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Power Saving Cost Efficient Irrigation Technique under Indian Condition

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SUMMARY

Energy is a basic requirement of human life, just like in agriculture, industry, transportation, communication and all other economic activities of the present civilization. So far India is concerned, agriculture constitutes foundation for the socio-economic structure, Seventy percent of the population is engaged in activities related to crop-animal-aqua production, processing and marketing. Energy is both fuel and feed stock for agriculture. Primary energy is the fuel, solar energy is the feed stock material. Both are essential in industrialized agriculture concern for the efficient and proper use of energy is evidenced from many questions, non-agricultural sources. Widely differencing proposals have been made for changes in agricultural policy in response to 226 the energy-related concerns. Controversy exists over the correctness and feasibility of many of these proposals. It is of extream importance, therefore, to identify the energetic relationships of agricultural systems and to be understood. We must be able to correctly identify and measure the flow of energy in the system comparing the crop and livestock production, food processing, distribution and preparation.

INTRODUCTION

Irrigation is the largest consumer of energy in agriculture, and agriculture accounts for 40-50% of India's energy use' 80-85% of water utilisation in India is from agriculture, with irrigation also being the largest consumer of agricultural energy. This is no small sum, given that agriculture accounts for 40-50% of India's energy use', Kapil said, as we walked around the development site, with sprawling lush lawns and lines of brightly coloured crops that reached into the distance. Agricultural water use therefore not only serious implications for India's increasingly erratic and dwindling water supply, but also for its carbon footprint.

India's electricity sector faces many issues:

- Government giveaways such as free electricity for farmers, partly to curry political favour, have depleted the cash reserves of state-run electricity-distribution system. This has financially crippled the distribution network, and its ability to pay for power to meet the demand. This situation has been worsened by government departments of India that do not pay their bills.
- Shortages of fuel: despite abundant reserves of coal, India is facing a severe shortage of coal. The country isn't producing enough to feed its power plants. Some plants do not have reserve coal supplies to last a day of operations. India's monopoly coal producer, state-controlled Coal India, is constrained by primitive mining techniques and is rife with theft and corruption; Coal India has consistently missed production targets and growth targets. Poor coal transport infrastructure has worsened these problems. To expand its coal production capacity, Coal India needs to mine new deposits. However, most of India's coal lies under protected forests or designated tribal lands. Any mining activity or land acquisition for infrastructure in these coal-rich areas of India, has been rife with political demonstrations, social activism and public interest litigations.
- The giant new offshore natural gas field has delivered less fuel than projected. India faces a shortage of natural gas.
- Hydroelectric power projects in India's mountainous north and northeast regions have been slowed down by ecological, environmental and rehabilitation controversies, coupled with public interest litigations.
- India's nuclear power generation potential has been stymied by political activism since the Fukushima disaster in Japan.
- Average transmission, distribution and consumer-level losses exceeding 30%.
- Over 300 million people in India have no access to electricity. Of those who do, almost all find electricity supply intermittent and unreliable.
- Lack of clean and reliable energy sources such as electricity is, in part, causing about 800 million people in India to continue using traditional biomass energy sources – namely fuel wood, agricultural waste and livestock

dung – for cooking and other domestic needs. Traditional fuel combustion is the primary source of indoor air pollution in India, causes between 300,000 to 400,000 deaths per year and other chronic health issues.

- India's coal-fired, oil-fired and natural gas-fired thermal power plants are inefficient and offer significant potential for greenhouse gas (CO2) emission reduction through better technology. Compared to the average emissions from coal-fired, oil-fired and natural gas-fired thermal power plants in European Union (EU-27) countries, India's thermal power plants emit 50 to 120 percent more CO2 per kWh produced.

Energy Efficient Irrigation

Irrigation is very important to productive agriculture, accounting for 20% of all farmland and 40% of all production worldwide. This is the major use of water in the world, accounting for about 70% of all freshwater use. Efficient irrigation systems use energy-efficient equipment and designs, and also minimize the amount of unnecessary water use, adding to the energy savings. As a result, farms that irrigate efficiently will not only reduce their operating costs but will also reduce the use of water resources that are increasingly scarce. There are two main ways a farm can improve the efficiency of its irrigation efforts: 1) improving the irrigation system, and 2) enhancing the management and operations of the system Modifying irrigation systems can reduce energy and costs. For example, according to the Natural Resources Conservation Service (NRCS), in certain areas of the United States, switching from high- to low-pressure sprinkler systems can save as much as $55 and 770 kWh per acre annually. In areas where ground and surface water availability is diminishing, efficient irrigation tools such as drip, trickle and lower-flow sprinkler systems save energy as well as water and money. Some common causes of wasted energy in irrigation systems are worn or improperly sized pumps, worn nozzles, and improperly sized or designed fittings. Irrigation equipment problems and maintenance problems tend to go hand in hand. Pumps, motors, and engines that are badly designed or poorly maintained reduce the irrigator's degree of control over water applications, making it impossible to maintain correct soil moisture levels. This leads to crop stress, reduced yields, runoff, erosion, and other problems.

Irrigation Management Improvements

On the other hand, mechanical improvements alone do not necessarily bring energy savings. Better system performance typically causes higher pressure and increased volumes of applied water. These improvements should make it possible to meet crop water needs with fewer hours of irrigation. But if the irrigator continues to run the system for the same number of hours, energy consumption often stays the same or even in In order to avoid both overwatering and under watering, all irrigators need to know their system's net water application rate, measured in inches per hour or inches per irrigation. All irrigators should know general irrigation guidelines for the crops they grow. They should also know how to check their soil moisture levels.

Solar Water Pumps

A solar powered pump can be more environmentally friendly and economical in its operation compared to pumps powered by an internal combustion engine (ICE) or nuclear power. For irrigation and drinking water solar PV water pumping systems are used in India. Solar water pumping system works on power generated using solar photovoltaic system. The solar energy is converted in to electricity by using a photo voltaic array. This electricity is used for running the motor pump set. The pumping system can draw water from bore well, open well, pond, stream etc.Usually 200 watt to 3000 watt motors are used in water pumps and these motors are powered with 1,800Wp PV array which can bear about 140,000 litres of water/day from a total head of 10 meters. There are basically 2 types of solar water pumps, which are positive displacement and centrifugal solar pumps. These are again classified in to submersible pumps, surface pumps and circulating pumps.

Requirements for solar water pumps:

Solar pumps require no fuel and little or no maintenance. This system needs a shadow � free area for installing the solar panel.

Utility:

A system having PV array capacity of 1800 watt and 2HP pump can discharge about 1.4 lakh litres of water per day from a depth of 6-7 meters. This amount water can be used for irrigation of about 5 -8 acres of land holding for several crops.

Advantages of solar water pumps:

- Clean and efficient
- Electricity is not required
- No fuel cost
- Low labour and maintenance cost
- Highly reliable
- Durable
- Eco friendly
- Long operating life (Usually 20 to 40 years)
- Easy to remove, transport and store
- Non polluting
- No need of complicated wiring
- Simple to install

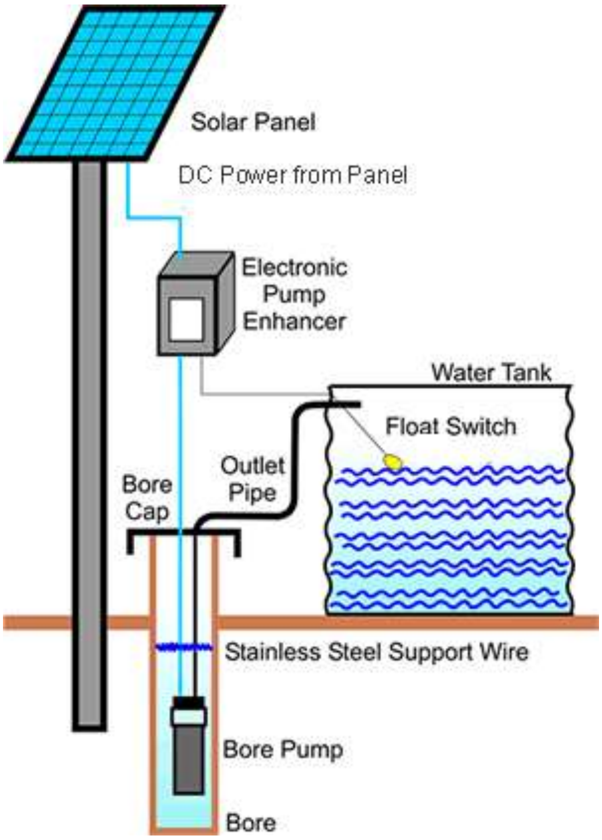


Fig 1. Solar Energy Water Pump

Benefits of Solar water pumps:

Solar water pumps are used for irrigation of crops, water livestock and provide portable drinking water. Solar water pump uses peak solar array output which frequently coincides with high water demand during long, dry summer days. In the event of cloudy weather solar water pump systems often use storage tanks to store excess water. Solar water pumps do not require fuel or constant maintenance. Solar water pumps can also be designed for portability to be moved as water demand or change of season requires. Their operating cost is less compared to diesel pumps.

How solar powered pumps score over diesel pumps:

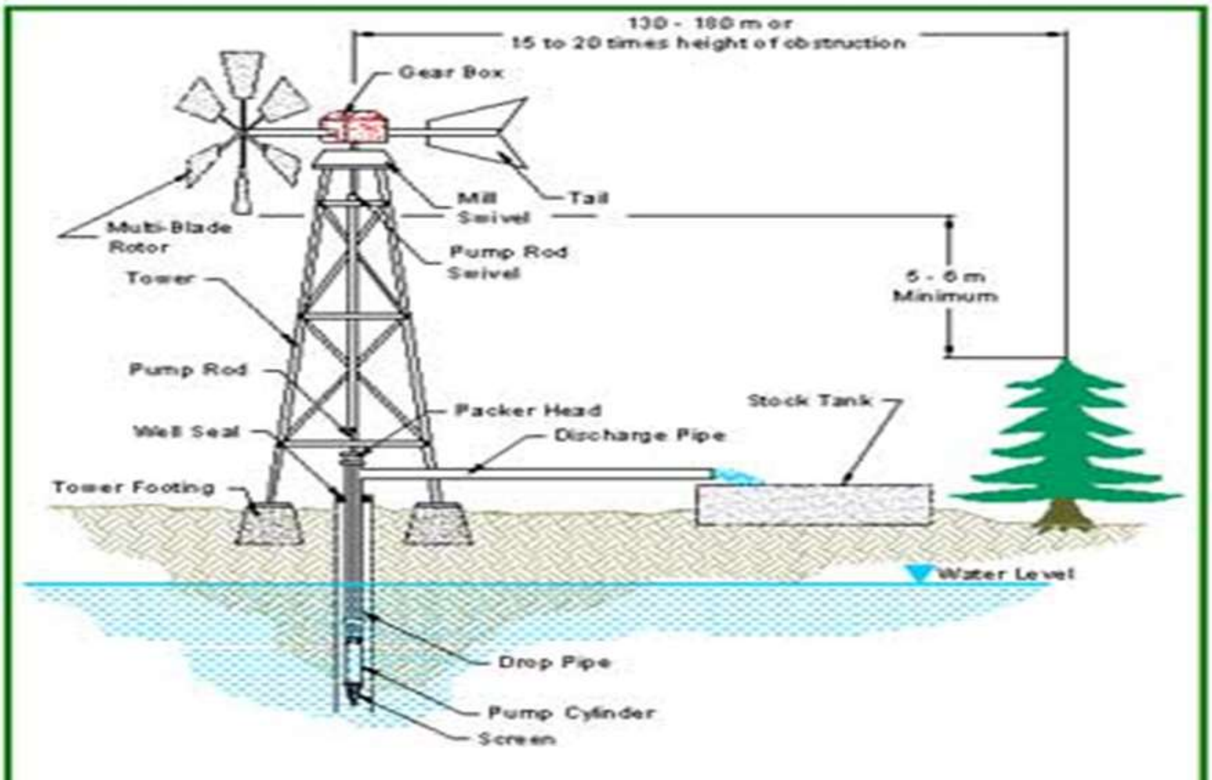
- Simple to install
- Solar pumps are good for bore holes as they pump over the whole day
- Weak boreholes can be used effectively with a low volume pump due to pumping 8 to 10 hours a day
- Require minimal attention since they are self starting
- To increase daily water pumping rates, tracking arrays can be used
- Environment friendly
- Solar pumps offer clean solutions with no danger of borehole contamination

Windmill Water Pump

Water is essential for humans, animals and crop irrigation. Frequently the water needs pumping from the ground, rivers, canals, and wells using hand pumps, centrifugal pumps, solar-powered water pumps, wind pumps etc. Wind pumps are particularly useful in remote areas where there is good wind but no electricity for the conventional water-lifting devices. Wind pumps are an established technology. A number of researches in wind pumps have taken place all over the world and many good wind pump designs, which are efficient and cost effective, are available. Over one million wind pumps are in use world-wide. In India, nearly 3000 wind pumps are in operation. A wind pump needs no fuel, little maintenance and usually lasts 20 years or more. For the areas where a wind speed of more than 6 Kms per hour (annual average) is available, it is a good option to use water-pumping windmills for irrigation purposes. A water- pumping windmill converts kinetic energy of the wind into mechanical energy for pumping of water from bore wells or open wells. Different designs are available out of which water can be pumped from the depth of 10 to 50 metre. This is equivalent to 0.75 hp of electrical water pump. One windmill is sufficient for the irrigation of one to three acres of land.

How a windmill works

The windmill's wheel (fan) has 15 to 40 galvanized steel blades which spin around on a shaft. The shaft drives a geared mechanism that converts rotary motion to an up-and-down motion like a piston in a car engine. That motion drives a long pump rod (aka sucker rod) going up and down inside of a pipe in the well. Attached to the end of the pipe is a cylinder with a sealed plunger going up and down in it that forces the water up the pipe. The seals (cupped seals that ride up and down in the pump-cylinder) are called "leathers." (Neoprene instead of leather is used in most cylinders today.) Each up-stroke pulls a certain amount of water into the cylinder, but on the down-stroke a check valve (aka foot valve) in the bottom won't let it be pushed out, so the water has nowhere to go but up (with the next upstroke). It's a simple efficient design that has remained virtually unchanged for more than 100 years.



Typical Windmill Water Pump

An average windmill (6 to 8 foot-diameter wheel) spinning in a brisk breeze (15 to 20 mph) will pump about three gallons a minute whenever the wind blows (about 35 percent of the time in many areas). That adds up to about 1500 gallons a day. Another example of output could be calculated by using a 10 to 12-foot wheel pumping against a theoretical 100-foot head (the column of water lifted from the static water level to the tank). This larger windmill will pump an annual average of 4500 gallons per day, or 1.63 million gallons of water a year. This figure is based on moderate winds (8-12mph) blowing part of the time, running the mill at half its rated capacity, and brisk winds (15 to 25 mph) blowing about 30 percent of the year and running the pump at maximum capacity.

Wind speed has an important effect on pumping capacity. Below certain speeds the mill can't "get going." Above 25-35 mph (depending on the model) the windmill's overspeed controls limit the output by turning (furling) the direct face of the wheel out of the main wind direction. This design feature protects the windmill mechanism, but it also limits the pumping rate no matter how fast the wind blows.

Construction

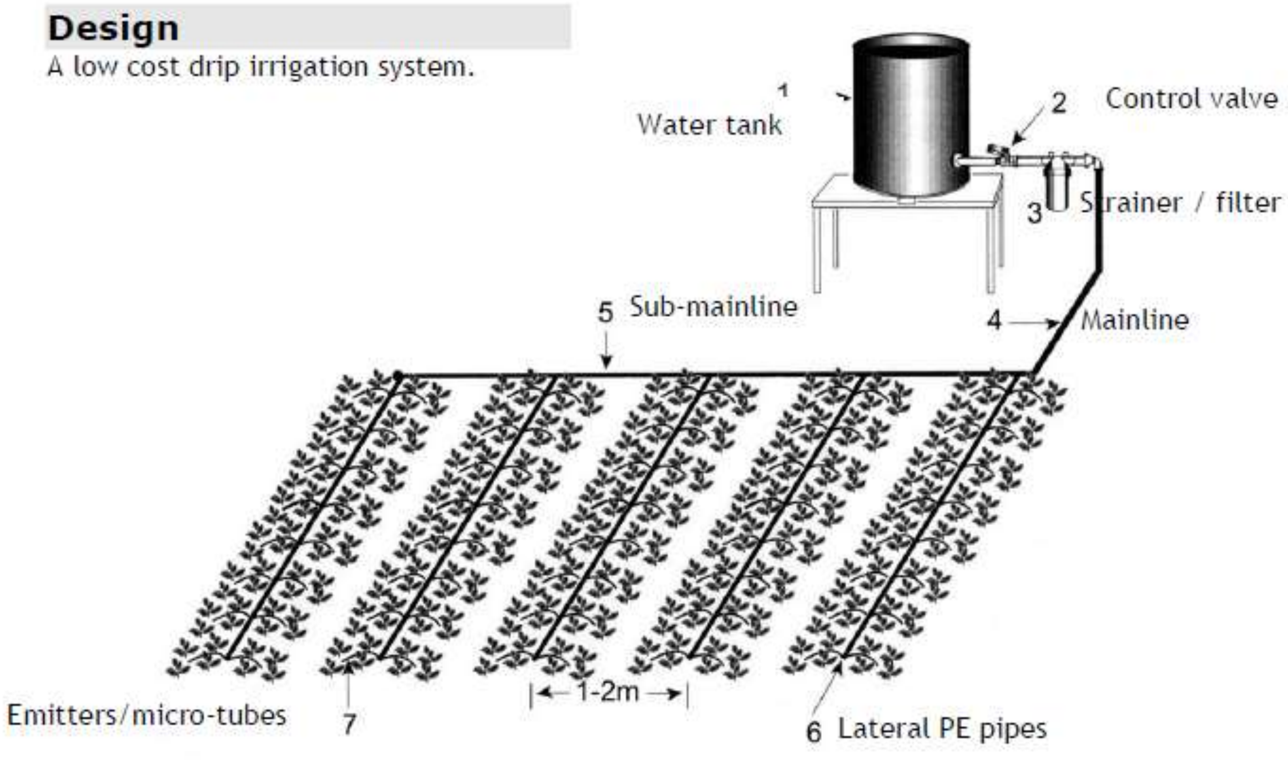
To construct a windpump, the bladed rotor needs to be matched to the pump. With non-electric windpumps, high solidity rotors are best used in conjunction with positive displacement (piston) pumps, because, single-acting piston pumps need about three times as much torque to start them as to keep them going. Low solidity rotors, on the other hand, are best used with centrifugal pumps, waterladder pumps and chain and washer pumps, where the torque needed by the pump for starting is less than that needed for running at design speed. Low solidity rotors are best used if they are intended to drive a electricity generator; which in turn can drive the pump.

Uses for a windmill

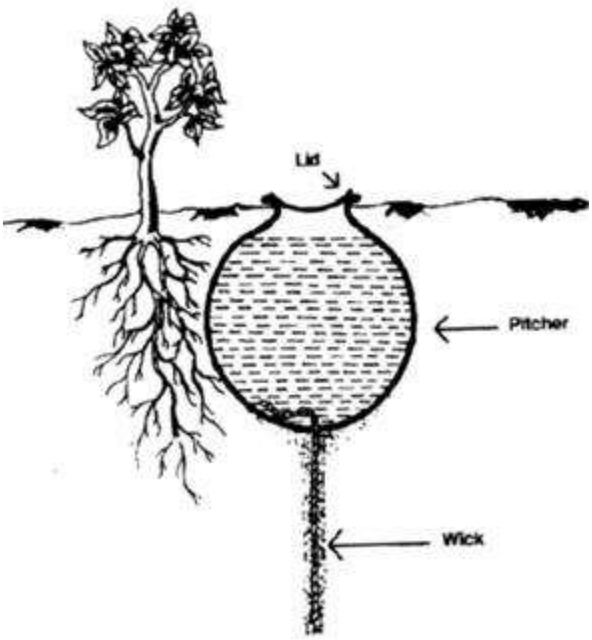
The most common practical uses for a windmill are to irrigate pastures and gardens, water livestock, and supply, and aerate ponds. Anything more than that requires a holding tank on "stilts," or a water tower, to provide enough pressure to be "on tap" for household use. Evidently a lot of people feel that windmills are making a comeback. Aerometer claims that sales of windmills, both for generating electricity and for pumping water, are increasing worldwide, and more windmills are pumping water today than at the turn of the century.

Low Cost Drip Irrigation

Drip irrigation is a water efficient irrigation system, where water is dripped to individual plant roots zones at low ratesat about 2.25 l/hour from emitters embeded in small diameter plastic pipes. The technology can be established in February and March for pre-monsoon vegetables and during September and October for winter vegetables. A simple drip irrigation uses low-cost plastic pipes cut to the appropriate lengths laid on the ground to irrigate vegetables, field crops and orchards. Small holes in the hose allow water to drip out and keep the base of the plant wet without wasting any water. A simple drip can consist of a 20 litre bucket with 30 metres (100 feet) of hose or drip tape connected to the bottom of the tank. The bucket is placed at least 1 metre (3 feet) above the ground so that gravity provides sufficient water pressure to ensure even watering for the entire crop. Clean water is poured into the bucket daily through a filter/ strainer. The water in the bucket fills the drip tape and is evenly distributed to 100 watering points. A multi-chambered plastic drip tape is engineered to dispense water through openings spaced at 30cm (12 inches). The bucket kit is the smallest type of drip irrigation technique.



Pitcher Irrigation



This is a technique for creating slow release of water below the ground, minimizing evaporation losses and risk of salinization. It is similar to drip irrigation, but less expensive to install. The pitchers are the round earthen containers used in rural areas for water storage, ranging from 10 to 20 liters in capacity. This kind of irrigation is ideal for spreading plants such as gourd, pumpkin, and melon because few pitchers are needed per unit area. It is also very good irrigation for saplings, promoting deep root growth. First, dig a pit as deep as the pitcher, and place the pitcher inside. Then surround the pitcher with finely powdered soil, pressed against the outer wall of the pitcher. Keep the neck of the pitcher above the soil surface. Fill the pitcher with water and replace the lid (to prevent mosquito breeding). In a day or two when the moisture in the pitcher has spread into the surrounding soil, plant seeds within the moist area (downhill from the pitcher if the ground is sloping). Refill the pitcher anytime ¾ of the water is gone. The pitcher should be positioned so that rainwater runoff cannot enter it directly, otherwise silt may block the pores of the pitcher. Soluble fertilizers can also be mixed with water and applied through the pitcher. If the water used for irrigation has high salinity, the pitcher location should be changed every 3 years. To increase the depth of irrigation, a wick can be added to the pitcher as shown in the picture (the hole in the bottom must be made before firing). The cotton wick must be firmly fixed in the hole to prevent plant roots from entering. If pitchers are used for starting saplings, they can be removed after 1 or 2 years and used elsewhere, because the young trees will have developed deep roots

CONCLUSION

By exploring renewable energy resources such as solar, biomass, wind, has abundant availability of these sources in agriculture. It has the benefits, challenges, and opportunities associated with the adoption of renewable energy technologies in the agricultural sector. Transitioning to alternative energy sources for energy management in agriculture holds great promise for reducing greenhouse gas emissions, improving energy efficiency, and promoting sustainability in food production. By advancing energy management practices and promoting the adoption of renewable energy in agriculture, we can contribute to a more sustainable and resilient agricultural sector, ensuring food security, mitigating climate change, and fostering overall sustainable development. Identifying renewable energy sources to replace today's dwindling supply of cheap and usable fossil fuel is the only practical response to the problem of depleting non-renewable resources.

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