# Solar Power Fencing For Crop Protection From Monkey Menace And Domestic / Wild Animals In Himachal Pradesh

## I. Introduction:

Farmers are always exposed to various external risks like weather dependence, market prices, inputs availability etc. Another potent risk for farming is damage to crops by stray/ wild animals. For Himachal Pradesh more than wild animals the farmers are exposed to risk of crop damage from monkeys. As per Department of Agriculture and Department of Horticulture Government of Himachal Pradesh estimates, an area of 1.56 lakh ha is affected by monkey and wild life menace which annually causes loss of Rs.229 crores to the farmers. The extent of loss is upto89% of the normal yield of crops in some cases. A study conducted by an NGO, GyanVigyanSamiti, found that the wild animal menace causes loss of Rs.400 crore to Rs.500 crore every year in the State. Loss in employment/livelihood is over and above these estimated losses. According to a census conducted in 2004 the population of monkeys in the state was 3,17,112 but the figure dropped to 226,086 in the last census held in 2012. To protect crops from monkeys', state government has devised various strategies like sterilizing the simians to resolve the problem, however, the problem still persists and needs alternative methods to protect the crops damages.

## II. Present practices of crop protection from monkey menace and wild animals:

The following measures are taken in the State in crop protection from monkeys and wild animals:

1. **Manually guarding the fields:** To protect the crops, farmers deploy labours during day and night or if fields are small, farmers on their own protect the crops. Farmers use crackers, gun fires for scaring away the monkeys / wild animals. Cost of labour is very high due to shortage of labour in the State. Labour from Nepal and other states like Uttar Pradesh & Bihar are routinely hired for this purpose. Deployment of labour to guard field crops from monkey menace do not always guarantee 100% protection of crops due to human limitations of functioning in difficult terrain & adverse weather and night hours.
2. **Crop diversification :**To avoid crop damage from monkey menace and wild animals, many farmers have changed their cropping pattern from traditional crops which are generally consumed by monkeys to newer crops like aloe vera, ginger, garlic, turmeric, medicinal and aromatic plants, which are not consumed / damaged by monkeys.

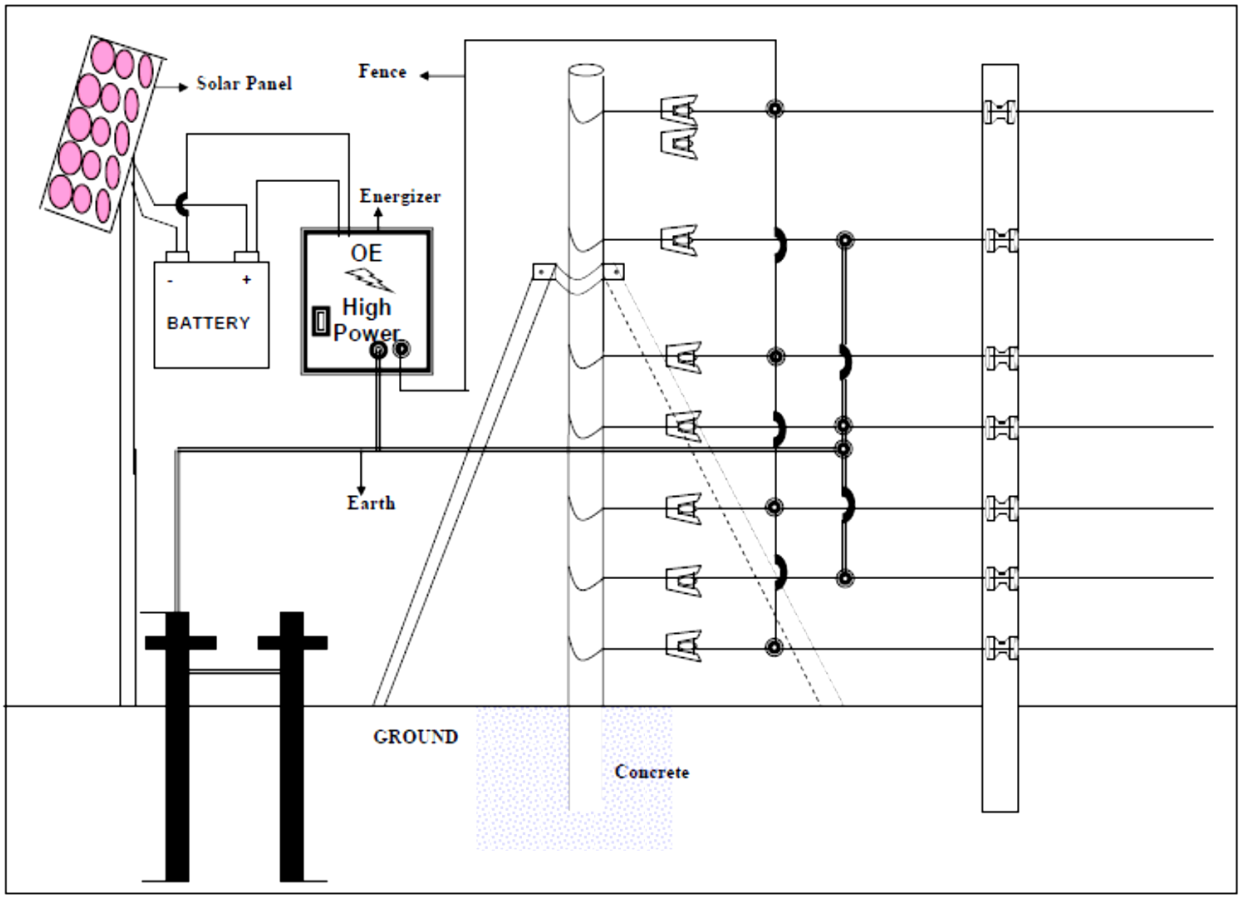
3. **Sterilising monkey to control population:** HP Forest Department is undertaking sterilization of monkeys in Shimla, Hamirpur, Kangra and Unadistricts to control the monkey population. Till December 2013, a total of 77,280 monkeys were sterilised.H.P. Forest Department is leading the innovative programme of monkey sterilization to control the ever increasing population of monkeys. Four Monkey Sterilization Centres (MSCs) located at Tutikandi (Shimla), Sastar (Hamirpur), Gopalpur (Kangra) and Boul (Una) are operative in the State. The sterilization in males is done through thermocautericcoagulative vasectomy and in females through endoscopic thermocauterytubectomy. The impact of monkey sterilization programme in stabilizing the monkey population is visible in many pockets of the State. The full impact of sterilization on monkey population shall be discernible in future when sterilization of considerable monkey population shall be achieved.

## III. The Solution:

While number of alternatives are practiced by farmers and government to protect the crops from damage by monkeys and wild animals, none of these assure 100% success in crop protection. A new technique of power fencing is seen as ultimate solution. The solar powered fenceelectrifies the fence with pulsating current and these pulses are the “shock” felt by an animal that touches an electrified fence. Unlike a conventional fence, an electric fence is a psychological barrier such that animals learn to respect the fence. Any periphery can be solar fenced, though the cost differs with respect to the area to be fenced.

## IV. The Solar Power Fencing Technology:

The fence is like barbed wire fencing with multiple strands of plain wires and metal/cement/ wooden posts to hold the strands in position. The wires carry high voltage current. The Solar Power Fence gives a sharp, short but a non-lethal shock to the intruder and creates psychological fear, against any tampering. The alarm incorporated in the system gets activated and alert the inmates of the protected area. These are tailor made fences and can be designed according to customer needs and site condition. The following diagram describes the solar fencing system:




*Solar fencing system*

**IV.1. Working of solar power fencing system**

A solar panel is made up of a number of photovoltaic cells connected in series. Electricity is generated by these cells. Combined into a solar panel, these cells can produce enough voltage to charge a regular 12 volt battery. The solar panel ensures that the battery remains charged at all times. The battery stores the energy generated by the panel, and powers the energizer 24 hours a day. The energizer is the device which transform the low voltage current from battery to high voltage (upto 10,000 volts) current and send it to the electric fence. This way the fence is electrified and animals touching the fence receive the shock. Due to high voltage shock to the animals touching the fence, animals keep away from the fence and field is protected.

**IV.2. Advantages of Solar Power Fencing:**

Solar power fencing offers a number of benefits over conventional fencing as under:

**a. Human and Animal safety**

The electric shock is completely safe and non-lethal for human and animals. The animal / human touching the fence will keep himself away from the fence. As current is pulsating (not live) and passing at every 1 to 1.2 second and only for amilli-second ($1000^{th}$ of second) of time,the animal gets enough time to get away from the fence. The pulsating current will not grab the animal which generally happens in continuous current which causes contraction of muscles / cramps and prevent the animal from moving away from the fence leading to electrocution. In solar fencing, even if an animal is trapped in the fence, after 10 consecutive shocks the system will trip and hooter will sound so that farmer can intervene and no death causes. Further, the wire used in the fencing is plain (not barbed wire) the animals will not be trapped in the fence. Further, on touching the fence by any animal a hooter will sound to alert the farmer so that human intervention can be made to free the animal. A warning board is placed at 10 m interval to caution the human about power fencing. If someone cuts the fence wire a security alarm will sound to alert the farmer for intervention. Two alarms are provided to ensure sounding of alarms in case one is failed. Before installing the system on its farm, Dr. YSPUHF, Nauni, Solan had obtained a certificate from Medical College, Bangalore to the effect that the shock from solar fencing is safe. All the safety features need to insisted from the company installing the fencing. Certificates from competent authority regarding human/ animal safety of energizer may be insisted from the executing company.

**b. Lower cost**

Electric fencing requires less set-up and material than conventional fences (barbed or woven wire). Animals are less likely to damage the electric fence as they usually don't touch it more than once which reduces maintenance. It is important to invest in quality components for fewer maintenance problems and greater fence life-expectancy, increasing value for money.

**c. Ease of construction**

Relatively simple and easy to build, electric fences can be installed quickly and with minimum tools, saving time and money.

**d. Flexibility**

Wire spacing and fence design can be modified to control a variety of animals.

**e. Long life**

Electric fences can last a long time – up to 40 years– when built with quality components and material.

**f. Assurance of protection**

The traditional fencing do not assure 100% protection of the fenced area from wild animals and monkeys, while solar power fencing assures maximum protection.

**IV.3. Performance in winter and rainy season**

When designed appropriately keeping in mind about winters and monsoon days, solar fencing will perform effectively during all seasons. The success of the solar panel will purely depend on the design because the design is going to be implemented as the final solution. Whether it is monsoon or rainy season does not matter if the location has ambiance light. The fencing system may not work properly where snow is accumulated on ground. In such area it is recommended to construct the fencing on a brick wall or a 1-2 feet fence is constructed with wire mesh fencing. However, this will increase the cost of fencing. Alternatively, if there is no crop during snow period the power in the fencing may be shut-off. If required, additional power source from AC current can be provided during design itself to ensure seamless operation of the system.

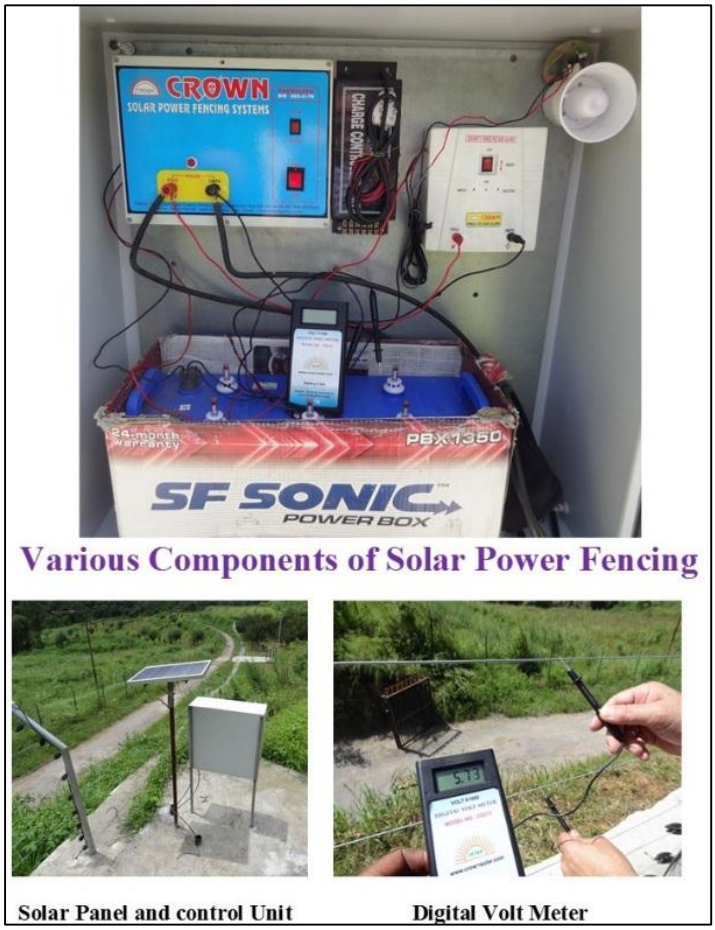
**IV.4. Effectiveness during night and alert system**

Solar fence whether operated day or night runs on battery, where the battery gets charged by the solar panel. In case of 24 hrs fence operation, battery and solar panel are appropriately sized. An alarm unit accompanies the system for any intruder detection.

Few pictures of solar power fencing system installed in campus of Dr.YSPUHF, Nauni

Pictures of solar fencing system established in Dr.YSPUHF, NauniSolan

## V. Components of a solar system are as under:




**Various Components of Solar Power Fencing**



**Solar Panel and control Unit**



**Digital Volt Meter**

### V.1. Solar panel:

Solar panel converts solar light into electricity and transfers it to battery for storage. The life of solar panels is about 25 years. At the end of 25 year the power output of panel reduces to 80%,as per the industry norms and as per the MNRE guide lines. As the battery approaches a full charge, current into the battery is reduced or switched off to maintain the battery at full charge, preventing any damage to the battery.

The selection of the correct size panel is determined by following factors:

a. **Current take-off of the energizer:** Larger energizers draw more current and require a larger battery or battery banks. Therefore a larger solar panel or multiple panels are needed to maintain battery charge.

b. **Pulse speed or power setting of the energizer:** The faster the pulse speed or the higher the power setting, the more current the energizer will draw, and larger panel will be required.

c. **Daily solar radiation conditions:** The amount of useful sunlight may vary considerably depending on the geographic location of the solar panel and the time of year. A larger solar panel will be required in an area with less useful sunlight hours and during winter time when sunshine hours are less.
d. **Required period of operation:** If the energizer is required to operate during winter when sunshine hours are lower, the battery and solar panels are designed to able to maintain desired output at these lower daily sunlight levels.

The solar panel size is designed in such a way that it charges the battery fully in the available sunshine hours and weather condition.

**V.2. Battery:**

Battery stores the power generated by solar panel and supplies it to the energizer. The battery size is selected to suit the electrical current consumption of the energizer being used, and has enough storage capacity to provide power to the energizer even during periods of reduced sunlight. The size of the battery depends on the type of energizer selected. More than one battery is selected to supply enough charge and storage capacity which is called as “battery bank”.

There are two kinds of batteries which are available in the country, one is basically C20 rated battery which are the UPS batteries and the other kind is specifically designed for solar application which are C10 solar batteries. The life of the battery depends upon the amount of current that goes inside the battery and the amount of current which is coming out of the battery. The C10 batteries normally have the replaceable warranty of 5 years.

**V.3. Energizer:**

The energizer is the device which transform the low voltage current from battery to high voltage current sent to the electric fence. The current voltage can be stepped up to 10,000 volts. The voltage requirement varies based on the type of animal to be kept away. However, most of the animals can be kept away with voltage of 6000 – 7000 volts.

There are several factors that to be considered when selecting an energizer:

a. The type of stock that will be fenced
b. The size of the area to be fenced
c. The total length of wire to be electrified and type of fence (single or multi-wire fence)

As an approximate guide, 1 joule of output energy will power 10km of single wire fence.

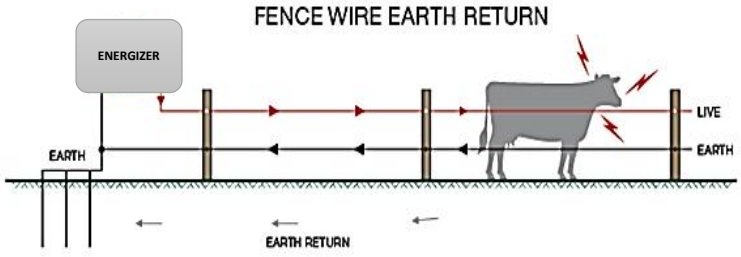
**V.4. Earth system:**

For an electric fence shock the current produced by an energizer must complete a full circuit. The current leaves the energizer and moves along the fence wires through the animal, into the soil and back to the energizer via the earth system. If the earth system is ineffective the animal will receive an inadequate shock.

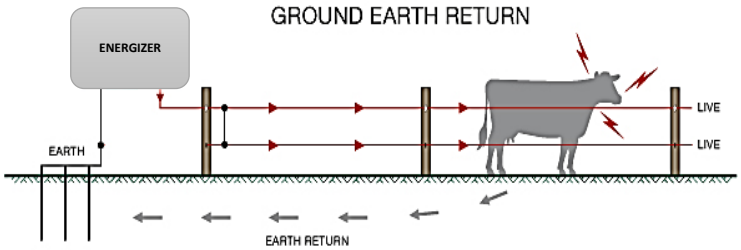
The earth system consists of a number of earth rods that provide an effective (low resistance) path for the current to return to the energizer's earth terminal. Larger energizers with large fence lines require more earthing rods. Larger energizers exerting more power on extensive fence systems require a larger earth system capable of capturing current returning to the energizer via the soil. Soil types, mineral content, and ground moisture and also fence load are all factors that determine how many earth rods will be required. Earth system is the most important component of electric fence. An effective earth system will optimize the performance of electric fence.

Following two types of earthing systems are practiced in the country.

**a.Fence Wire Return System.** Practiced where soil is not conductive. If the soil is dry or sandy it is usually not conductive. The fence is constructed using both live and earth wires. The animal touches the live wire the current flows through the animal and the ground back to the earth rods. This system is also practiced to keep away monkeys who can touch the fence without touching the ground preventing completion of electric circuit. When crossing the fence monkey can touch two wires and complete the circuit to receive shock.



**b. Ground Earth Return System:** Practiced where soil is conductive. This system is suitable for most moist soils. Current flows through the animal and the ground back to the earth rods.




## VI. Installation:

A good solar power fence installation involves:

a. Proper grouting of end and corner posts to get required strength,
b. Clearing of vegetation along the fence to prevent any energy drain as also crossing of fence by monkeys by jumping from one tree to another across the fence.
c. Aesthetic layout of fence,
d. Tight joints,
e. Proper electrical connections,
f. Testing of fence,

While installation of base unit is in progress, the vegetation clearance and post installation are initiated. The corner posts are installed first. A wire is temporarily drawn between the end posts to align the intermediate posts. Insulators are installed close to the posts so that wide gaps are not left for animals to get into the fence easily. Voltage is checked to see if it is between 5 and 10 kV. If voltage is less than 5kV, the fence line is checked for shorts or improper connections.

## VII. Do's and Don'ts

**Do's:**

a. Take help of an authorised/ experienced agency to install the unit.
b. Keep the fence neat and clean.
c. Maintain the wire tension regularly.
d. Water the fence earth system periodically.
e. Maintain battery health properly.

f. Remove Energizer connections during heavy storms like lightening.
g. Test the fence voltage at 2 or 3 points on the fence regularly.
h. Always use proper fence tools during fence construction and maintenance.

**Don'ts:**

a. Do not connect AC mains power to the Energizer and to the fence lines, unless system is designed for.
b. Do not add acid to your battery where dry maintenance free battery is installed
c. Do not power the Energizer directly from the charger or from the solar panel.
d. Do not electrify barbed wires as this can trap the animals and lead to death
e. Do not over extend the fence beyond limits of the energizer.

## VIII. Certification of Components

The company erecting solar fence has to source all the products/components from MNRE approved and certified companies. Certificates regarding animal & human safety need to be insisted upon. Solar fencing is a solution and not a product, hence it is to be designed as per the requirements laid out by the customer, solar fencing as a unit is not certified, however, all the individual components are.

## IX. Maintaining solar fence system

While minimal maintenance is required, regular checks of solar system (every 6 to 8 weeks)will ensure reliable performance.

Some pointers to maximise the life and performance of solar fencing system are as under:

a. Solar panel need to be cleaned with a soft, damp cloth to remove any residue or dust film. Any snow accumulated on the panels need to be cleaned to maintain the system in operation.
b. Check the mounting bracket is secure and the tilt angle is correct. If necessary, the angle can be changed to accommodate the change in seasons.
c. Check all leads and connections are secure and undamaged by animals or vegetation.
d. Check electrolyte level in batteries
e. Check all exposed terminals and wires for evidence of corrosion from environmental conditions such as salt or chemicals.

f. Clear any debris or vegetation that may be causing a short on the fence. Vegetation touching the fence will also complete the loop causing the output voltage of the energizer to drop. It is very important, therefore to keep any growth on the fence line to minimum to ensure the animal receives the maximum shock available. Trees near the fence can allow crossing the fence by monkeys.

## X. Cost and Economics

Unit cost has been worked out for 5 different models viz. 1 Acre, 2.5 Acre, 5 Acre, 10 Acre and 20 Acre. Higher area models are suitable for group of farmers. Unit cost of these models is given in Table 1:

*Table 1: Unit cost of Solar Power Fencing Models*

| Model | Protected Area | Perimeter for fencing | Unit Cost | Cost per Running meter |
|---|---|---|---|---|
| | Acre | Meter | Rs. | Rs. |
| **Model 1** | 1 | 300 | 161907 | 540 |
| **Model 2** | 2.5 | 500 | 210793 | 422 |
| **Model 3** | 5 | 700 | 259679 | 371 |
| **Model 4** | 10 | 1000 | 407716 | 408 |
| **Model 5** | 20 | 1400 | 505489 | 361 |

(Detailed cost estimates are given in Annexures)

The average cost per running meter of 7 rows fence comes to Rs.396/Meter.

The economics of the solar fencing is worked out based on the following assumptions:

a. For estimating the economics, 40% crop loss is assumed.
b. Economics has been worked for solar fencing investment in three scenarios where farmers grow food grains, vegetables and fruit crops.
c. Discounting factor of 15% is assumed.

The economics of the investment for different models and scenarios is given in Table 2:

*Table 2: Economics of Investment of different Models*

| Model | Protected Area (Acre) | IRR | | | BCR (1:x) | | | NPV (Rs.) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Food grain | Vegetables | Fruit crops | Food grain | Vegetables | Fruit crops | Food grain | Vegetables | Fruit crops |
| Model 1 | 1 | 16% | >100% | 88% | -0.23 | 2.61 | 1.28 | -189443 | 248193 | 42424 |
| Model 2 | 2.5 | 31% | >100% | >100% | 0.24 | 5.69 | 3.13 | -152786 | 941306 | 426882 |
| Model 3 | 5 | 57% | >100% | >100% | 0.87 | 9.72 | 5.56 | -31813 | 2156370 | 1127522 |
| Model 4 | 10 | 89% | >100% | >100% | 1.36 | 12.63 | 7.33 | 141487 | 4517853 | 2460158 |
| Model 5 | 20 | >100% | >100% | >100% | 2.67 | 20.85 | 12.30 | 805008 | 9557741 | 5442351 |

(Detailed economic analysis is given in Annexures)

It is found that the models 1 to 5 are not financially viable if farmers grow food grain. However, the same are viable if farmers grow cash crops like vegetables and fruit crops.

## XI. Potential for solar fencing in the State:

The Department of Agriculture and Department of Horticulture Government of Himachal Pradesh has estimated the damages due to monkey and other wild animals to agriculture and fruit crops in the state. Total area affected by monkey menace and other animals is 1.56 lakh ha and value of damages is Rs.229.09 crores as given in Table 3:

*Table 3: Damages to crops due to monkey menace and wild animals*

| Land use | Affected Area (ha) | % of total affected area | Value (Rs. Crore) |
|---|---|---|---|
| Field crops | 126372 | 80.70% | 184.27 |
| Fruit crops | 30213 | 19.30% | 44.82 |
| **Total** | **156585** | **100.00%** | **229.09** |
| Affected area Includes abandoned area of 19,563 ha | | | |

The above affected area is ready potential for crop protection from monkey and wild animals by solar power fencing. District-wise affected area / potential for investment and bank finance is given in Table 4:

*Table 4: District-wise Potential for investment in Solar Fencing*

| District | Area (ha) | District | Area (ha) |
|---|---|---|---|
| Kangra | 34245 | Hamirpur | 10275 |
| Una | 29348 | Solan | 8012 |
| Chamba | 21457 | Sirmour | 7288 |
| Bilaspur | 14925 | Kullu | 2963 |
| Mandi | 13919 | Kinnaur | 350 |
| Shimla | 13757 | L&S | 45 |
| **Total** | | | 156585 |

## XII. Experience of solar power fencing by Dr. Y S Parmar University of Horticulture & Forestry, Solan:

To protect the new stone-fruit plantations in University campus at Nauni, Solan from monkeys, porcupines and wild boars, four watchmen were stationed on day and night duties. The scientists at the University of Horticulture & Forestry at Solan came up with a seemingly guaranteed solution - a solar powered electric fence to protect fields of farmers, scores of whom have been forced to abandon their farmlands due to the menace. Two years ago the experimental farm of the university's fruit science department was fenced with a 1,725 metre solar powered electric wires to ward off wild animals. Ever since the experimental farm was fenced not a single monkey has been sighted in the area. The solar powered fence has helped the university to raise more than 2,000 plants of different stone-fruits. The fence has proved to be highly effective in keeping marauding monkeys away besides being cost effective.

## XIII. Existing subsidy scheme in the Country:

Government of Goa is offering subsidy for maximum length of 2000 running meter per farmer. Subsidy is restricted to 90% of admissible cost to Rs.2.0 lakh for individuals and Rs.3.0 lakh for farming groups. Government of Telangana is offering 50% Subsidy for maximum length 1000 m at the rate of Rs.201/meter.

## XIV. Recommendation:

Based on the study NABARD recommends the following:

1. State Government may form a committee to study the feasibility of Solar Power Fencing in the State for crop protection.
2. State Government may examine setting up solar power fencing units on a pilot basis as demonstration units at few places to find out its effectiveness and utility for crop protection and measures to replicate the same.
3. With a view to make investment in farm fencing by farmers on individual or joint liability mode State Government may examine providing of subsidy to the small and marginal farmers to install the solar power fencing.

*****

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**Disclaimer**

The models have been prepared based on information gathered orally or otherwise from various sources and no responsibility is accepted by NABARD for accuracy of facts and figures. The banks, government departments and other users are advised to use it only as a reference documents and use their own judgement for sanctioning or execution of the projects.

| | | | |
|---|---|---|---|
| Area to be protected | Acre | 1.00 | |
| Fence Length (Perimeter) | Meter | 300 | |
| Fence Height above ground level | Meter | 2.14 | (7 ft) |
| Number of wire rows / strands | Number | 7 | |
| Specing between wire rows | Meter | 0.30 | (1 ft) |
| Pole to Pole distance | Meter | 5 | |
| Total Pole Height (Above+Below Ground level (1.5 ft)) | Meter | 2.74 | (8.5 ft) |

**Technical Specifications for above Model and its cost**

| Sr. No. | Name of items | Specification | Quantity | Rate (Rs.) | Amount (Rs.) | Remarks |
|---|---|---|---|---|---|---|
| **I** | **Fencing work** | | | | | |
| **A.** | **The Electrical Unit** | | | | | |
| 1 | Energizer | Input Voltage: 12V DC, Input Current: 500MA, Output Voltage: 6.0 KV - 10.0 KV, Pulse Interval: 1.2 Second, Pulse Duration: 0.3 Milli Second, Output energy: 2.5 Joules | 1 | 10000 | 10000 | |
| 2 | Fence Voltage Alarm | | 1 | 1000 | 1000 | |
| 3 | Solar PV Module | 72 Wp | 1 | 5500 | 5500 | |
| 4 | Battery | 80 Ah | 1 | 5500 | 5500 | |
| 5 | Hooter | 320 DB | 1 | 500 | 500 | |
| 6 | Lightening Diverter | Copper | 2 | 2500 | 5000 | |
| 7 | Mounting box | Mild Steel with Powder coating | 1 | 3000 | 3000 | |
| 8 | Module Mounting Structure with Pole | Mild Steel with Powder coating | 1 | 1500 | 1500 | |
| 9 | Cables and Hardware | 2-Core copper flexible cable (Mtrs) | 5 | 30 | 150 | |
| **B** | **Fence** | | | | | |
| 1 | H.T. Wire | ACSR Conductor wire, 2.59 mm (12 guage), TATA make or equivalent | 2200 | 5.5 | 12100 | Total perimeter for protection X no. of wire rows + 100 m extra |
| 2 | Corner / End Posts | MS with Galvanised, 40x 40 Sq.mm Pipe, 8.5 Feet with PP Insulator revetting | 8 | 640 | 5120 | 2 at gates + one per 50 meter at corners/end |
| 3 | Support Posts | MS with Galvanised, 25x 25 Sq.mm Pipe, 8.5 Feet with PP Insulator revetting | 22 | 390 | 8580 | 2 each at corner/end post + 2 at each post at 10 m |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4 | Intermediate Posts | MS with Galvanised, 25x 25 Sq.mm Pipe, 8.5 Feet with PP Insulator revetting | 60 | 390 | 23400 | As per spacing |
| 5 | Support Poles Bolts | Mild Steel | 22 | 25 | 550 | One for each support post |
| 6 | Corner Poles/End Insulators | Poly Propylene | 56 | 7 | 392 | No. of Corner post and end post X number of wire rows |
| 7 | Intermediate Poles Insulators | Poly Propylene | 420 | 7 | 2940 | No. of intermediate posts X number of wire rows |
| 8 | Corner Pole Hooks | SS | 56 | 7 | 392 | No. of Corner post and end post X number of wire rows |
| 9 | Wire Tightners | MS | 21 | 25 | 525 | One each at 100 m fence length |
| 10 | Joint Clamps | GI | 21 | 7 | 147 | One each at 100 m fence length |
| 11 | Double Insulated Cable Single Core | ACSR wire, 2.0mm Dia | 50 | 25 | 1250 | LS |
| 12 | Earth Kits (Galvanizing) | Copper | 6 | 700 | 4200 | one at each 50 m fence length |
| 13 | Warning Sign Boards | PVC | 30 | 75 | 2250 | One each at 10 m fence length |
| **C** | **Gates** | | | | | |
| 1 | 4 ft wide gate 1 leaf | | 1 | 32350 | 32350 | LS |
| **D** | **Instruments / tools** | | | | | |
| 1 | Digital Multi meter | Range Upto -20000 KV | 1 | 7500 | 7500 | |
| 2 | Xenon Flash Tube | | 1 | 3000 | 3000 | |
| 3 | Neon Tester | | 1 | 2500 | 2500 | |
| 4 | Tool kit (wire tightener handle twistin tool, pliers, double ended spanner for joining clamp tighteninig | | 1 | 1000 | 1000 | |
| | **Total Fencing work** | | | | **140346** | |
| **E** | **Transportation with transit insurance** | | | | **7017** | 5% of above |
| II | **Civil Work** | | | | | |
| 1 | Excavation for Poles :- 0.45mx0.60mx0.60m (CuM) | 0.162 | 14.58 | 150 | 2187 | CuM x number of corner/end, intermediate and support posts |
| 2 | Providing and laying cement concrete for Post (Cum) | | 14.58 | 800 | 11664 | |
| | **Total Civil Work** | | | | **13851** | |
| | **Grand Total (I+II)** | | | | **154197** | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **III** | **Installation and commissioning** | | | | **7710** | 5% of above |
| | **Total** | | | | **161907** | |
| | **Cost per meter of fence length** | | | | **540** | |

**Model 1 (a): Economics**

**Fencing Area (acre)** **1.00**

| | Area | Name of crop | Production cost (Scale of finance) | Pre-development yield | Post development Yield (i.e. normal yield) | Incrimental yield | Rate | Increased income from area | Crop damage due to wild animals & monkeys (%) |
|---|---|---|---|---|---|---|---|---|---|
| | **Acre** | | **Rs./acre** | **Q/acre** | **Q/acre** | **Q/acre** | **Rs./Q** | **Rs.** | |
| **Gross Area 1:** | 2 | Foodgrains | 10000 | 9 | 15 | 6 | 1400 | 16800 | |
| **Gross Area 2:** | 0 | Vegetables | 60000 | 39 | 65 | 26 | 2000 | 0 | |
| **Gross Area 3:** | 0 | Fruits | 60000 | 27 | 45 | 18 | 3500 | 0 | |
| | | | | | | | | **16800** | 40% |

**Minimum wage rate** **Rs./day** **162**

(Amount Rs.)

| S.No. | Particulars | | Yr-1 | Yr-2 | Yr-3 | Yr-4 | Yr-5 | Yr-6 | Yr-7 | Yr-8 | Yr-9 | Yr-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A** | **Expenditure** | | | | | | | | | | | |
| i | Fixed Cost of Fencing | | **161907** | | | | | | | | | |
| ii | Operation & Maintenance Cost (2% of fixed cost) | | | 3238 | 3238 | 3238 | 3238 | 3238 | 3238 | 3238 | 3238 | 3238 |
| | **Sub-Total Cost** | | **161907** | **3238** | **3238** | **3238** | **3238** | **3238** | **3238** | **3238** | **3238** | **3238** |
| **B** | **Income Estimates** | | | | | | | | | | | |
| i | Incremental Income with fencing | | 16800 | 16800 | 16800 | 16800 | 16800 | 16800 | 16800 | 16800 | 16800 | 16800 |
| ii | Saving in Labour Cost | 45 mandays / season X 2 seasons | 14580 | 14580 | 14580 | 14580 | 14580 | 14580 | 14580 | 14580 | 14580 | 14580 |
| | **Net Income + Savings in labour** | | -130527 | 28142 | 28142 | 28142 | 28142 | 28142 | 28142 | 28142 | 28142 | 28142 |
| | Discounting factor | | 0.87 | 0.76 | 0.66 | 0.57 | 0.50 | 0.43 | 0.38 | 0.33 | 0.28 | 0.25 |
| | Discounted Costs | | 140789 | 2448 | 2129 | 1851 | 1610 | 1400 | 1217 | 1059 | 920 | 800 |
| | Discounted Income | | -113502 | 21279 | 11046 | 9605 | 8353 | 7263 | 6316 | 5492 | 4776 | 4153 |
| | PV of Costs | | 154224 | | | | | | | | | |
| | PV of Benefits | | -35219 | | | | | | | | | |

| | | | |
|---|---|---|---|
| | **Internal Rate of Return (IRR)** | | **16%** |
| | **Benefit Cost Ratio (BCR)** | | **-0.23** |
| | **Net Present Value (NPV)** | | **-189443** |

| Repayment Schedule | | Rate of interest | 12.00% | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Bank Loan | Principal outstanding | Interest | Interest Outstanding | Surplus | Repayment | | Total Outgo | Net Surplus |
| | | | | | | Interest | Principal | | |
| 1 | 145716 | 145716 | 17486 | 17486 | 0 | 17486 | 0 | 17486 | 0 |
| 2 | | 145716 | 17486 | 17486 | 28142 | 17486 | 5328 | 22814 | 5328 |
| 3 | | 140388 | 16847 | 16847 | 28142 | 16847 | 5648 | 22494 | 5648 |
| 4 | | 134741 | 16169 | 16169 | 28142 | 16169 | 5986 | 22155 | 5986 |
| 5 | | 128754 | 15450 | 15450 | 28142 | 15450 | 128754 | 144205 | -116063 |
| | **Total** | | | | **112567** | **83438** | **145716** | **229154** | |
| | | | | **DSCR** | **0.5** | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

**Model 1**

| | | | |
|---|---|---|---|
| Area to be protected | Acre | 1.00 | |
| Fence Length (Perimeter) | Meter | 300 | |
| Fence Height above ground level | Meter | 2.14 | (7 ft) |
| Number of wire rows / strands | Number | 7 | |
| Specing between wire rows | Meter | 0.30 | (1 ft) |
| Pole to Pole distance | Meter | 5 | |
| Total Pole Height (Above+Below Ground level (1.5 ft)) | Meter | 2.74 | (8.5 ft) |

**Technical Specifications for above Model and its cost**

| Sr. No. | Name of items | Specification | Quantity | Rate (Rs.) | Amount (Rs.) | Remarks |
|---|---|---|---|---|---|---|
| **I** | **Fencing work** | | | | | |
| **A.** | **The Electrical Unit** | | | | | |
| 1 | Energizer | Input Voltage: 12V DC, Input Current: 500MA, Output Voltage: 6.0 KV - 10.0 KV, Pulse Interval: 1.2 Second, Pulse Duration: 0.3 Milli Second, Output energy: 2.5 Joules | 1 | 10000 | 10000 | |
| 2 | Fence Voltage Alarm | | 1 | 1000 | 1000 | |
| 3 | Solar PV Module | 72 Wp | 1 | 5500 | 5500 | |
| 4 | Battery | 80 Ah | 1 | 5500 | 5500 | |
| 5 | Hooter | 320 DB | 1 | 500 | 500 | |
| 6 | Lightening Diverter | Copper | 2 | 2500 | 5000 | |
| 7 | Mounting box | Mild Steel with Powder coating | 1 | 3000 | 3000 | |
| 8 | Module Mounting Structure with Pole | Mild Steel with Powder coating | 1 | 1500 | 1500 | |
| 9 | Cables and Hardware | 2-Core copper flexible cable (Mtrs) | 5 | 30 | 150 | |
| **B** | **Fence** | | | | | |
| 1 | H.T. Wire | ACSR Conductor wire, 2.59 mm (12 guage), TATA make or equivalent | 2200 | 5.5 | 12100 | Total perimeter for protection X no. of wire rows + 100 m extra |
| 2 | Corner / End Posts | MS with Galvanised, 40x 40 Sq.mm Pipe, 8.5 Feet with PP Insulator revetting | 8 | 640 | 5120 | 2 at gates + one per 50 meter at corners/end |
| 3 | Support Posts | MS with Galvanised, 25x 25 Sq.mm Pipe, 8.5 Feet with PP Insulator revetting | 22 | 390 | 8580 | 2 each at corner/end post + 2 at each post at 10 m |
| 4 | Intermediate Posts | MS with Galvanised, 25x 25 Sq.mm Pipe, 8.5 Feet with PP Insulator revetting | 60 | 390 | 23400 | As per spacing |
| 5 | Support Poles Bolts | Mild Steel | 22 | 25 | 550 | One for each support post |
| 6 | Corner Poles/End Insulators | Poly Propylene | 56 | 7 | 392 | No. of Corner post and end post X number of wire rows |
| 7 | Intermediate Poles Insulators | Poly Propylene | 420 | 7 | 2940 | No. of intermediate posts X number of wire rows |
| 8 | Corner Pole Hooks | SS | 56 | 7 | 392 | No. of Corner post and end post X number of wire rows |
| 9 | Wire Tightners | MS | 21 | 25 | 525 | One each at 100 m fence length |
| 10 | Joint Clamps | GI | 21 | 7 | 147 | One each at 100 m fence length |
| 11 | Double Insulated Cable Single Core | ACSR wire, 2.0mm Dia | 50 | 25 | 1250 | LS |
| 12 | Earth Kits (Galvanizing) | Copper | 6 | 700 | 4200 | one at each 50 m fence length |
| 13 | Warning Sign Boards | PVC | 30 | 75 | 2250 | One each at 10 m fence length |
| **C** | **Gates** | | | | | |
| 1 | 4 ft wide gate 1 leaf | | 1 | 32350 | 32350 | LS |
| **D** | **Instruments / tools** | | | | | |
| 1 | Digital Multi meter | Range Upto -20000 KV | 1 | 7500 | 7500 | |
| 2 | Xenon Flash Tube | | 1 | 3000 | 3000 | |
| 3 | Neon Tester | | 1 | 2500 | 2500 | |
| 4 | Tool kit (wire tightener handle twistin tool, pliers, double ended spanner for joining clamp tightenig | | 1 | 1000 | 1000 | |
| | **Total Fencing work** | | | | **140346** | |
| **E** | **Transportation with transit insurance** | | | | **7017** | 5% of above |
| II | **Civil Work** | | | | | |
| 1 | Excavation for Poles :- 0.45mx0.60mx0.60m (CuM) | 0.162 | 14.58 | 150 | 2187 | CuM x number of corner/end, intermediate and support posts |
| 2 | Providing and laying cement concrete for Post (Cum) | | 14.58 | 800 | 11664 | |
| | **Total Civil Work** | | | | **13851** | |
| | **Grand Total (I+II)** | | | | **154197** | |
| **III** | **Installation and commissioning** | | | | **7710** | 5% of above |
| | **Total** | | | | **161907** | |
| | **Cost per meter of fence length** | | | | **540** | |