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A Review on Application of Solar Energy in Agriculture Sector

Narendra Nath Saxena
Sanskriti University, Mathura,
Uttar Pradesh, India
Email Id-narendra.ag@sanskriti.edu.in

Dr. Prafull Kumar
Sanskriti University, Mathura,
Uttar Pradesh, India

ABSTRACT
Solar radiation is waste when it falls on the earth in countries like India. It is predicted that if 1% of the solar radiation received can be turned into energy, this energy will be sufficient to satisfy the world's future energy needs. India has a large agricultural industry that feeds the stomachs of the majority of the world's people, in addition to solar radiation. The Indian government has implemented measures to promote solar energy usage and reduce the use of non-renewable resources. The current research examines different advances in the use of solar energy in Indian agriculture, which may be utilized to reduce electricity consumption from non-conventional sources, which are both expensive and ecologically harmful. According to current study, further research is needed to improve the applicability and efficiency of solar power consumption for long-term use.

Keywords
Agriculture, Farmers, India, Renewable, Solar Energy.

1. INTRODUCTION
Agriculture is the most important source of sustenance for people. However, the usage of different energy production sources such as coal power plants, automobiles, and agricultural methods such as stubble burning, fertilizer use, and so on have resulted in the environment's devastation. It has been predicted that non-renewable resources would be exhausted soon, necessitating the development of renewable resources that are also environmentally benign. Agricultural farms also need a large quantity of electricity to irrigate, operate their tractors, and perform other tasks related to crop care[1].

There are many renewable energy sources accessible throughout the globe, including wind, hydro, tidal, geothermal, and biomass energy, but solar energy is the best of them since it can be utilized for a variety of agricultural purposes. Various academics and scientists working to combat climate change and global warming advocate for the usage of renewable energy sources and are working to increase awareness about them. The use of fossil fuels and other pollution-producing activities are contributing to climate change and global warming. These energy sources produce greenhouse gases, which have the ability to absorb solar radiation, resulting in a rise in global temperature. Developing nations, such as India, have a variety of difficulties when it comes to energy production. More than half of Indian households do not have access to power. As the world's population grows and the temperature rises, more people are becoming aware of the benefits of using solar energy to carry out their everyday tasks. Power demand is rising while electricity output is decreasing.

The energy required to water the crops will increase in the future years. Low ground water levels and a lack of energy to pump subterranean water have caused many fields to dry up. The monsoon's reliance is growing, but this is due to the delays in rainfall caused by climate change and global warming. Electricity is primarily used in agriculture for irrigation reasons. Solar panels may assist increase production in arid regions that are mostly reliant on rain[2-6].

2. BENEFITS OF SOLAR ENERGY
The sun is the ultimate and limitless source of energy. Solar power is a renewable energy source that comes from the sun and is released in the form of heat and light. Solar energy may be harnessed thanks to technological advancements. Solar panels, solar photovoltaic, solar heating and solar cooking may all be used to harness the sun's energy. Solar energy used with agriculture may aid in the development of sustainable farming. Many nations are now using solar energy into their farming processes in order to boost agricultural yields. Many programs, such as the Jawaharlal Nehru National Solar Mission (JNNSM) and the Rooftop PV and Small Solar Power Generation Program (RPSSGP) for farmers, have been launched by the Indian government. However, farmers in India are unaware of these programs[5]. In many nations, most equipment is now powered by solar energy rather than conventional fuels such as diesel, gas, or oil. Some of the technologies are briefly explained:

2.1 Pumps for Water
Farmers in India irrigate their crops using diesel-powered water pumps. They utilize diesel, gas, or oil-powered water pumps to pump water from wells or open dams for a variety of agricultural purposes. Countries such as the United States, Europe, France, Germany, China, Finland, Canada, and India are adopting different irrigation systems. Motor pumps, switches, solar panels, and tracking systems are all part of various solar water pumping systems. These solar pumps are less expensive, utilize less energy, and produce less greenhouse emissions. In India, the Rajasthan government launched the KUSUM initiative, which suggested that these fields produce electricity for $3.14 per kWh. Solar power is superior in operation, finance, and environmental aspects in certain nations, according to the World Bank, while a few countries are still unaware of the advantages offered by solar power.

2.2 Dryers Solar
Farmers utilize diesel or gas-powered dehydrators to dry their harvests so they may be packed and sent to storage facilities. A few farmers use solar energy to dry crops after harvest, which is both cost-effective and environmentally beneficial. A solar dryer is made up of three parts: a solar energy collector, drying tracks, and a shelter. Farmers use a solar-powered fan to blast hot air that circulates over the fan, dehydrating the crops.

2.3 Solar Mower
Various farmers use solar-powered mowers to trim crops or grasses in the same way as conventional mowers do. Solar energy outperforms diesel-powered mowers, which are detrimental to the environment. Solar lawn cutters have a

solar panel that charges the battery, as well as electric circuits, DC motors, blades, and three wheels.

2.4 Solar Tractors

Tractors may be found on almost every farm and are considered important agricultural equipment. Tractors are typically powered by diesel or gas; however, some scientists and researchers have installed solar panels on the tops of tractors to allow these panels to get the most sunshine, allowing these hefty tractors to operate on solar power. The combination of solar panels and lithium batteries is revolutionizing the agricultural industry. These tractors may be powered directly or indirectly by solar energy; some tractors operate on lithium batteries, which are charged by solar panels; others are equipped with solar panels on the top, which can either drive the tractor or charge the batteries while it is running.

2.5 Solar Greenhouses

Greenhouses are utilized in a variety of fields, and the crops in these greenhouses need heat. Solar panels installed on these homes offer enough heat to improve the crops and increase production. These green buildings are utilized in the winter to allow crops to be produced in spite of the severe weather. These solar greenhouses are powered by the sun and include solar energy heaters for lighting and warmth. By maintaining a comfortable temperature, these greenhouses assist farmers in growing fruits and vegetables out of season.

2.6 Solar Water and Space Heaters

Farmers utilize space and water heaters to keep the temperature of the animals at a comfortable level. Solar power is used to turn sunlight into heat energy in these heaters. The poultry and pig industries confront many challenges in terms of supplying heat and food, as well as maintaining the livestock industry's revenue. These solar water and space heaters are required to replace the harmful dust and toxic gases to crops and vegetation. These heaters may also be used to sterilize and clean different types of equipment.

2.7 Solar Electric Fences

Animals such as cows, elephants, and buffalos wreak havoc on crops and plants. Farmers employ many types of fence to protect their crops all around the globe. Solar-powered fence is made up of solar panels that supply electricity to the wires, and anytime an animal or creature comes into contact with the fencing, it receives an electric shock, preventing the crops from being damaged.

2.8 Solar Pumping System

Photovoltaic (PV) panels are used to irrigate agricultural fields since they only need a little quantity of energy to carry out different operations. The energy generated by the PV panels may be used for a variety of different tasks, such as storing crops, fruits, and vegetables, or spraying pesticides. PV systems are not suitable for sectors that need a high level of power input, such as rice mills or agricultural operations. Solar panels, submersible pumps, solar charge controllers, and batteries make up simple solar pumping systems.

2.9 Solar Panel

Solar panels are made up of solar cells made of semiconductor materials. These solar cells' primary purpose is to convert the solar energy that falls on them into DC electrical power. The number of cells and the load rating are both directly proportional to each other. If the load grows, the number of solar cells must be increased. One of the most significant disadvantages of solar panels is that they must be oriented to the angle of the sun in order to provide maximum output.

2.10 Submersible Pump

It's a kind of pump that's buried deep within the well, either up to the groundwater level or where there's a natural stream of water. The depth of the well, as well as the accessible ground water level, determines the pump's size and power.

3. IMPORTANCE OF RENEWAL ENERGY FOR AGRICULTURAL FARM

Several literature studies have shown the importance of combining renewable energy with agricultural production. Crop and grain drying, room and heating systems, greenhouse heating, photovoltaic solar systems, and irrigation water pumps were all investigated as solar energy technology applications. The solar panel/photovoltaic (PV) system has been regarded as the most appropriate option in agricultural operations, particularly in distant rural regions, since its maintenance is cheap, has little environmental effect, and can be utilized for a variety of purposes. Qoaider and Steinbrecht, who investigated the economic feasibility of PV technologies in providing irrigation energy requirements in distant agricultural communities in rural desert areas with the objective of allowing farmers to decrease the high cost of generating diesel power, backed up this claim. This innovative energy technology plan is the key to guiding the area to long-term development. It is hypothetically designed, including estimates of the life cycle cost (LCC) of a PV device that can meet the energy needs of the whole community. This solar panel generator can pump about 111,000 m3 of lake water each day, enough to irrigate 1,260 hectares of land and power the homes of the surrounding communities. By comparing the solar panel system generator's efficiency to that of a diesel generator[7].

4. LITTERATURE REVIEW

Bardi et al. looked at the possibility of farmers switching from fossil fuels to renewable green energy sources, which may enhance the quality and quantity of food processed on a wide range of farms. It may also provide electricity for agricultural equipment, such as road haulage, as well as field research. Only a few agricultural equipment operators are now aware of the problems posed by the depletion of fossil fuels and global warming. The root of the climate change problem is this. Unless farmers' attitudes change, the issue will continue to worsen. Growers should also employ energy-saving equipment for growing crops and utilize the PV system to optimize land, since it is cost-effective and can be used for a variety of purposes[8].

Dupraz et al. investigated the best methods for converting solar radiation into both energy and agriculture. It's also known as photovoltaic (PV) or agro-photovoltaic (APV) farming, and it's a natural answer to agriculture's lack of renewable energy. This system was set up to enhance the mild shadow of the crops by raising the solar panels to a height of 2 meters above the ground. Climate conditions, sufficient water availability, and energy supply are all variables that influence agricultural growth. As a result, contemporary technology must be combined with innovative economic efficiency farming methods and the effective use of limited land resources with minimum environmental impact to maximize agricultural output and improve land usage. The solar panel's DC energy is transferred to the battery. The converter receives this DC feed from the battery and converts it to AC power. AC electricity is utilized to operate the ventilation systems in the greenhouse in order to generate heat or control temperature[9].

Maher et al. proposed a greenhouse model with a fuzzy-based management system to maintain the indoor greenhouse

environment using induction motors, heating systems, and other components for ventilation, heating, humidification, and dehumidification applications for long-term greenhouse agricultural production with efficient climate control for increased yield. Their research has shown that both the fuzzy controller and the PV generator may be used in greenhouses to save energy and lower the cost of agricultural output[10].

5. DISCUSSION

The solar panel system generates low-cost renewable energy and is suitable for long-distance agricultural activities like irrigation water pumping. The operation of a solar panel technology system, on the other hand, requires sufficient energy, a solar panel, a pump controller, a motor pump, water sources, and a water tank. Many silicon cells or solar cells make up the solar panel. The solar cell is the panel's smallest component. When the sun shines on the solar sheet, solar cells gather energy. Solar energy is transformed to direct current (DC) by semiconductors, which is then converted to AC or alternating current by the alternator in the pump regulator and transferred to the water pump, which subsequently drains and stores the water from the water resource.

5.1.Factors affecting performance of Solar Power

The production efficiency of solar panels is influenced by several factors, like:

5.1.1. Load Resistance

The voltage at which the panel can function is established. Because the panel's performance is determined by the load's strength, a control system that monitors the maximum power point must ensure that the load's voltage and current operating requirements are balanced.

5.1.2. Cell Temperature

As the cell temperature rises beyond the usual manufacturing temperature of 25 ° C, the panel performs less efficiently, and the voltage drops. As a result, heat may be thought of as a reaction to electron mobility. For every degree rise in temperature, a panel at 80-90 C loses 0.5 percent of its efficiency. As a result, airflow over and beneath the panel is required for the design of the mounting scheme to remove heat.

Subtle shadowing of PV panels usually resulted in a significant decrease in output. The ability of a solar panel device is influenced by factors such as solar irradiation and cell temperature. Other contributing variables, such as the durability of other components and other environmental conditions, affect its efficiency in addition to these. The local ecosystem refers to the environment that has been directly or indirectly shaped by human activities, such as the urban environment, plant types, and weather patterns. All of these variables will have a technical impact on the solar panel's efficiency, resulting in a decrease in power output of 2-50 percent in different regions.

5.2. Advantages and Disadvantages Solar Panel System in Agricultural Farm

5.2.1. Advantages

There are many benefits to adopting renewable energy technologies, including:

- Solar panel water pumping system with no fuel costs.
- There is no noise or waste of air.
- Maintenance expenses are lower, and solar panel replacement parts are less expensive than a diesel-powered generator.
- It is secure, abundant, and useful.
- It may be used to a wide range of industries.
- Agriculture is included.

5.2.2. Disadvantages

Solar panel systems have a number of drawbacks, including high installation and early setup expenses. According to the World Energy Evaluation study, the present cost of PV energy is comparable to conventional power plants, which is a significant barrier to large-scale PV implementation. There are also a slew of questions surrounding greenhouse manufacturing, including:

- Managing the Internal Climate
- Changing the supply control decision
- The requirement to calibrate the system in response to changing external circumstances.

Setting to allow crops or plants grown on the underground surface to produce similarly to those grown on the surface.

- A uniform standard must be established in order to standardize the design and size of solar panels or photovoltaic agricultural projects. Solar panel producers must offer a variety of PV products for agricultural production in order to satisfy farmers' needs.
- Government planners must create technologies with appropriate respect for cost and quality to encourage farmers to adopt sustainable renewable energy generating equipment rather than conventional fossil fuel energy for a pollution-free environment.
- Farmers must be trained on how to use and operate the PV system, as well as get excellent assistance.
- Agricultural production is important because it has an impact on a country's food security via yearly harvests. As a result, technical advancements must be used to improve manufacturing performance. Nonetheless, there is growing concern about the environmental consequences of the increased use of fossil fuel energy in agricultural methods that release a lot of CO2. As a consequence, companies and governments, both public and private, are converting to green energy, or migrating to alternative sources of renewable energy such as solar energy, to reduce greenhouse gas emissions from day-to-day production and equipment operations across the globe.
- Solar panel agriculture provides new possibilities for the agricultural industry, as it continues to support the development of modern agriculture, even in rural regions. The development of agricultural field equipment, building, and processing facilities has led to the growth of solar panel power systems in agricultural methods. Solar panel agriculture has quickly grown in industrialized nations as a consequence of government policies of innovative agricultural technology, resulting in rural farm electricity and greenhouse equipment to improve production while reducing land usage. However, in order to optimize the combination of solar panel energy production and agriculture in developing nations, further research and practical investigations must be conducted utilizing new designs with reduced construction costs and higher performance.

6. CONCLUSION

This paper suggests that solar energy may offer a long-term solution to many of the world's current issues, including climate change, energy shortages, atmospheric conservation, and drought. Farmers in the United States, the European Union, and Asian countries are at the forefront of adopting

solar energy, as evidenced by the literature. However, despite the fact that this technology has numerous advantages, as demonstrated in this article, most farmers on the African continent are less accepting of solar systems for agriculture. The African continent also benefits from increasing solar radiation and has 60% of the world's productive land. Solar power is suitable for agricultural applications such as electrical shielding, threshing, aerating, grinding, drainage, purification, and so on. Solar energy is now widely used by Indian farmers in the water sector, especially in irrigation systems, for their agricultural.

Despite this, farmers believe that the initial cost of solar water pump systems is more than the cost of a diesel water recirculating pump, but neither system considers production or maintenance expenses. The PV collection of solar water pump systems, which may be utilized to generate power if irrigation is not required, is one of the most essential features. Solar water pumping devices can efficiently meet the needs of marginal farmers in the landholding system for irrigation water. Pump sets are installed every year in India due to increasing fuel costs on a regular basis. The solar water pump system allows for better use in order to decrease fuel consumption. Solar water pumps have been available in different designs for over three decades, therefore they are not a new idea. Using up to 30% of the world's available energy will need expensive money to continue to utilize more of the power production. It claims that certain expenses are imposed on society and the environment based on the periodicity of the energy market and thermal power plants. Based on the above, we conclude that the solar pumping system is more feasible than the diesel engine pumping method for watering India's agriculture. Solar water pumps are not more expensive on an economic level if solar energy is utilized continuously, but their capital expenses are considerable.

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