprised of Dodona tree, corn, sunflower seed husks, date palm kernels, and reed stalks. The moisture content, volatile substances, ash content, fixed carbon, and greater heating value of the biomass materials were evaluated in the study using proximate, ultimate, and caloric value analyses (Alhwayzee et al., 2020). In one study, sugars were also examined to evaluate the possibility of producing biofuel from date pits of the Al-Zahdi variety in Iraq and to evaluate the value of the biomass (Al-Qayim, 2022). Also, the potential for using five different types of agricultural residue products from Iraq as fuel—directly or indirectly—was examined and assessed, with a focus on thermochemical processes such as gasification, combustion, and pyrolysis (Ethaib et al., 2020). One of the studies also aimed to discuss the present and future of renewable energy in Iraq, as the study showed that biomass energy has the potential to contribute significantly to the future of renewable energy in Iraq (Saleh et al., 2022). Potential sources of biomass energy in Iraq include crop production (date palm, wheat straw, barley straw, rice straw, sorghum straw), livestock manure, and solid residue (Alhassany et al., 2022). Date palm agricultural residue is also a potential source of biomass energy in Iraq, where about 600.000 tons of palm by-products are produced annually (Tahir et al., 2020). These initiatives demonstrate Iraq's commitment to utilizing its agricultural residue to generate sustainable energy. The results of this study will provide information on the potential of biomass from agricultural residues in Iraq.

2. MATERIALS AND METHODS

The geographical conditions in Iraq are suitable for growing most types of agricultural products. In this article, plant residues of wheat, barley, oat, maize, rice, cotton, and sugar beet were used to study the energy potential of biomass. The remaining quantities of the identified products were also calculated using FAO statistical data for the year 2021. The net potential of residues was calculated using the availability of residues and the amount of agricultural product based on Equation 1 (Karaca et al, 2017; Naeimi et al., 2023).

$$AAR = AAP \times RPR \times A \quad [1]$$

AAR for available agricultural residues of the crop (tons), AAP stands for agricultural product quantity (tons), RPR is for residue to product ratio, and A for residue availability.

RPR and A values were obtained from FAO (Natural Resources-Biomass Potential Assessment) and LHV values from Phyllis (Phyllis2-Database for Biomass and Waste) (Table 1).

Table 1. The product-to-residue ratio, availability, quantity of agricultural product, and heating values of a particular range of agricultural residues

Field Crops	Residues	Ratio of Product to Residues (RPR)	Availability (A) (%)	Amount of Agricultural Product (AAP) (ton/year)	Heating Value (LHV) (MJ/kg)
Wheat	Straw	1.28	15	3.565.349	16
Barley	Straw	1.35	15	813.037	17.3
Oat	Straw	1.42	15	469	17.67
Maize	Cob	0.33	60	366.665	16.38
Rice	Straw	1.33	60	327.761	14.92
Rice	Husks	0.25	80	327.761	12.06
Cotton	Straw	3.4	60	28.702	17.85
Sugar beet	Tops/Leaves	0.2	50	9.717	14.8

The energy potential of the residue was obtained by calculating the total calorific value of agricultural residue according to Equation 2 (Jorjani et al., 2021).

$$THV = AAR \times LHV \quad [2]$$

THV is the total heating value of the crop's agricultural residues (GJ), AAR is the amount of agricultural residues that are available (tons), and LHV is the lower heating value of the crop's air-dry residues (MJ.kg-1).

3. RESULTS AND DISCUSSION

The total agricultural residue for eight crops of wheat, barley, oats, maize, rice (straw), rice (husks), cotton, and sugar beets were calculated at approximately 1.308.516 tons in Iraq (Table 2).

Table 2. Quantity of agricultural products and residue available in Iraq

Field Crops	Amount of agricultural product (AAP) (ton/year)	Available Residues (AAR) (tons)
Wheat	3.565.349	684.547
Barley	813.037	164.640
Oat	469	99.897
Maize	366.665	72.599.67
Rice (straw)	327.761	261.553.3
Rice (husks)	327.761	65.552.2
Cotton	28.702	58.552.08
Sugar beet	9.717	971.7
Total		1.308.516

As shown in Figure 1, wheat, and rice (straw) had the highest number of residues, at 52.31% and 19.98%, respectively. Wheat and rice are important agricultural residues as a source of energy. These residues, including wheat straw and rice straw, can be used to produce energy through various methods such as combustion, fast and slow pyrolysis, gasification, and microbial fermentation. In addition, they have been identified as promising feedstocks for environmentally friendly energy production (Islam et al., 2021). The abundance of rice and wheat straw crop residues represents a great opportunity to harness this untapped energy source and contribute to a cleaner and more sustainable energy future. Studies have also indicated the possibility of generating electricity from agricultural biomass produced from wheat and rice (Saleem 2022). Therefore, the use of wheat and rice residue as a renewable energy source holds great promise and can contribute to meeting energy needs in a sustainable manner.

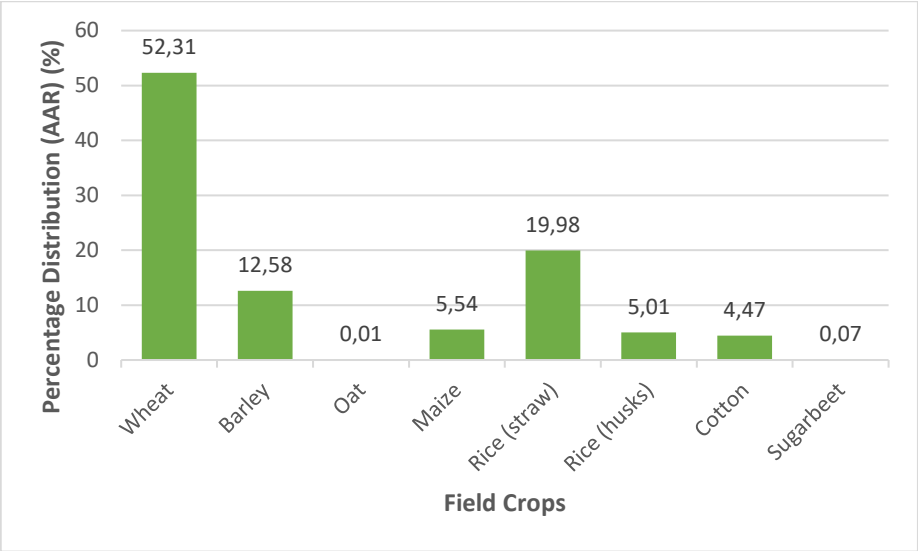

Figure 1. Percentage of crop residues in Iraq

The total calorific value of agricultural residues for the 8 crops examined in this research was calculated to be approximately 20,744,442 GJ (Table 3).

Table 3. Total heating values of agricultural residues in Iraq

Field Crops	Heating Value (LHV) (MJ/kg)	Total Heating Value (THV) (GJ)
Wheat	16	10.952.752.13
Barley	17.3	2.848.271.87
Oat	17.67	1.765.17999
Maize	16.38	1.189.182.595
Rice (straw)	14.92	3.902.374.908
Rice (husks)	12.06	790.559.532
Cotton	17.85	1.045.154.628
Sugar beet	14.8	1.4381.16
Total		20.744.442

It is clear from Figure 2 that the highest value of the total calorific value was for wheat and rice (straw), at 52.79% and 18.81%, respectively. According to the results of this study, it can be said that producing heat and electricity from alternative and renewable energy sources means protecting traditional energy sources in the country. According to the Energy Information Administration's 2021 report, electrical energy production in Iraq reached 21,145 megawatts, and according to the data of this research, part of this energy can be provided through agricultural residue biomass due to the abundance of agricultural resources in Iraq, the favorable climate, and the potential for biomass energy production. Implementing residue-to-energy projects can help Iraq harness these resources and contribute to sustainable energy development.

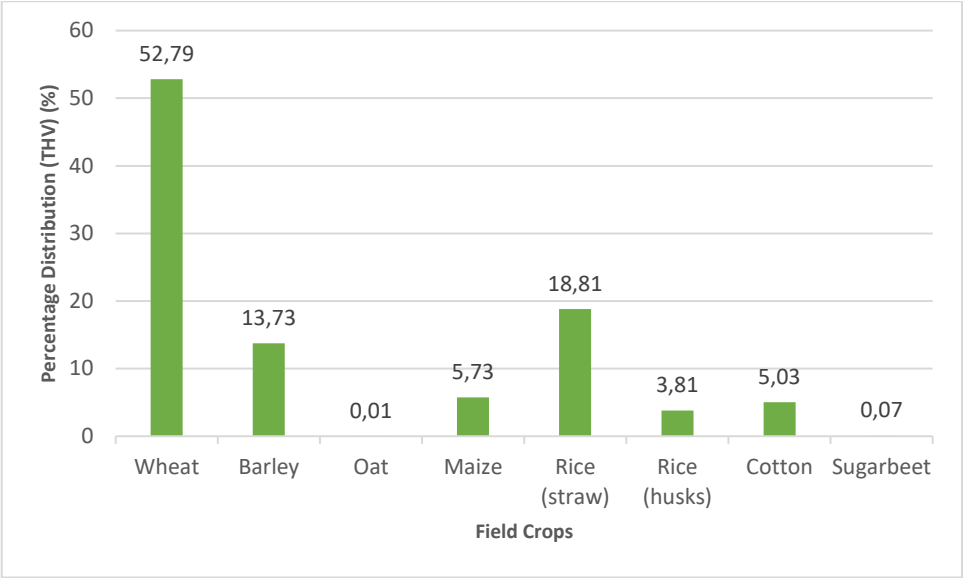

Figure 2. Percentage of total calorific values for crops in Iraq

3.1 CONCLUSION

Fossil fuels remain the main source of energy production in Iraq. Iraq suffers from a shortage of electrical energy, and many obstacles must be overcome to meet expected increases in electricity demand. Biomass energy plays a major role in the country's sustainable energy future. Biomass has emerged as one of the most important energy sources for the world. Iraqi farmers fertilize their crops and produce cooking gas for their homes using agricultural waste, an environmentally benign bioenergy source. Larger-scale electrical power generation is possible with the advancement of conversion technology, as is the case in many nations. Therefore, this study was conducted with the aim of estimating the remaining quantity and total calorific value of some agricultural products for energy production in Iraq. The total amount of agricultural residue (wheat, barley, oats, maize, rice (straw), rice (husks), cotton, and sugar beets) amounted to 1,308,516 tons. The total calorific value of agricultural residue amounted to about 20,744,442 GJ for the crops in all regions of Iraq. Where wheat and rice (straw) crops gave the highest value of residues and calorific value. Therefore, agricultural residue in this country has the potential to generate a sustainable source of biomass.

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