APPLICATIONS OF SOLAR ENERGY IN MODERN AGRICULTURE: A REVIEWOF TECHNOLOGIES AND PRACTICES

Giridhar M¹, Rohini M², Dheeraj M¹ and Lakshmikanth Reddy G N¹

¹Department of Agronomy, College of Agriculture, Mandya, University of Agricultural Sciences, Bangalore, Karnataka ²Department of Agronomy, S.V. Agricultural College, Tirupati, Andhra Pradesh

The growing global demand for energy, coupled with the environmental consequences of fossil fuel consumption, has prompted increased interest in clean and renewable alternatives. Solar energy, recognized as one of the most sustainable and environmentally friendly sources, is being widely adopted across various sectors. This paper presents a state-ofthe-art review of recent advancements in solar energy technologies with a focus on agricultural applications. It emphasizes the role of solar energy as a clean technology and a reliable energy source, particularly relevant in the context of sustainable agricultural development. The review covers solar photovoltaic (PV) and solar thermal systems employed in key agricultural processes such as water pumping, crop drying, storage cooling, and greenhouse climate control. Findings suggest that these technologies offer feasible and efficient solutions, especially in off-grid and rural areas, making them valuable tools for enhancing productivity and sustainability in agriculture.

INTRODUCTION

Solar energy applications in agriculture diverse and include powering are irrigation systems, drying crops, heating greenhouses, and providing lighting and power for various farm operations. These applications reduce reliance on fossil fuels, lower energy costs, and enhance agricultural productivity and sustainability. Renewable energy, on the other hand can be a clean energy resource. Using renewables to replace conventional fossil fuels can prevent the release of pollutants into the atmosphere and help combat global warming. For example, using solar energy to supply a million homes with energy would reduce Co2 emissions by 4.3 million tons per year, the equivalent of removing 850,000 cars from the road. Renewable energy is energy which comes from natural resources such as sunlight, wind, rain, tides, and geothermal heat, which are renewable (natural replenished).



KEY APPLICATIONS OF SOLAR ENERGY IN AGRICULTURE:

Solar-Powered Irrigation: Solarpowered water pumps extract water from wells or reservoirs for irrigation, ensuring a consistent water supply for crops, especially in areas with limited or no grid electricity.

Crop and Grain Drying: Solar dryers utilize solar energy to dry crops and grains, preserving them and improving their shelf life.

Greenhouse Heating: Solar-powered heating systems in greenhouses maintain optimal temperatures for crop growth, extending growing seasons and boosting yields.

Lighting and Power: Solar energy provides lighting for barns, farm buildings, and other farm areas, as well as

power for various agricultural machinery and equipment.

Water and Space Heating: Solar water heaters provide hot water for livestock, farm buildings, and other agricultural needs, while solar space heating can be used to warm livestock buildings and greenhouses.

Agrivoltaics: Combining solar panels with agricultural activities, such as growing crops or raising livestock, can generate electricity while also utilizing the land for farming.

Other Applications: Solar-powered cooling systems, solar-powered beekeeping, and even solar-powered insect traps are also examples of how solar energy is being used in agriculture.



BENEFITS OF SOLAR ENERGY IN AGRICULTURE:

Reduced Energy Costs: Solar energy reduces reliance on traditional energy sources, lowering energy bills and making farming more economically viable.

Increased Self-Reliance: Farmers can become more self-sufficient by generating their own electricity, reducing their dependence on external energy providers. **Environmental Benefits:** Solar energy is a clean and renewable energy source, reducing greenhouse gas emissions and contributing to a more sustainable agricultural system.

Enhanced Productivity: Solarpowered equipment and systems can improve the efficiency of agricultural operations, leading to increased yields and reduced labour costs.

Diversified Revenue Streams: Agrivoltaics and other solar energy projects can create new revenue streams for farmers, boosting farm profitability.



ON FARM UTILIZATIONS:

1. Solar operated sowing machine





Fig.1: Solar operated sowing machine & its mechanism

2. Solar fencing

The Solar module generates the DC energy and charges the Battery. The output of the battery is connected to Energizer. The energizer will produce a short, high voltage pulse at regular rate of one pulse per second. The live wire of the energizer is connected to the fence wire and the earth system. The basic building blocks of a power fence are:

- 1. Energizer
- 2. Earthing (Grounding System) and
- 3. Fence system



Fig.2: Solar fencing & its mechanism



JUST AGRICULTURE | JUNE 2025 40

3. Solar sprayer



Fig.3: Solar sprayer & its mechanism



Table.1: Comparison b/w solar photovoltaic operated sprayerand hand lever knapsack sprayer

Parameters	SPV operated knapsack sprayer	Hand lever operated knapsack sprayer
Swath width (m)	0.51	0.46
Speed of operation (km hr-1)	1.80	1.18
Theoretical field capacity (ha hr-1)	0.092	0.054
Actual Field Capacity (ha hr-1)	0.082	0.044
Field Efficiency (%)	89.42	80.39
Solution required (lit ha-1)	498	512

4. Solar insect traps

The solar light system includes a 12volt, 7.5 amp battery, 10 watt power solar panel, solar charging unit, 12watt LED lamp (dc). The scientist from ZARS, Mohitnagar developed the solar light trap. Found that as an alternate of chemical pesticide. This tool is eco-friendly nature and low cost involvement to both the farmers and agricultural experts. Found to be most effective IPM tool which provide better safeguard to the nature in comparison to the other method of pest control.



Fig.4: Solar insect traps

5. Solar pump

To run 2HP motor for irrigation. 1.5 KW Energy required and with voltage of 240 V 1.5 KW-1500 watt. Nearly 8 solar panels are required to generate 1500 Kw (1 solar panel of 72 cells generates 200 W). 2 batteries are required (Rechargeable batteries of 120 V).



Fig.5: Solar pump & its mechanism





CONCLUSION

Agricultural technology is changing rapidly. Farm machinery, farm buildings and production facilities are constantly being improved. These sources of energy are clean, risk-free and constitute no harm to man and environment. Cheaper and improved sources of solar energy are needed for efficient and smooth operations of the facilities.