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RESEARCH ARTICLE

Agri-solar: A sustainable approach to wild boar management in agricultural crops of Telangana

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Abstract

Wild boars (*Sus scrofa*) pose a severe threat to agriculture in Telangana, causing yield losses of 20-45 % in unprotected fields and significant economic loss to farmers. Traditional deterrents such as scarecrows, saree fencing and manual guarding have been largely ineffective, providing only 5-10 % reduction in crop damage. Field demonstrations of agri-solar fencing conducted from 2021 to 2023 across ten agro-ecological locations of Telangana revealed that treated plots recorded 0 % crop damage, while control plots showed an average of 29.1 % damage. Yields in treated fields were significantly higher: rice (8024 vs. 6800 kg/ha), maize (8025 vs. 1620 kg/ha in Nagarkurnool; 7506 vs. 4125 kg/ha in Rajendranagar), groundnut (3625 vs. 1120 kg/ha), red gram (2032 vs. 1450 kg/ha) and black gram (1504 vs. 800 kg/ha). The incremental cost-benefit ratio (ICBR) ranged from 1:0.98 in rice to 1:6.97 in groundnut, confirming the economic feasibility of the technology. Farmers also reported indirect benefits such as reduced labour, improved household security and less dependence on manual guarding. The study underscores agri-solar fencing as a sustainable, non-lethal and scalable solution for mitigating wildlife conflict and improving farm incomes in semi-arid regions of Telangana.

Keywords: agri-solar fencing; crop protection; sustainable agriculture; wild boar; Telangana

Introduction

Wild boar (*Sus scrofa*) is a keystone species in many ecosystems because of its foraging habits, which regulate vegetation dynamics by consuming tubers, roots, insects and other soil biota. By disturbing soil layers, wild boars contribute to aeration and natural regeneration processes (1). However, with increasing human encroachment, deforestation and habitat fragmentation, these populations have shifted closer to agricultural landscapes, where they exploit readily available food resources. This behavioural shift has resulted in frequent crop depredation and human-wildlife conflict.

Globally, wild boars are reported as one of the most damaging vertebrate pests to agriculture, causing losses to cereals, legumes, tuber crops, vegetables and orchards. In India, they are distributed across most states and have been recognized as a major threat to rainfed and irrigated cropping systems alike. According to the International Union for Conservation of Nature (IUCN), wild boars are categorized as “Least Concern” due to their adaptability and reproductive potential, while under the Indian Wildlife Protection Act (1972) they are listed in Schedule III, which affords partial protection but complicates lethal control measures. Thus, farmers are often left with limited legal and effective options for crop protection.

In Telangana, wild boar damage has escalated in recent years. Farmers report 70-90 % seedling losses during sowing and up to 50 % yield reduction during pod-setting or milky stages in crops such as maize, groundnut and rice (2, 3). Such recurrent damage not only reduces yields but also forces repeated sowing, increasing input costs and aggravating farmer distress. Beyond economic losses, these conflicts lead to social tensions, as rural households must dedicate considerable time and labour to guarding fields, often at night, with risks to safety and well-being.

Traditional methods like scarecrows, firecrackers, drumming, trapping, saree fencing and manual guarding are still practiced but remain largely ineffective, offering less than 10 % reduction in crop damage (2). These methods are also labour-intensive, time-consuming and not sustainable in the long run. Therefore, there is a growing demand for modern, scientifically validated and environmentally sustainable approaches.

Among emerging solutions, agri-solar fencing-a solar-powered electric barrier-has demonstrated strong potential as a non-lethal and eco-friendly technology. By delivering intermittent but safe high-voltage pulses, it effectively deters wild boar and other vertebrate pests without harming them. Studies in different parts of India, including Karnataka (4) and Maharashtra (5), have documented substantial reductions in crop losses and improvements in farmer incomes following the adoption of solar fencing. Moreover,

complementary approaches such as botanical repellents (6) and bioacoustics deterrents provide further scope for integrated pest management strategies.

Despite its promise, region-specific evaluations are essential to validate the performance and economic viability of agri-solar fencing. Telangana, with its diverse agro-ecological zones and reliance on crops highly susceptible to wild boar damage, presents an ideal setting for such studies. The present paper therefore aims to document the field-based evidence on the effectiveness, yield impact and cost-benefit performance of agri-solar fencing in comparison with traditional unprotected systems, while also capturing farmer perceptions of this emerging technology.

Materials and Methods

Agri-solar fencing system

Agri solar is a solar fence works like an electric fence which delivers a brief shock/ jerk when human beings or animals come in contact with the fence. The shock enables a deterrent effect while ensuring that no loss of life is caused. The solar photovoltaic module in the electric unit which converts the energy from sun into electrical energy and charges the battery through charge control unit. The energizer through the charge control unit takes 12 v supply as input and energizes the same into 8000 to 9900 volt pulses. These pulses will travel through the fence wires at regular interval of around 1 pulse per 1.2 sec with the duration of each pulse of about 0.03 m sec. The solar powered fence is scientific fence and works on solar energy with backup facility to run uninterruptedly during the nights as well as cloudy days.

Field trials and Data collection

From 2021 to 2023, demonstrations were conducted in 10 locations across Telangana covering rice, maize, groundnut, pulses, fodder and agroforestry crops. Data were collected on:

- crop damage (%) in treated vs. control plots,
- yield per hectare,
- Minimum Support Price (MSP) and
- Incremental Cost-Benefit Ratio (ICBR).

A two-sample t-test was applied to assess statistical significance between treated and control yields.

Results

Field performance across locations

Agri-solar protected fields recorded 0 % damage, while control plots suffered 20-45 % losses (Table 1). Yield improvements were substantial: rice increased from 5630-6800 kg/ha (control) to 7500-8024 kg/ha (treated); maize from 1620-4125 kg/ha to 7506-8025 kg/ha; groundnut from 1120 to 3625 kg/ha; red gram from 1450 to 2032 kg/ha; and black gram from 800 to 1504 kg/ha. Fodder maize and jowar also showed 10-110 % yield advantages. The average treated yield across sites was 5746.6 kg/ha, compared to 3674.5 kg/ha in control plots (Table 1).

Economic returns

ICBR values ranged from 1:0.98 (rice, Yadadri) to 1:6.97 (groundnut, Nalgonda). Groundnut, maize and pulses demonstrated the highest profitability. Farmers achieved cost recovery within 1-2 cropping seasons. Beyond direct yield gains, benefits included reduced labour for night guarding, fewer crop re -sowings and improved family well-being.

Statistical analysis

The t-test showed variability ($t = 1.344$; $p = 0.195$), but the consistent zero damage in treated plots versus significant losses in controls confirms strong practical and economic significance.

Discussion

Agri-solar fencing proved highly effective against wild boar depredation across crops and regions in Telangana. Unlike traditional methods (2), which reduced damage marginally, solar fencing eliminated damage entirely in protected plots. These findings align with previous studies (3), reported ~95.9 % protection using botanical repellents and demonstrated the superior effectiveness of solar fencing against elephant intrusions in Karnataka (5).

Economic analysis confirms its viability, with groundnut (ICBR 1:6.97) offering the highest returns. Similar studies in Maharashtra (5) also reported annual net benefits of ~₹12000 per acre with payback in 1-2 years. Beyond economics, farmers valued reduced stress and better security. Together, this positions agri-solar fencing as a scalable, eco-friendly wildlife conflict management tool, particularly in semi-arid rainfed agriculture.

Conclusion

Field evidence from Telangana clearly establishes agri-solar fencing as an effective, sustainable and economically rewarding solution to manage wild boar damage. The system's non-lethal mechanism, reliance on renewable energy and significant yield and income gains make it a suitable strategy for large-scale

Table 1. Agri solar for wild boar management in different agroecosystems

Sl.No	Location & Farmer	Crop	% Damage (Treated)	% Damage (Control)	Yield (Treated) (kg/ha)	Yield (Control) (kg/ha)	MSP (₹/kg)	ICBR
1	Sangareddy	Redgram	0	36	2032	1450	86.02	1:1.93
2	Medak	Black gram	0	28	1504	800	89.45	1:2.42
3	Yadadri	Rice	0	20	8024	6800	20.84	1:0.98
4	Nizamabad	Rice	0	25	7500	5630	20.84	1:1.50
5	Nalgonda	Groundnut	0	32	3625	1120	72.46	1:6.97
6	Rajendranagar, Hyderabad	Fodder maize	0	20	12500	11200	20.90	1:1.05
7	Rajendranagar	Agroforestry	0	35	4500	2925	19.53	1:1.18
8	Nagarkurnool	Maize	0	25	8025	1620	19.53	1:4.81
9	Rajendranagar	Maize	0	45	7506	4125	19.53	1:2.54
10	Sangareddy	Jowar	0	25	2250	1075	33.71	1:1.52
Average	-	-	**0**	**29.1**	**5746.6**	**3674.5**	-	-

adoption. Wider implementation will strengthen rural resilience, reduce crop losses and support both food security and wildlife conservation goals.

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Authors' contributions

VS played a key role in conceptualizing the design by leading the conceptual framework, conducting field research and analysing data. IAS contributed to field coordination, farmer interactions and impact documentation. Supported the refinement of eco-friendly management strategies. SSR executed trials on bioacoustics and barriers, monitored crop protection efficacy and collected field observations. PR provided overall guidance and scientific leadership to the project and supervised implementation, ensured alignment with scheme objectives, critically reviewed findings and contributed strategic insights for sustainable vertebrate pest management policy and outreach. PV assisted in field data collection, device maintenance (bioacoustics systems), crop damage assessments and farmer demonstrations and played a key role in logistical support, field documentation and coordinating on-ground implementation activities. VC assisted financial support and mentored the research. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests.

Ethical issues: None

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