International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2020; 8(1): 1248-1253

Received: 20-11-2019
Accepted: 24-12-2019

MK Ghosal
Professor, Department of Farm Machinery and Power, College of Agricultural Engineering and Technology, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, India

SK Mohanty
Professor, Department of Farm Machinery and Power, College of Agricultural Engineering and Technology, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, India

Corresponding Author:
MK Ghosal
Professor, Department of Farm Machinery and Power, College of Agricultural Engineering and Technology, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha, India

Studies on use of renewable energy gadgets for enhancing livelihood of farm women

MK Ghosal and SK Mohanty

DOI: https://doi.org/10.22271/chemi.2020.v8.i1q.8423

Abstract
Women are the backbone of the agricultural workforce and are a vital part of nation's economy. Over the years, there is a gradual realization of the key role of women in agricultural development and their contribution in the field of agriculture, food security, horticulture, dairy, nutrition and other allied sectors. Women comprise the majority of the agricultural labourers and put themselves in labour not only in terms of physical output but also in terms of quality and efficiency. Based on the 2011 census, 37% of the total number of agricultural workers in the country are women and by 2020, this figure is expected to be about 45%. The involvement of women in enhancing the livelihood for their family can also not be neglected. Hence propagation of various renewable energy gadgets needs to be popularized among the farm women for livelihood improvement.

Keywords: Renewable energy gadgets, farm women, solar pump, kitchen gardening, forced draft solar cooker

Introduction
The growing demands of energy in the present agricultural sector have necessitated the adoption of reliable, sustainable and environment-friendly technologies so as to combat against the energy crisis in near future. It has been established that conventional sources of energy like oil, gas, coal etc. would not be able to provide the desired levels of energy security to mankind in foreseeable future. Hence, there is a global consensus for exploitation and utilization of different renewable energy resources. Renewable energy represents an area of tremendous opportunity for the country like India as it has been endowed with plenty of renewable energy resources from the point of view of its geographical location. Development of conventional forms of energy for meeting the growing energy needs of society at a reasonable cost is the responsibility of the Government. However, limited fossil fuel resources and associated environmental problems have emphasized the need for new sustainable energy supply options. We are still heavily depending on coal and oil for meeting our energy demand which contributes to smog, acid rain and greenhouse gases' emission. Last 25 years has been a period of intense activities related to research, development and production of alternate sources of energy with a view to achieve energy security and environmental protection. Though major energy sources for electrical power are coal and natural gas, development and promotion of non-conventional sources of energy such as solar, wind and bio-energy, are also getting sustained attention now-a-days. Sustainable sources of energy in agricultural sector are also presently the urgent need of the hour in order to attain secured source of energy and to achieve food security for the fast growing population of our nation. Hence popularization and approach for switching over slowly from conventional to non-conventional sources of energy should be the present day's strategy of the society so far as the economic feasibility, social desirability and environmental soundness are concerned. In this discussion, the use of some renewable energy gadgets particularly in the agricultural activities has been discussed briefly in order to provide the appropriate insights among the farming community to adopt with highly reliable, non-polluting and naturally available energy sources for overall sustainable development.

Solar pumping based kitchen gardening and drinking water supply

Kitchen gardening is a viable option for a family due to the constraints in the availability of sufficient space around their residential house. With the small plot of land, kitchen gardening may be adopted for growing remunerative and short duration vegetables which not only supports livelihood but also supplies fresh produces for nutrition. The green vegetables contain vitamins and minerals which protect us against diseases. Apart from the availability of fresh vegetables, kitchen garden prevents pollution of air. It purifies the air through the plants. Plants breathe in carbon dioxide and breathe out oxygen which is vital for our life and maintains a clean environment around us. However, for sustainable farming, water is a critical input and its scarcity is now-a-days a major concern for achieving assured irrigation. Hence, solar photo voltaic water pumping system is today a superior option left for the farming community as its pumping cost is cheaper as compared to electric and diesel pump sets. Moreover, the risk of environmental pollution is less and its repair and maintenance cost is very low. It can be installed at any location as per the desire of the farmers as solar energy is available profusely and free of cost in the nature. It is a stand-alone system not only for pumping water in irrigating plants but also supplying clean and safe water for drinking purpose. The set up may also be adopted on community basis covering ten families in order to reduce the sharing cost among them. The raw banana and leafy vegetables may be grown throughout the year in a small patch of land to earn their livelihood. The set-up is shown below.

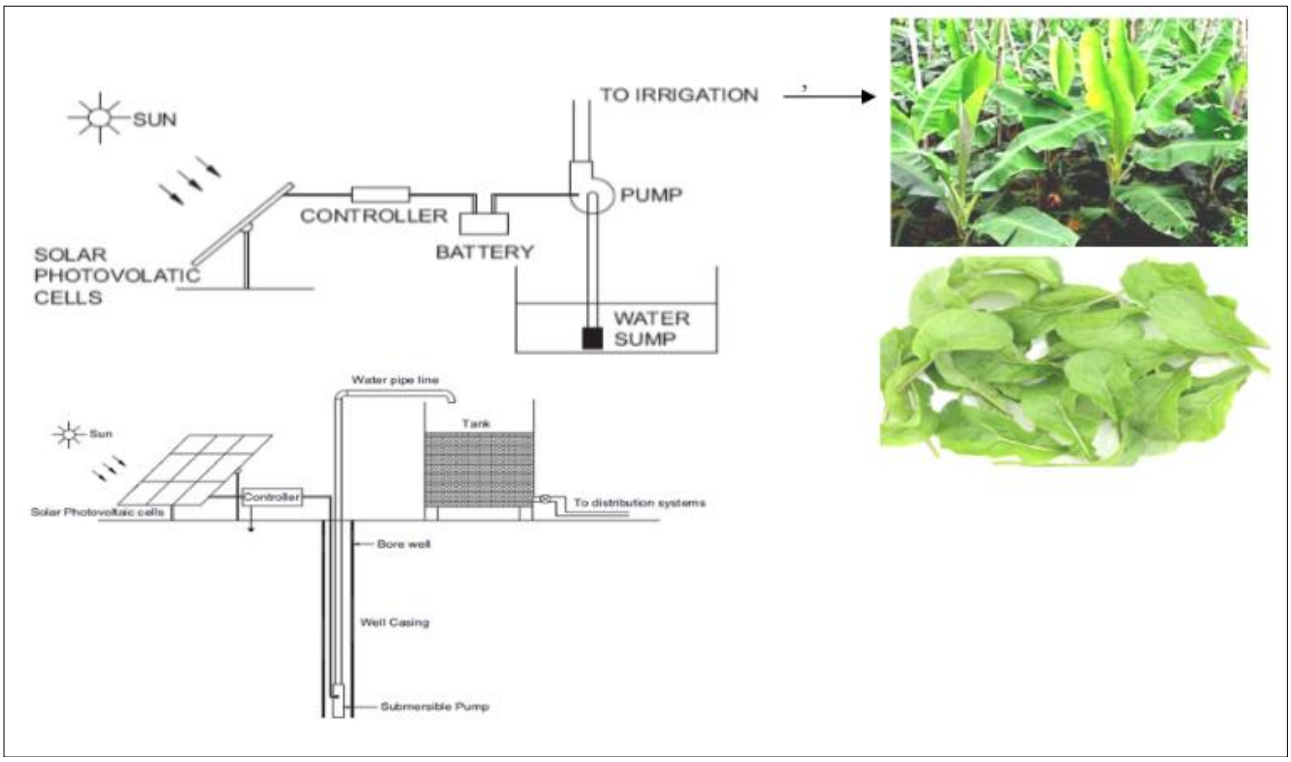

Fig 1: Both for irrigation and drinking water supply

Cost of solar water pumping system

Solar PV Module (4 x 220 w_p) = 880 watt @ Rs. 40 per w_p = Rs. 35,000

Solar pump

1.0 hp DC pump set with controller	= Rs. 75,000
Boring of deep tube well	= Rs. 50,000
Total	= Rs. 1,60,000

Submersible screw type pump, DC Pump (1.0 hp), Head: 50-70 meter, Pumping water: 18, 000 - 21, 000 litres per day

Economics of using one solar pump for ten families

Sharing Cost of installation of one solar pump for each family: Rs. 16,000

Expected space available for each tribal family for kitchen gardening: 500 sq. ft (50 sq, m)

Tissue culture raw banana cultivation

Submersible screw type pump, DC Pump (1.0 hp), Head: 50-70 meter, Pumping water: 18, 000 - 21, 000 litres per day

Economics of using one solar pump for ten families

Sharing Cost of installation of one solar pump for each family: Rs. 16,000

Expected space available for each tribal family for kitchen gardening: 500 sq. ft (50 sq, m)

Tissue culture raw banana cultivation

Number of tissue culture raw banana plants cultivating on the boundary area of one tribal family with available boundary length of 90 ft. with 4.5 ft plant to plant spacing: 20

Yield of banana from one plant per annum with assured irrigation (1 bunch with 200 bananas): 200 number

Income from one banana plant per annum with Rs. 4.00 per piece: Rs. 800

From 20 plants total income per annum: Rs. 16,000

Leafy vegetable (greens) cultivation

Yield of leafy vegetables (greens) (amaranthus, spinach and coriander etc.) in expected space of 50 m^2 area (500 sq. ft.) in one-time cultivation = 100 kg

Eight bundles of marketable greens weigh 1 kg, costing Rs. 20/-

Duration of cultivating leafy vegetables for one time: 60-70 days
Income from 100 kg = 2000 and taking cost of cultivation = Rs. 500
Net Income in 50 m^2 area in one-time cultivation = Rs. 1500
Cultivating five times in a year, total income = Rs. 1500 x 5 = Rs 7500
Total income per annum from raw banana and leafy vegetables = Rs. 23,500
Expected monthly income for a family = Rs. 2000

Solar cooking

Traditional cook stoves and mostly open fire cooking system are being followed by the tribal people since last 2-3 generations due to lack of knowledge and awareness and also unavailability of any improved cook stove in that locality. The energy of burning biomass fuels into an open fire is about 90%, but 10% to 20% of the released energy is only transferred to the cooking pot. The improvement on the combustion efficiency of the biomass fuel does not appreciably help to use less biomass fuel. In comparison, the efficiency on the heat transfer to the pot makes a lot more difference than combustion efficiency due to the fact that the lesser the use of the fuel, the lesser be the amount of pollution it can contribute. Women and girls of a rural based family spend major part of a day regularly in collecting firewood for cooking purpose. Traditional cook stoves not only consume a lot of biomass but also emit harmful pollutants causing health hazards for the women and girls who spend most of the time in a day for domestic cooking in an unventilated kitchen. Propagation of improved cook stove from non-conventional sources of energy is therefore the urgent need of that locality in order to reduce biomass consumption for cooking purpose and to save the cooking time, offer convenience in cooking process and create smokeless environment in the kitchen or reduction in the volume of smoke produced during cooking against the traditional stove. The cost of the proposed forced draft cook stove is quite affordable for each family. Therefore, improved biomass cook stove, at present, may be the appropriate solution to meet the energy requirement for rural households looking into their socio-economic conditions. Solar powered forced draft cook stove is shown below.

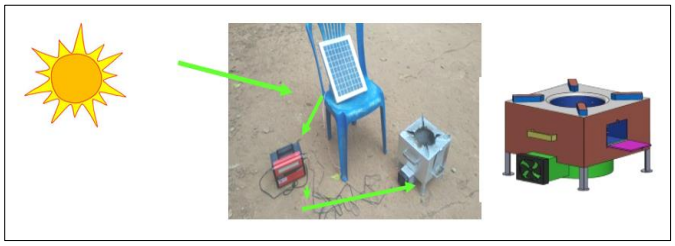

Fig 2: Solar Powered Forced Draft Cook Stove

Solar powered forced draft cook stove

Cost of cook stove, solar module, battery and exhaust fan (solar powered forced draft cook stove)

1. Cook stove
   Weight: - 6.2 kg
   Cost: -1800/-
   Capacity: -1kg/h
2. Solar Module
   10-watt capacity = Rs. 750/-
3. Solar battery with lighting system
   12V-7.5 Ah = Rs. 1050/-
4. DC Fan
   Voltage= 12 V, Current = 0.08 A, rpm = 1400 and speed 2.5 m/s
   Cost = Rs. 400/-
   Total cost per piece = Rs. 4000/-

Solar home lighting

Solar lighting system is a viable option in off-grid areas where there is the abundant availability of solar radiation throughout the year. For non-electrified and remote areas, lighting systems powered by solar photovoltaic device would be an appropriate and sustainable alternative for the people as sun is a reliable and environment-friendly source of energy. As the price of solar photovoltaic technology is decreasing day by day due to the advancement in research and development, the devices would become affordable and acceptable for all categories of people in the societies for their little maintenance and high durability. In rural dominated areas, grid electricity has not yet reached. The reasons are due to the disinterest for availing electricity owing to their poor economic condition or inaccessible for supplying electricity to the remote areas. In the evening hours, rural people are mostly using kerosene lamps for lighting purpose. The hazardous emissions from the lamp are not only harmful for human health but also polluting the nearby environment. The localities of rural people are usually remaining dark during night time. Therefore, many cases of snake bites and elephant attacks are occurring in those areas. Due to unavailability of any lighting system, many families cook their meal one time during the day hours. Availability of required quantity of kerosene per family is now-a-days also a major concern. Propagation of solar lighting system i.e. solar lanterns and solar street lights at individual level is therefore the urgent need of those areas to enhance their living standards. The other features of solar lighting system are as follows. They are (i) Safe & easy to install and use (ii) Free from noise, smoke and pollution (iii) Elegant and efficient luminaries (iv) Available in different configurations (v) Highly reliable (vi) No fuel dependence (vii) Modular design allows system expansion (viii) Power for any location (ix) Highly advanced charge controller (x) Requires very little attention. A Solar lantern is a simple application of solar photovoltaic technology, which has also found good acceptance in rural regions where the power supply is irregular and scarce. The photograph of solar lantern is mentioned below.

Fig 3: Cost of solar lantern is Rs. 2500 which is also affordable by rural people.

Zero energy cool chamber

A considerable amount of perishable horticultural produce is wasted every year in our state due to lack of appropriate storage facilities. In a tropical climatic condition, maintenance of low temperature is a great problem. Mechanical cooling is energy intensive, expensive and not easy to install and run in rural areas. The zero energy cool chambers (ZECC), utilizing the principle of evaporative cooling is reported to maintain relatively low temperature and high humidity compared to ambient conditions which is required for short term storage of fruits and vegetables. Evaporative cooled storage structures are designed to reduce air temperature in cooling applications through the process of evaporation of water. Odisha ranks second in the country in the production of vegetables and a good amount of fruits are also produced in tribal areas of the State. The wide variation in the coastal environmental conditions poses huge difficulty in storing fresh fruits and Vegetables. The majority of farmers is usually small and marginal categories and have poor resource availability. In the absence of proper storage technique, the farmers usually sell their vegetables in the local markets soon after the harvest. This situation very often compels for a distress sale of the products at very low price. Zero energy cool chamber (ZECC) with drip irrigation system through gravity flow is becoming more effective for safe storage of vegetables. Drip irrigation system is used for uniform wetting of sand layer for proper evaporation to occur resulting into decrease in temperature and increase of humidity in zero energy cool chamber. Application of water in the chamber plays a vital role in regulating temperature and RH. Too dry cool chamber will not provide the desired cooling effect and too moist chamber causes unnecessary wastage of water and may sometimes lead to fungus growth. Therefore, it is necessary to find out the optimum quantity of water needed under different situations of seasonal variations to achieve effective performance of the chamber.

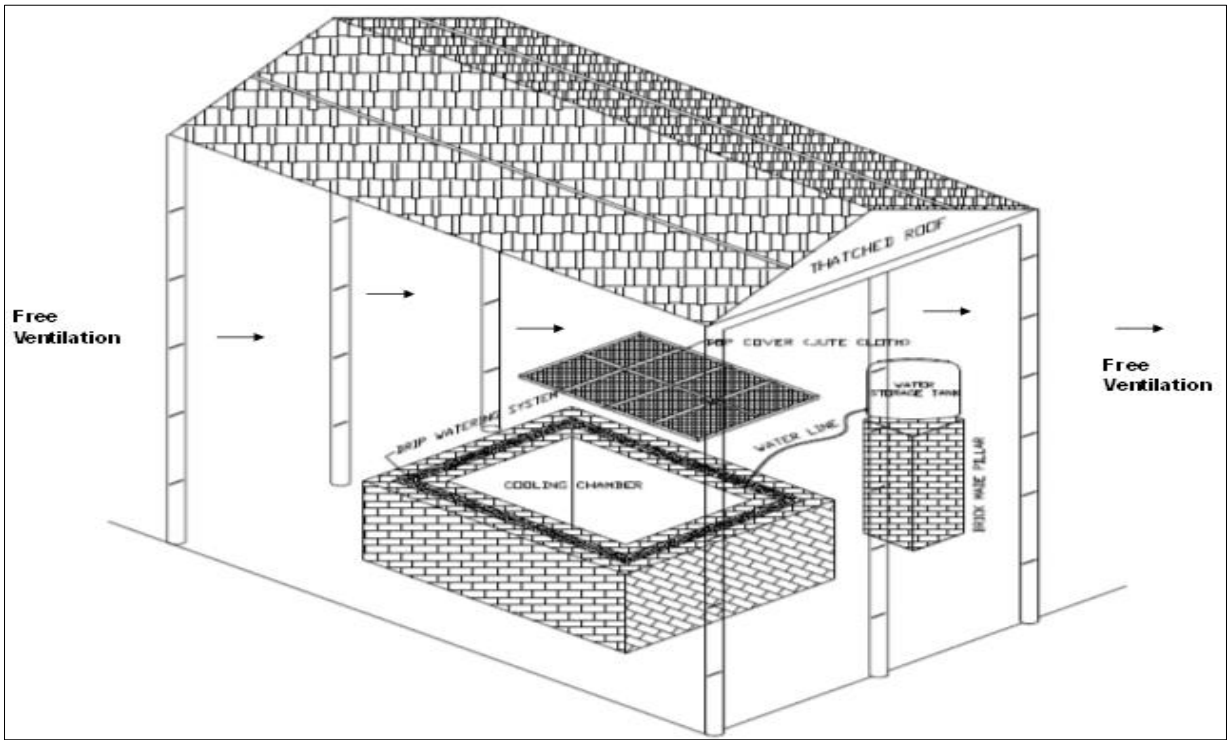

Fig 4: Zero energy cool chamber

Solar Refrigerator

One of the important applications of solar refrigeration is the preservation of fruits and vegetables due to the major concern of about 30-35% of their annual post harvest losses in the leading vegetable growing country like India. India is the second largest producer of vegetables having 9.20 million ha under vegetable crops, with a production of 162 million tones (Jain 2007). Vegetables are required to be stored at lower temperature because they are highly perishable in nature. There are many methods to cool the environment. Preserving them in their fresh form demands that the chemical, bio-chemical and physiological changes are restricted to as minimum as possible by close control of space temperature and humidity. The high cost involved in developing cold storage or controlled atmosphere storage is a pressing problem in several developing countries. Several simple practices are useful for cooling and enhancing storage system efficiency wherever they are used, and especially in developing countries, where energy availability may be critical. The refrigeration and other commercial cold storage systems are the solution of the problem, but could not be fully exploited due to heavy initial cost and demand high input of energy. Mechanical refrigeration is also energy intensive and expensive, involves considerable initial capital investment, and requires uninterrupted supplies of electricity which are not always readily available, and cannot be quickly and easily installed. Available cold storage in India is used primarily for the storage of potatoes. Appropriate cool storage technologies are therefore required in India for on farm storage of fresh horticultural produce in remote and inaccessible areas, to reduce losses. The favorable environment for storage of fruits and vegetables is low temperature and high humidity due to their high moisture contents. Combination of both temperature and relative humidity to the recommended storage condition is very important to enhance the shelf life of vegetables. Recommended temperature may be achieved due to mechanical refrigeration but desired humidity cannot be maintained. Hence to maintain both the parameters, mechanical refrigeration as well as evaporative method of cooling are required.

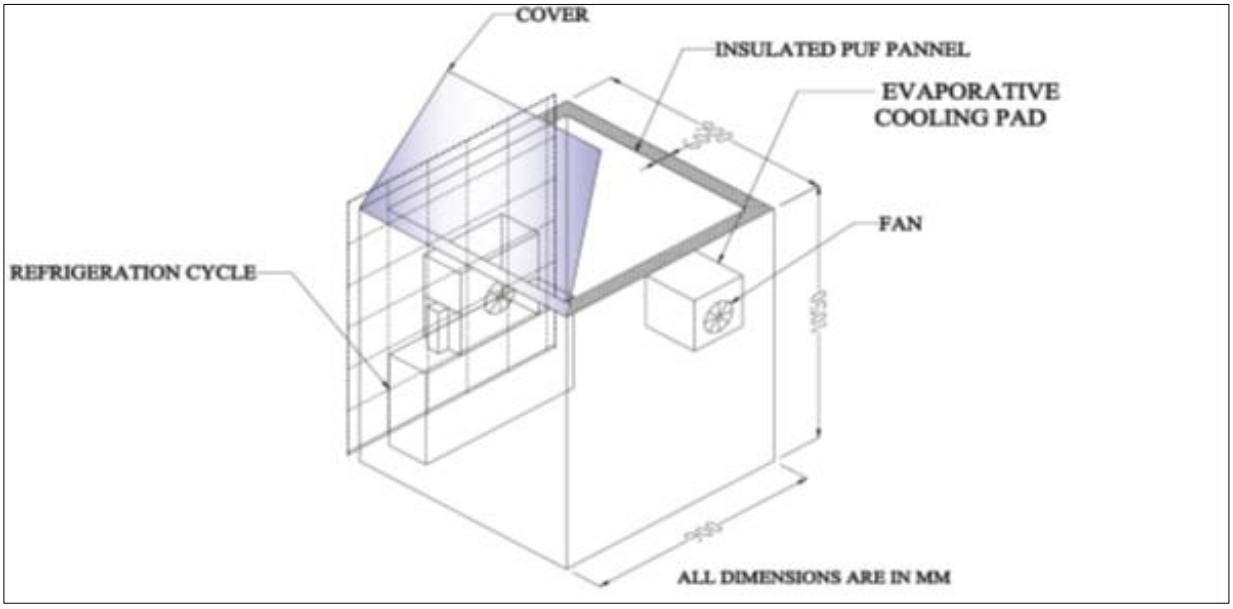

Fig 5: Experimental cooling chamber for 100 KG storage capacity

Cooling through evaporation is an ancient and effective method of lowering temperature. Both plants and animals use this method to lower their temperatures. Trees, through the method of evapo-transpiration, for example, remain cooler than their environment. The basic principle relies on cooling by evaporation. When water evaporates, it draws energy from its surroundings which produce a considerable cooling effect. Evaporative cooling occurs when air that is not too humid passes over a wet surface: the faster the rate of evaporation, the greater the cooling. The efficiency of an evaporative cooler depends on the humidity of the surrounding air. Evaporative cooling is dependent on the conditions of the air and it is necessary to determine the weather conditions that may be encountered to properly evaluate the possible effectiveness of evaporative coolers. On the other hand, the amount of water vapour that can be taken up and held by the air is not constant: it depends on two factors: the first is the temperature (energy level) of the air, which determines the potential of the air to take up and hold water vapour. The second involves the availability of water: if little or no water is present the air will be unable to take up very much. The operational effectiveness of an evaporative cooler is made up of a porous material that is fed with water. Hot dry air is drawn over the material. The water evaporates into the air raising the humidity and at the same time reducing the temperature of the air. However, required drop of temperature in the cool chamber compared to ambient condition may not be obtained in evaporative cooling method, but desired humidity may be achieved if active method of using a motor for water circulation and a fan for sucking outside air are integrated in the system. But reliable source of power to operate such a system comprising mechanical refrigeration system and active evaporative cooler is a major constraint in rural and off-grid areas. To make the system sustainable with respect to energy independence and reliability in grid-isolated remote areas for short-term on-farm storage of vegetables, there is the necessity of a device integrating both mechanical compressor and passive or active evaporative cooling system which can be powered by an environment-friendly and renewable source of energy. Among the various renewable energy sources, application of solar energy may be a viable option because of its adequate availability in a tropical country like India. Hence, in this paper, current status of research and recent developments in solar refrigeration systems has been reviewed for their application in various sectors including storage of vegetables. For storage of vegetables, the developments of cool chambers should be such that the temperatures in the range of 10–15 °C and relative humidity from 85 to 95% can be maintained for obtaining better performance from the device.

Economic benefits

- Adoption of solar water pumping among rural family for kitchen gardening would achieve assured irrigation throughout the year and improve livelihood by cultivating seasonal vegetables and leafy vegetables (Greens) with less space.
- Monthly income of around Rs. 2,000/- throughout the year would be possible by adopting remunerative and short duration vegetable cultivation in 1/100th acre of land in the kitchen garden.
- The proposed set up may also be utilized for drinking water supply from underground source.
- Pay- back period of the proposed set up for ten families is 1 year, due to which, it may be easily accepted by the resource poor people in spite of its high initial cost.
- Life of the solar water pump is around 20 years
- The health of rural women can be protected from indoor air pollution by using solar powered cook stove
- Solar home lighting can provide safety and security for the lives of the rural people.

Conclusion

There is no doubt that renewable sources of energy would play critical role in ensuring energy security of the country. There is enormous potential to generate energy from renewable sources like solar and wind. The government of India has been very actively involved in promoting renewable energy. It is high time for the government to develop a comprehensive renewable energy policy and design support schemes for the benefit of the farming community.

References

1. Amit Garg, Bhushan Kankal, Shukla PR. Methane emissions in India: Sub-regional and sectoral trends. Atmospheric Environment. 2011; 45(2011):4922-4929.

2. Anjneyulu Y. Introduction to Environmental Science. B. S. Publications, Hyderabad, 2004, 500095.
3. Bahaj AS. World's first solar powered transport refrigeration system. Renewable Energy. 1998; 15(1-4):572-576.
4. Eltawil MA, Samuel D. Performance and Economic Evaluation of Solar Photovoltaic Powered Cooling System for Potato Storage. Agricultural Engineering International: the CIGRE journal. Manuscript EE 07008. Vol. IX. November, 2007.
5. Tom EI, Omer OMM, Taha SA, Sayigh AAM. Performance of a photovoltaic solar refrigerator in tropical climate conditions. Renewable Energy. 1991; 1(2):199-205.
6. FAO. Report on climate change and food security, FAO, Rome, 2010.
7. GEO_5, Global Environment Outlook, UNEP, 2012, 38.
8. IEA. Carbon dioxide emissions from fuel combustion highlights. International Energy, 2011.