

# Solar Energy in Agriculture and Food

## **Aim:**

**To make awareness about the importance of solar energy and efficient use.**

*On International millet year 2023:*

*The food is not merely to satiate the hunger, but also should supplement of the nutrients and nutraceuticals. Now, time has come to think over either the life on pill or coming back to traditional foodgrains with green energy cooking. Millets are loss in past few decades considering the poor men's food, which are now coming back to nutritious, functional and nutraceutical capabilities.*

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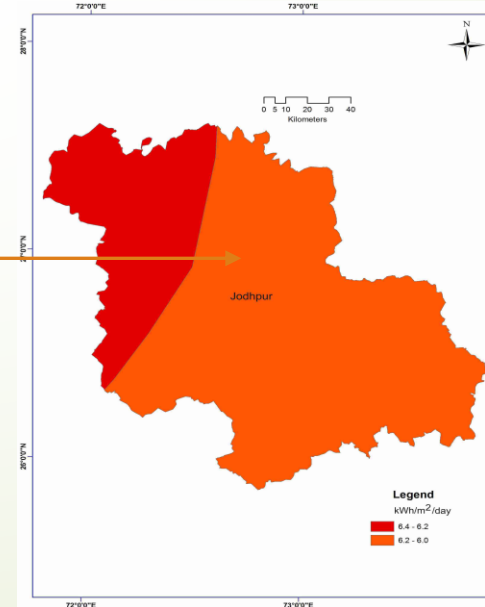
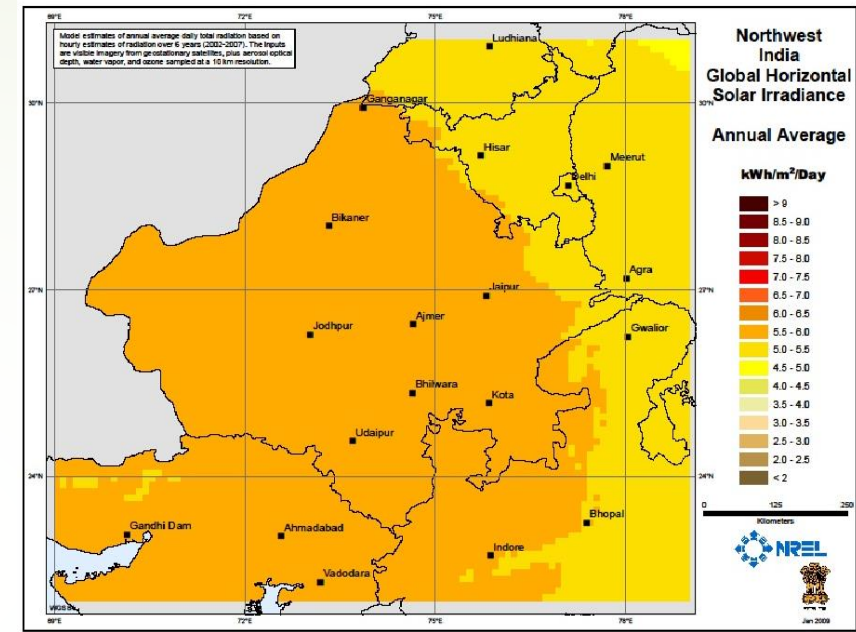
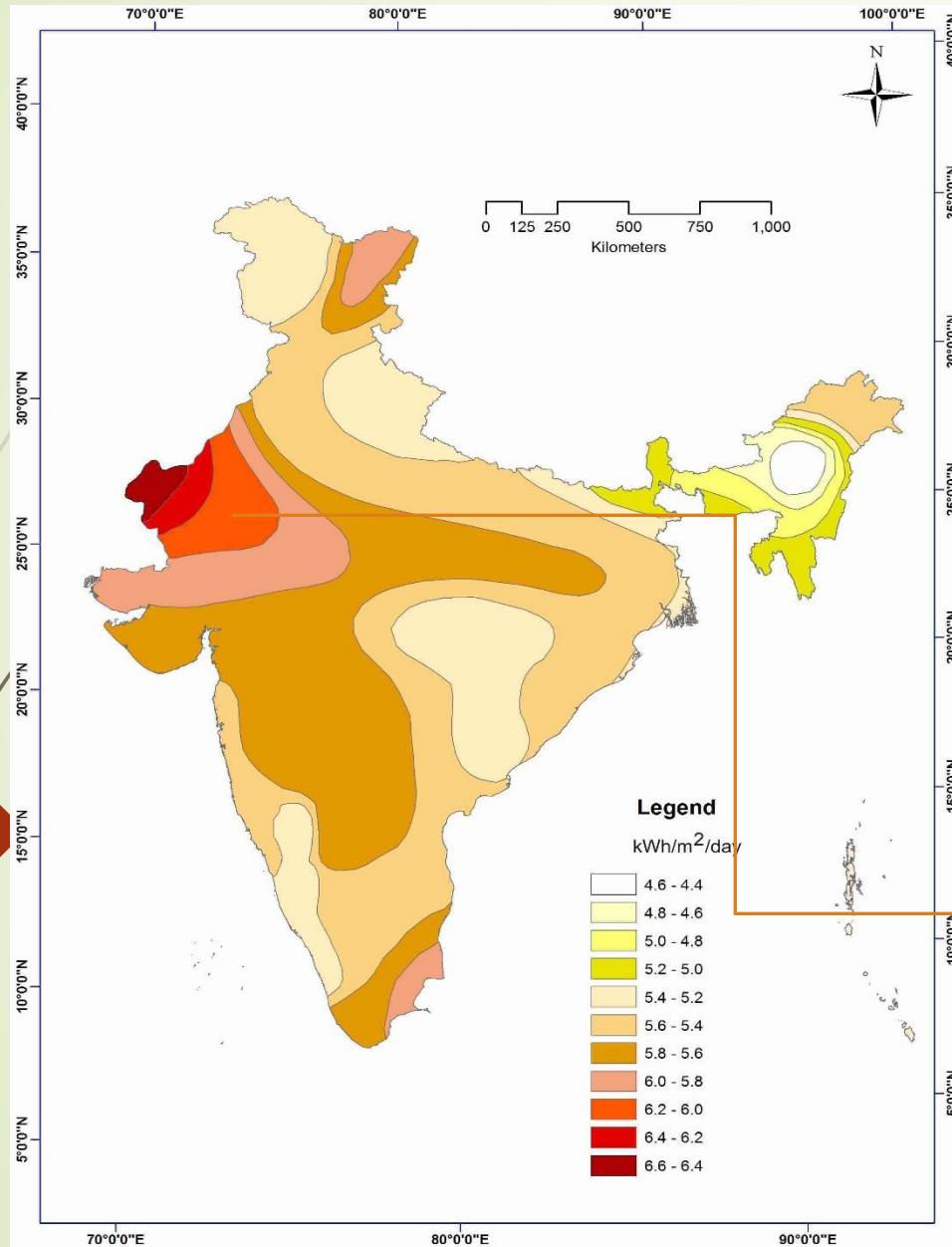
## **Why solar energy in food processing? The multiple benefits are:**

- Reduced climate change impact
- Reduce air pollution and improve health
- Reduce the cost of food
- Increase food nutrition availability
- Improve energy security
- Fulfill sustainable development goal of UN (No. 7 Affordable and clean energy)
- Reduction of the price risk of energy

## **How solar energy can be made in used?**

- Technology
- Policy
- Attitude

# Annual mean daily global solar radiation in India (kWh/m<sup>2</sup>/day)



# Solar Energy in India

Winter season: 4.0 to 6.3 kWh/m<sup>2</sup> day

Summer season 5.0 to 7.4 kWh/m<sup>2</sup> day

Average daily value of irradiance

India : 5.6kWh/m<sup>2</sup>

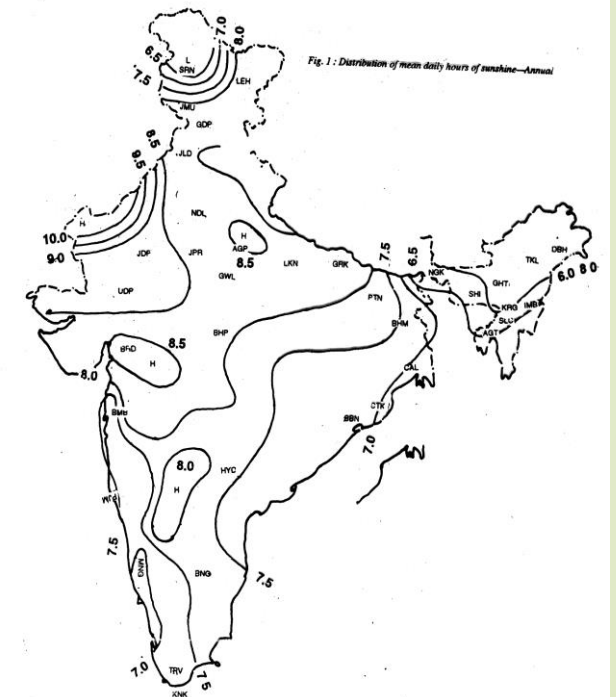
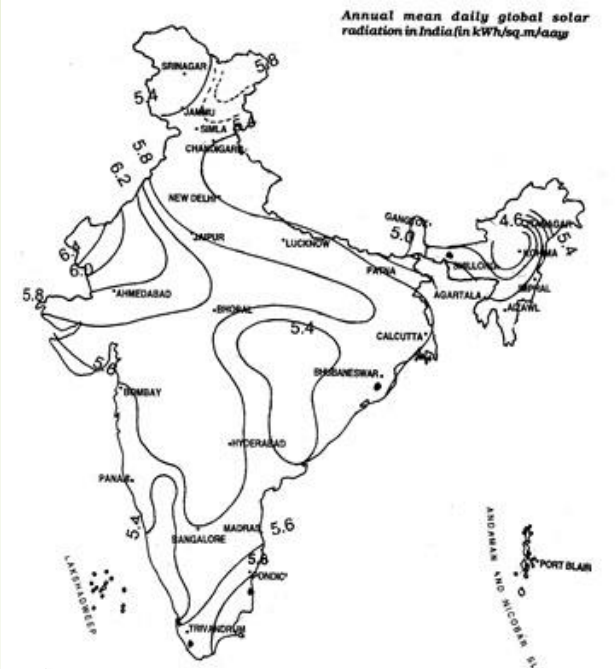
Jodhpur : 6.0kWh/m<sup>2</sup>

India receives 5000 trillion kWh/year

Sunshine hours 2300-3200 per year


**Solar Power generation: 1 MW/2-4 ha**

1% is sufficient to meet electrical need





# Role of Agriculture Technology in use of Solar Energy

- Solar thermal processing: cooking, drying, water heating, distillation
  - Greenhouse design: structure and orientation
  - Solar water pumps
  - Solar PV operated farm machines
  - Agrivoltaic technology
  - Passive cooling technique.
- 



# Food processing industry

- Typical energy intensive processes in the food sector
  - pasteurization, sterilization
  - bio-chemical reactions, fermentation
  - drying
  - evaporation, distillation
  - washing, rinsing
    - bottles, kegs, boxes, ... – Cleaning-in-Place

Process	Temperature level °C
Drying	30 - 90
Washing	40 – 80
Pasteurising	80 – 110
Cooking	95 – 105
Sterilising	140 – 150
Heat treatment	40 – 60
preheating of boiler feed	30 – 100
Water heating of production halls	30 – 60

# Solar Thermal Devices

## Incline Solar dryer

### Utility:

To dry vegetables and other agricultural products, retains of colour and aroma

### Capacity & Cost:

10 kg to 100 kg,  
Rs. 12000/- per unit  
for 10 kg capacity

Energy saving/year  
(MJ): **1584**

Reduction in GHG  
emission:  
CO<sub>2</sub> **1127 kg** / year

## PCM based Solar dryer

### Utility:

Precision drying for herbs and spices (coriander, fenugreek, chilli, ber, date palm etc.)

### Capacity & Cost:

10-12 kg per batch, Rs.  
1,00,000/- per unit

Energy saving/year  
(MJ): **2250**

Reduction in GHG  
emission:  
CO<sub>2</sub> **1442 kg** / year

## PV/T hybrid solar dryer

### Utility:

To dry different arid fruits and vegetables, retains of colour and aroma

### Capacity & Cost:

8 kg to 10 kg,  
Rs. 15000/- per unit for  
10 kg capacity

Energy saving/year  
(MJ): **1850**

Reduction in GHG  
emission:  
CO<sub>2</sub> **1315 kg** / year



Inclined Solar dryer



PCM based solar dryer



PV/T hybrid solar dryer

# Solar Thermal Devices

## Solar water purifier

### Utility:

Water purifier for sterilizing and contaminated nadi and pond water

### Capacity & Cost:

Purified 30 litres water per day, Rs. 5000/- per unit

Energy saving/year (MJ): **2715**

Reduction in GHG emission:

CO<sub>2</sub> **1020 kg** / year

## Animal feed solar cooker

### Utility:

Boiling of animal feed, saves conventional fuel, maintains nutritional value of feed

### Capacity & Cost:

10 kg feed per day, cooking time: 6 hr., Rs. 12000/- with reflector per unit

Energy saving/year (MJ): **2250**

Reduction in GHG emission:

CO<sub>2</sub> **1442 kg** /year

## Solar cooker

### Utility:

Baking, roasting and boiling food using solar energy, Length to width ratio 3:1, No need of tracking

### Capacity & Cost:

Cooking for 4-5 persons. Rs. 5000/- per unit

Energy saving/year (MJ): **2587**

Reduction in GHG emission:

CO<sub>2</sub> **815 kg** /year



Solar water purifier



Animal feed solar cooker



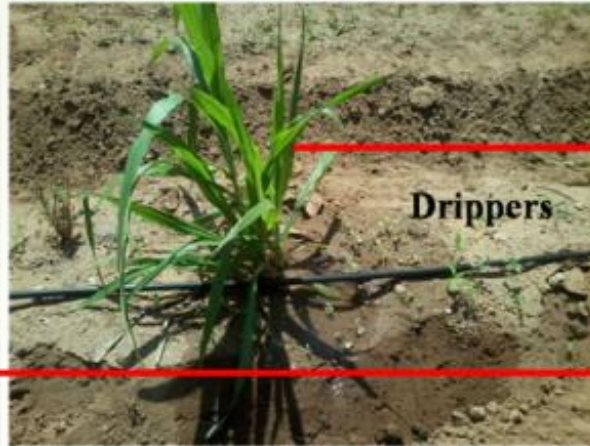
Non tracking solar cooker



# Advantages of solar PV pumping system

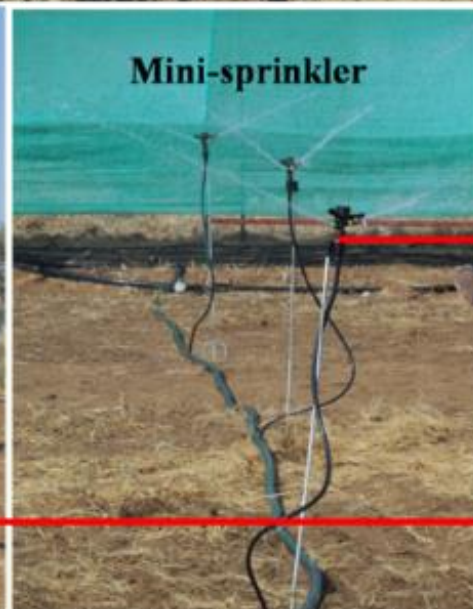
**Solar PV pumping systems has been viewed as one of the most viable options for future energy secured agriculture.**

- (i) Lower life cycle cost than diesel operated and grid tied electric pump
- (ii) PV panels of a solar pumping system reduce the CO<sub>2</sub> emission in atmosphere at a rate of about **CO<sub>2</sub> 1360 kg /y/ m** panel area
- (iii) Assured power supply in a solar PV pumping system enables the farmer to get an improvement in crop yield
- (iv) During off time, electricity generated by the solar PV pumping system may be used for domestic needs and for operating small farm machines
- (v) Solar PV pumping system may be used in far remote locations, where electric grids are not available.



Hybrid napier with drip system  
(discharge: 4 lit/hr/drip) under  
DC pump; operating pressure:  
 $1.5 \text{ kg cm}^{-2}$

Operating pressure of  $1.1 \text{ kg cm}^{-2}$   
with 50 micro-sprinklers under  
DC pump



Operating pressure of  $2.1 \text{ kg cm}^{-2}$   
with 9 mini-sprinklers under AC  
pump (discharge: 5 litre/nozzle/min)

Shade net house with ETHE  
based temperature regulation  
under solar pump (AC)



# Solar Power as Remunerative Crop



Incentivize farmers to become water and energy efficient

Offer farmers an additional climate-proof income source

Improve financial viability of Power Distribution companies

Reduce the dead weight of farm power subsidies

Curtail the carbon footprint of India's agriculture economy

Generate 'green' energy and contribute to India's RE target



# Solar Photo-voltaic plant protection devices

## Solar PV sprayer

### Utility:

Spraying of agricultural chemicals for protection of crops from pests and diseases

### Capacity & Cost:

Tank capacity of sprayer was 30 litre, cover an area of about 0.21 ha h<sup>-1</sup>, Application rate of 84 litre h<sup>-1</sup> and Rs. 25000/- per unit

**Energy saving/year:** 12.5 kWh /ha/ year by using solar PV operated pump (250 W)

**Reduction in GHG emission:**  
CO<sub>2</sub> **10.25 kg** /year

## Solar PV duster

### Utility:

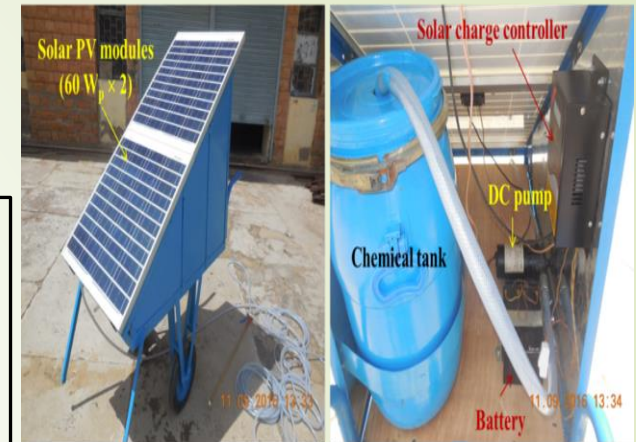
Useful for plant protection in agriculture, provides shade to the user, can be used for illumination also

### Capacity & Cost:

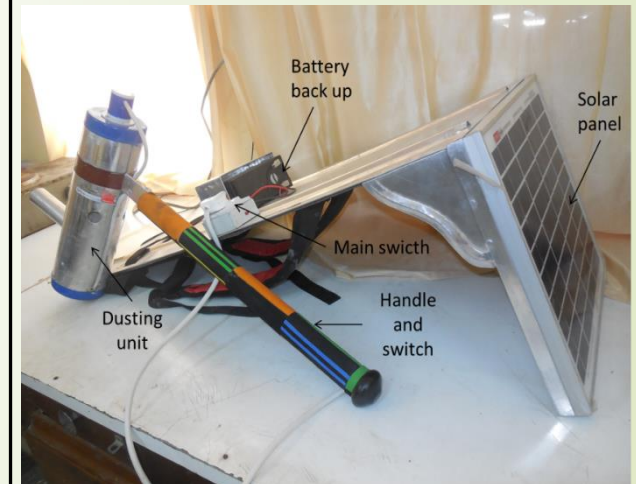
Comprises PV module 7.5 Wp storage battery and compatible duster, field capacity 0.075 ha h<sup>-1</sup> and Cost Rs. 8000/- per unit

**Energy saving/year (MJ):** 12.0 kWh /ha/ year by using solar PV duster

**Reduction in GHG emission:**  
CO<sub>2</sub> **10 kg** /year



Solar PV sprayer



Solar PV duster



# Animal Feed Solar Cooker

## Utility:

Boiling of animal feed, saves conventional fuel, maintains nutritional value of feed, Can be made easily with locally available materials

## Capacity & Cost:

10 kg feed per day, cooking time: 6 h., INR 12000/- with reflector per unit

**Energy saving/year (MJ): 2250**

## Reduction in GHG emission:

CO<sub>2</sub> **1442 kg** /year

## Attributes economics:

Benefit cost ratio (BCR): 2.40

Pay back period (PBP) (years): 1.90



# Solar Still

## Utility:

Useful for getting distilled water, Output not affected in different seasons, Multi basin and tilting arrangements for maximum output.

## Capacity & Cost:

8-10 litre per day, INR 12000/-

## Attributes economics:

Benefit cost ratio (BCR): 2.46

Pay back period (PBP) (years): 0.65



# Cool Chamber

## Utility:

For enhancing shelf life of fruits and vegetables by 3-5 days, Construction with bricks, cement, sand with provision for air circulation, Depression in temperature 8-10°C, Humidity > 90%

## Capacity & Cost:

80-100 kg, INR 12000/-

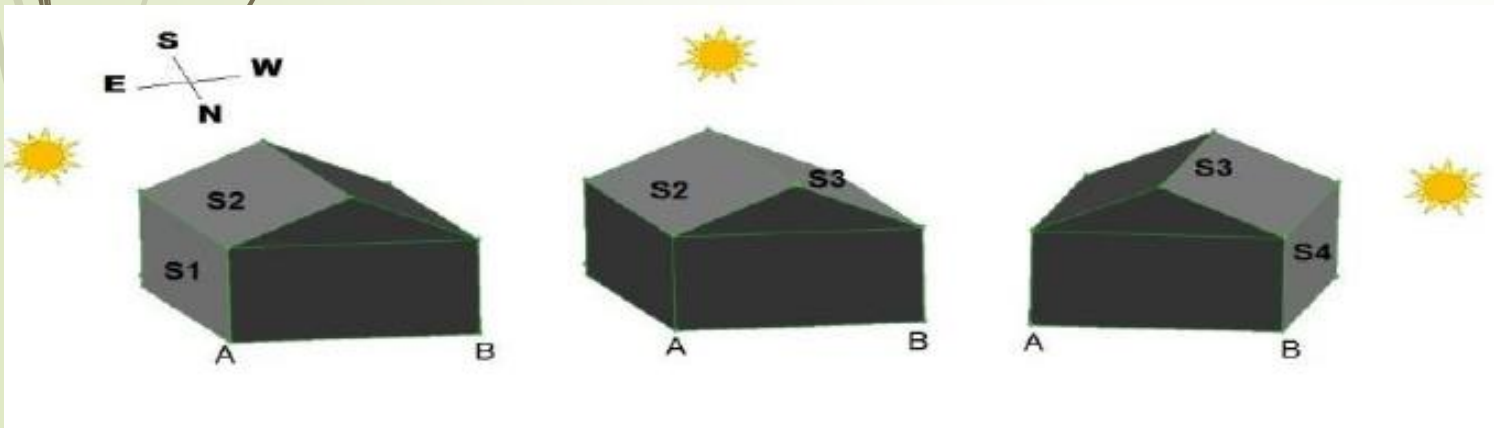




# Greenhouse Technology : Energy saving



East – West orientation of greenhouse



North – South orientation of greenhouse

- The North – South orientation needs more energy for cooling summer and heating in winter.
- Summer (June) :  
35 kWh/100 m<sup>3</sup>/ d  
more for cooling
- Winter (January) :  
25 kWh/100 m<sup>3</sup>/ d  
more for heating

# Rooftop harvesting of solar energy

Roof area = 9073 m<sup>2</sup>

- SPV panel size that can be installed: 375 kW<sub>p</sub>
  - Director office, Div. I & III: 154.7 kW<sub>p</sub>
  - Div. II & IV: 74.1 kW<sub>p</sub>
  - Div. V: 49.4 kW<sub>p</sub>
  - Div. VI: 28.6 kW<sub>p</sub>
  - Administrative block: 49.4 kW<sub>p</sub>
  - ABI building: 19.5 kW<sub>p</sub>
- Total Cost: Rs 14686376/- @ Rs 39,000/ kW
- Tariff value (Rs./kWh): 3.19
- Average generation/day: 1590 kWh
- **Average generation/month: 48160 kWh**
- Average Revenue generation/month: Rs 156311
- Total Revenue generation/year: Rs 1875733








# Policies and Politics of Solar Energy

- Solar energy as can be seen above, have a considerable potential for improving the sustainability and incomes along the agricultural value chains.
- However, this potential is not always utilized due to a lack of sufficient political will to challenge fossil-fuel based technologies. Political economy plays a key role in the development of the solar energy sector.
- Enabling policies and regulations are often essential for promoting solar energy technologies, especially during their early stages, when they lack large commercial scales.
- However, there are many politically sensitive issues in energy policies and regulation regarding, ensuring food security, the premise of job creation, reducing the dependence on fossil fuels, climate change mitigation, preserving the ecological integrity and concerns over large scale land acquisitions in developing countries, and many more.



# Small changes in attitude can add up to big saving in energy, water and environment

- Use natural light
- Turn water off when shaving, washing hands, brushing teeth
- Take shorter shower
- Fix the leakage
- Turn off unnecessary lights, the air conditioner and other electric appliance, not in home
- Use passive cooling systems wherever possible
- Use bicycle for shorter distance : good for health and wallet
- Do not waste food in your plate.
- Use solar gadgets wherever possible for cooking, drying and water heating.

