Choice Analyses For Using Solar Energy In Aiding Agricultural Activities In Borno And Yobe State

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Abstract

Human hesitations caused by the exhaustion of fossil fuels have quickened research on acquiring energy from unconventional sources. One of such sources is the Solar (glowing Sun). The paper reviews the possibility of using solar energy in agricultural activities. It should also be stressed that it is energy-friendly to the ecosystem, whose accession to agricultural land, which occasionally had a defective approach to the power grid, is now authentic and lucrative. This study focuses on two states of Nigeria that are geographically east in the north considering the sun intensity in the region. The research overviews related articles on solar power use in agriculture; Solarization of farms, applications, chances and hazards; Synergies in the water-energy-food nexus through solar energy farming; Agricultural application of solar; solar greenhouse; solar water heaters; Agricultural solar technologies; advantages and disadvantages of solar on the farm; the importance of renewable energy in agriculture; missing capacity; factors affecting solar panel. Recommendations based on the findings.

Keywords: *solar energy, agriculture, aiding, borno and yobe state*

Introduction

Borno State and Yobe State have excellent potential for the use of solar energy technologies, such as photovoltaic (PV) systems, concentrating solar power (CSP) systems, and solar water heating (SWH) systems. The high solar intensity in these states allows for efficient solar power generation, with an average of 6.50hrs/ day in Borno and 6.20hrs/day in Yobe and with solar irradiance values of 4 kWh/m^2 to 7 kWh/m^2. The use of PV systems for electricity generation would allow the states to reduce their reliance on fossil fuels and improve their energy security. CSP systems would be suitable for the states.

Solar power has the potential to improve agricultural production in Borno State and Yobe State. PV systems can be used to power irrigation pumps and water-lifting devices, which would help to increase crop yields and improve food security. CSP systems can also be used to generate thermal energy for crop drying and pasteurization, as well as for space heating and cooling. In addition, solar energy can be used for livestock watering, fish farming, and many other agricultural applications.

Energy–to–land evolution is rising in advance as well as the remote part of the globe. Community difficulties such as the impact of climatic change, the demands to increase pure energy and reduce emissions (or carbon emission), as also quick population and economic growth have led to additional needs for energy, water, and food. Concurrently, the comparative advantages of renewables in agriculture and public policies to improve water, energy, or food security increase the integration between energy and land use (IRENA 2015).

In Nigeria, especially in the Northeastern region, the use of solar energy is an excellent option because of the region's good sunlight exposure. Several publications suggest that solar systems that operate independently from the power grid and are located just a few dozen meters away from it in urban areas or a few hundred meters away in rural areas can be quite profitable.

Photovoltaic generators are most efficient when the inverters that connect the PV cells to the rest of the system are operating at their maximum power point. The control algorithm in the inverters enables them to operate at peak efficiency by adjusting the amount of power they draw from the PV cells.

Increasing the share of renewable energy sources is a necessary response to the depletion of conventional energy sources and the resulting energy security concerns. In addition, the degradation of the environment caused by increased CO_2 emissions and the threat of irreversible climate change are further arguments in favor of increasing the use of renewable energy. Increasing the use of renewable energy sources has numerous advantages, such as increased efficiency of raw material usage, energy savings, environmental protection, and reduced waste production.

Review of Related work

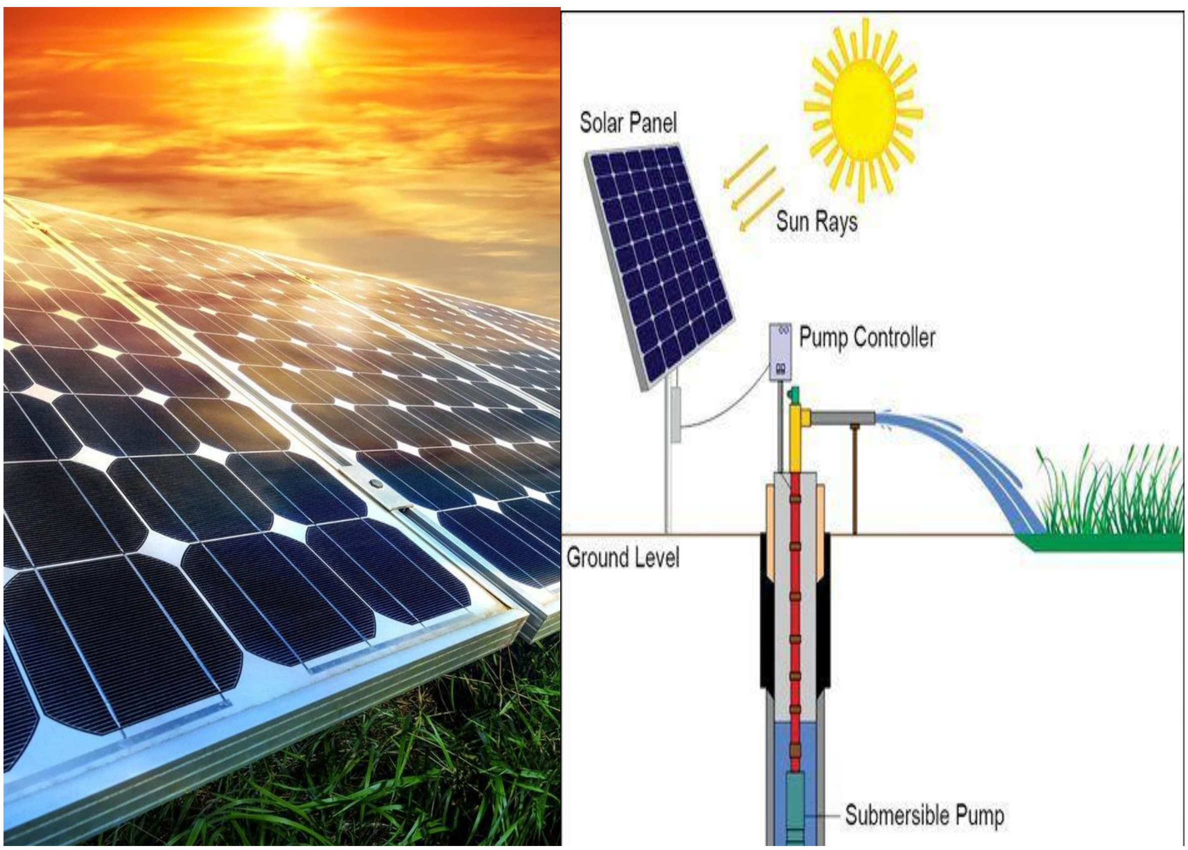
The economic benefits of using renewable energy sources like solar power will encourage farmers to adopt these technologies in the future. This is especially true if fossil fuel subsidies are removed, as farmers will recognize the long-term advantages of solar energy over fossil fuels. These advantages include lower operating or variable costs, the modular nature of solar systems, the relative reliability and longevity of solar energy systems, and the avoidance of pollution, soil contamination, and emissions from fossil fuels. The fall in PV module prices and the availability of financing are two important factors that will increase the adoption. For example, in the United States alone, price decreases are expected to accelerate by as much as 75% by 2020 in comparison to 2010 (Goodrich, James, and Woodhouse 2012). Globally, in the last 30 years, the cost of PV declined by almost one-fifth each time the cumulative installed capacity increased twofold (Cengiz and Mamis 2015).

Public programs and donor funds are steering the transition toward renewable use in agriculture. In developed countries, an important reason lies in the reduction of the carbon footprint by achieving renewable energy targets (Nelson, Gambhir, and Ekins-Daukes 2014). Here, In the case of the co-location of renewable energy systems and agriculture, the main concern is to minimize the trade-offs between energy production and land productivity. To achieve this, the land area required for large-scale renewable energy projects can be reduced, while still allowing and providing financial support for dual land use systems, which combine energy production with livestock grazing and crops. Solar photovoltaic (PV) and wind energy already represent 90% of capacity growth in India due to decreased costs, while renewables are showing record-breaking growth each year in other countries in both the northern and southern hemispheres (IEA 2017). In Jordan, for example, according to the National Energy Strategy Plan, renewable energy is anticipated to reach 10% of the total energy supply mix by 2020 (Ministry of Environment 2017). The water sector is one of the major energy con-summers, with 15% of total energy demands in Jordan used for water pumping. The sector is therefore targeted for renewable use and increasing energy efficiency (Ministry of Water and Irrigation 2016a). Sectors such as agriculture and water will benefit from renewable energies, as they can replace current energy sources and make relatively cheap energy available for various uses in agriculture, such as water heating, water abstraction, crop drying, grinding of grains, greenhouse heating, and lighting of facilities (Chel and Kaushik 2011).

Solarization of farms, applications, chances, and hazard

Solarizing farms has many applications and opportunities, but there are also potential pitfalls that need to be considered. On the positive side, solar energy can provide electricity for irrigation pumps, water treatment, and cooling, reducing the need for expensive diesel fuel. Solar energy can also be used to power remote, off-grid farms, providing them with a reliable and clean source of power. However, one potential pitfall is the potential loss of land productivity, as large solar arrays can take up valuable agricultural land. Another potential issue is the high upfront costs of solar installations, which may be a problem. storage is an important issue, as the intermittent nature of many renewable energy sources means that some form of storage is often required to ensure a reliable power supply, which can be a challenge for the wide-scale adoption of renewables.

Solarizing farms has a great role to play in terms of reducing the energy subsidy responsibility on the governments. The Middle East and North African (MENA) region harbors almost half of the global pre-tax energy subsidies, and many MENA countries have started to reduce these market-distorting subsidies (Verme and Araar 2017). In the agricultural sector, the use of subsidized fossil fuels is dominant. The fall of PV costs, an increase in fossil-fuel costs, and the provision of rouses for renewables (e.g. feed-in tariffs, tax breaks, and subsidies) are expected to increase the rate of return for options such as SEF. For example, according to KPMG (2014), current economics show an internal rate of return for replacing diesel pumps with solar pumps of around 10–19%, depending on whether additional benefits such as increased crop yields are achieved. Whether the use of SEF will be advantageous for water use is dependent on many factors. First, solar applications offer important comparative advantages from a lifecycle perspective. Solar and wind energy are among the most water-efficient production systems from a "liters per MWh" perspective and expected water savings if water withdrawals and consumption of water-intensive fossil fuels were replaced with solar or wind energy. Using solar power can help save water, especially in Arab countries, which largely rely on power from oil and gas. Second, depending on the specific application and institutional context, using solar energy can increase on-farm water usage. In any SEF application, maintaining solar panels requires regular dust cleaning using water, which could vary significantly in different environments from fortnightly to daily (Mani and Pillai 2010). In Jodhpur, India, some PV panels are cleaned four times a month during the summer season and twice during winter, each time consuming 20,000 liters for each 0.5 MW block (Santra et al. 2017).



Source: https://Solar power. Guide/solar energy-solar-potential

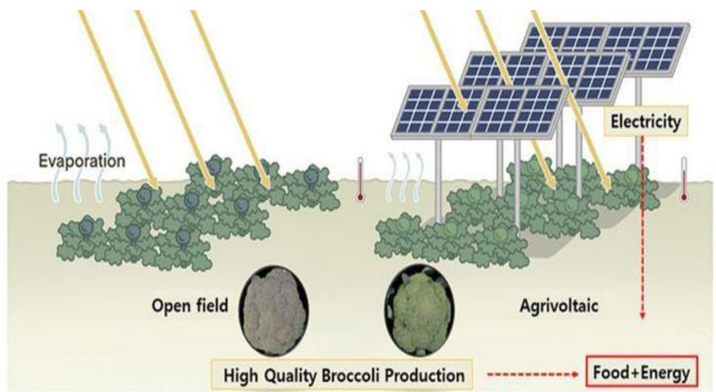
Synergies in the water-energy-food nexus through solar energy farming

Solar energy for farming in developing countries with limited water and arable land resources can create an opportunity cost for inefficient or wasteful energy use. Instead, excess energy can be used for productive purposes, such as heating, chilling, drying, and grinding, or can be sold (Chel and Kaushik 2011). Solar energy can also help to reduce the carbon footprint of the food sector, which accounts for about 30% of the world's energy consumption (FAO 2011). In addition, solar greenhouses and solar-powered aquaculture can be especially valuable in colder climates for year-round food production.

To maximize the benefits of solar energy for farming activities, it is important to connect solar energy technologies with extension services, water user associations, or similar organizations. This will allow for improved capacity building and representation of farmers, leading to changes in crop patterns or timing, and the adoption of sustainable irrigation practices. These efforts can lead to greater food production, improved water use efficiency, and increased farmers' incomes (Xue 2017).

Agricultural Applications of solar

Solar energy is a vital resource for agriculture, providing an opportunity to meet many energy needs while also helping to promote sustainable farming practices. Solar energy can be used for drying crops and cereals, which can be done simply by spreading grains and fruits in the sun, but this method is prone to losses and risks from pests, weather, and contaminants. More complex solar dryers can protect crops and cereals while also reducing losses, increasing drying speed, and producing better quality products. These solar technologies are especially important for addressing growing energy costs, a changing climate, and the need for solar energy.



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Solar Greenhouse

Traditional greenhouses rely on non-renewable energy sources like oil or gas to heat the space and support plant growth. However, modern greenhouses can use solar energy to meet both their lighting and heating needs. In addition, these greenhouses are designed to control excess heat and light to protect plants from being damaged by high temperatures or too much sunlight.

Solar water heaters:

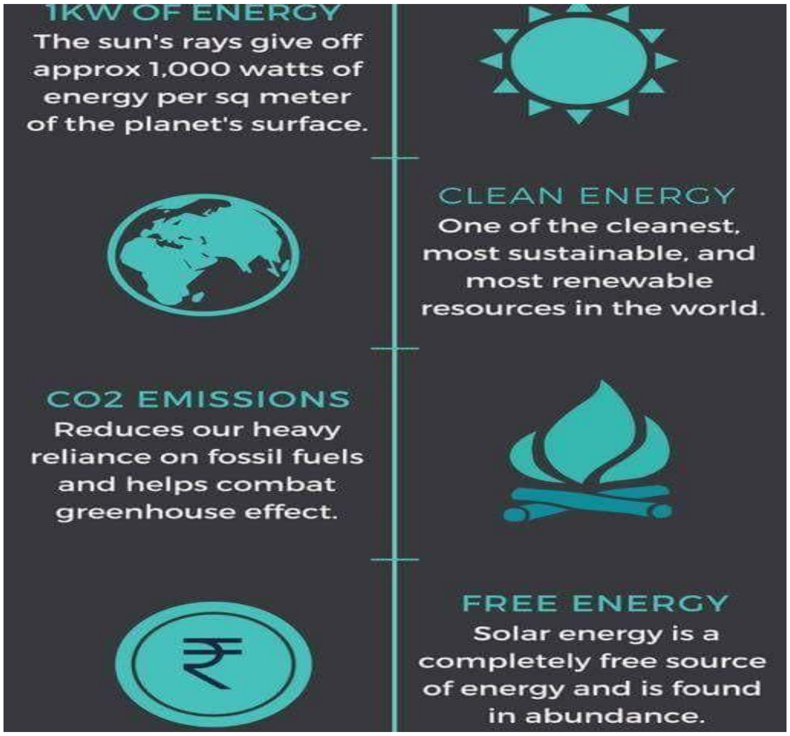
Solar-powered water and space heaters are a promising alternative to traditional heating systems for agricultural applications. These heaters use solar energy to provide clean, efficient heat for livestock and poultry, reducing the need for fossil fuels and the associated emissions. In addition, solar heaters can be used for cleaning and sanitizing equipment, further improving food safety and preventing the spread of diseases. Ultimately, solar-powered heaters can help to improve the sustainability and efficiency of agricultural operations while reducing their environmental impact.

Agriculture Solar Technologies

Solar energy has been used in various forms for centuries, from simple drying techniques to more complex systems like photovoltaics and thermal duals. These technologies have the potential to meet a growing need for energy while also reducing the impact on the environment. With continued innovation and investment, solar technologies can play a critical role in the future of energy production.

Importance of renewable energy in Agriculture (on the farm)

The efficiency of solar energy systems compared to traditional diesel generators has demonstrated the potential of solar power as a viable, environmentally friendly alternative for farmers. However, despite the clear advantages of solar energy, many farmers are still unaware of the benefits or the risks associated with continued reliance on fossil fuels. Increased education and awareness about renewable energy technologies and their impact on food production, environmental protection, and climate change could be key to driving the adoption of solar power in the agricultural sector.



Source: https://Solar power. Guide/solar energy-solar-potential

Missing capacities

Farmers in this region often lack the technical and managerial knowledge to engage in renewable energy projects and require support to do so, especially when competing with professional enterprises in highly lucrative renewable energy markets. Additionally, public institutions are not yet well-equipped to monitor and administer cross-sectoral projects, as they are often sector-specific. Lead institutions for such projects must have expertise in various sectors and therefore require training and support to develop project guidelines, policies, and monitoring tools for solar energy farming to improve groundwater quantity and quality. Extension services and private sector companies that provide advice and services to farmers. it's important to note that such intermediaries can play a key role in building the capacity of farmers and farmer associations to adopt and benefit from solar energy farming practices. Ultimately, this can lead to improved water and land management and increased agricultural production.

Factors affecting solar panels performance

The efficiency of solar panels is affected by the following factors

1. Load resistance: The voltage at which the panel operates is determined. The panel performance depends on the load strength, so the control system that monitors the

maximum power point must balance the load voltage with the current operating specifications.
2. Intensity of sunlight: The power of solar panels is directly proportional to the amount of solar radiation.
3. Cell temperature: My rephrasing of this section is as follows: Solar panels work less efficiently as the temperature of the cells increases above 25°C. As the temperature of the cells increases by 10°C, their efficiency decreases by 0.5%. To maintain optimal efficiency, airflow above and below the panels is required to remove heat. This can be achieved through passive or active cooling systems, such as ventilation or heat exchangers. The efficiency of a solar panel is also affected by the angle of incidence of the sunlight, the amount of dust and dirt on the panels, and the intensity of the sunlight.
4. Shading of photovoltaic panels can reduce the amount of power produced by 2-50% depending on the severity and location of the shading. Even partial shading of a small portion of a panel can reduce the overall power output. According to the National Renewable Energy Laboratory (NREL), even a 3% shading of a panel can result in a power loss of up to 50%. Therefore, it is important to consider shading when designing and installing photovoltaic systems to maximize their efficiency.

Advantages and Disadvantages of Panels System in Agriculture

Advantage

1. No reliance on fluctuating fossil fuel prices
2. No noise or air pollution
3. Lower maintenance costs and lower cost of replacement parts than traditional systems
4. Can be used in a variety of industries, including agriculture
5. Helps address issues related to population growth and land scarcity, while also helping farmers increase income and reduce the environmental impact of agriculture by reducing CO_2 emissions.

Disadvantages:

1. High upfront costs are a major barrier to the widespread adoption of solar energy technology.
2. Additional considerations for greenhouse production such as climate control, heating, lighting, and water management.
3. Need for automation and software systems to manage variables such as weather, climate, and water levels.
4. Seasonality of sunlight and availability of sunlight may affect the ability to produce consistent yields.
5. Difficulties in long-term energy storage for use when the sun is not shining, requiring the use of batteries.

6. Expensive and difficult to obtain replacement parts and skilled labor for repair and maintenance.
7. Electricity storage batteries may be hazardous and have a limited lifespan.
8. Can disrupt ecosystems, habitats, and wildlife due to the large amounts of land required for installation.
9. May require costly improvements to existing infrastructure such as transmission lines and power grids.
10. Solar power plants can alter the appearance of the landscape, potentially lowering property values in surrounding areas.
11. Local laws and regulations may restrict the ability to install solar energy systems.

Conclusion

Solar energy farming is a complex and dynamic process, with various approaches and outcomes depending on the local context. While some projects aim to completely replace traditional agricultural practices with solar energy farming, others seek to achieve a balance between the two. In all cases, farmers require support to navigate the transition, including addressing risks and building capacity. The feed-in tariff is an important factor in incentivizing farmers to switch to solar farming, but the sustainability of this model depends on its long-term viability. Ultimately, any successful transition to solar farming requires a Human effort. A holistic approach that considers the economic, environmental, and social aspects of the transformation. By considering the needs and aspirations of farmers, local ecosystems, and the broader energy landscape, solar energy farming can become a sustainable and viable source of livelihood for rural communities.

Solar energy farming in the agricultural sector can be a double-edged sword, presenting challenges for water management while also offering opportunities for improved water, energy, and food security. However, for solar energy farming to be successful, it must be designed to meet the specific needs and resources of the local context. For example, the location of the project will determine the potential for resource use, as well as the feasibility of specific technologies and policies.

To summarize the key points, Solar energy is a valuable resource for agriculture, helping to meet energy needs for drying crops and operating machinery. It can also support sustainable farming practices that are more climate-friendly and reduce costs. However, farmers need to be aware of the latest technological developments to make the most of these benefits. Overall, solar energy has the potential to play a significant role in improving the sustainability and resilience of the agricultural sector.

Recommendation

It is recommended that solar energy be used in agriculture in Borno and Yobe State to improve the productivity and sustainability of the agricultural sector. Solar energy can be used for irrigation, water pumping, and processing, as well as for refrigeration, cold storage, and transportation. The use of solar energy in agriculture can also reduce the dependence on fossil fuels, lower greenhouse gas emissions, and create jobs in the renewable energy sector.

Additionally, it is important to consider the climate and geography of Borno and Yobe State when designing and implementing solar energy systems for agriculture. Borno and Yobe State have a hot, dry climate with long hours of sunlight, making them ideal for solar energy applications. Solar energy can be used for water desalination, crop drying, and livestock cooling, as well as for crop protection and greenhouses.

Furthermore, solar energy can be used to power mobile refrigeration units to transport produce to markets and storage facilities. The use of solar energy can also be combined with other sustainable agriculture practices such as rainwater harvesting, and organic farming.

To further improve the viability of solar energy in agriculture in Borno and Yobe State, it is recommended that financial incentives and subsidies be offered to farmers and small businesses. This can include tax credits, grants, and low-interest loans to offset the cost of solar energy systems. In addition, public-private partnerships can be established to support the development and deployment of solar energy technology.

In conclusion, it is important to invest in training and capacity building to ensure that farmers and workers have the necessary skills to operate and maintain solar energy systems.

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