DOI: 10.2305/QGQL8047
Technical Report Gajah 58 (2025) 40-50

Community-Based Seasonal Electric Fences for Human-Elephant Coexistence

Prithiviraj Fernando[1]*, Sampath K. K. Ekanayaka[1], M. K. Channa R. De Silva[1] and Jennifer Pastorini[1,2]

[1]*Centre for Conservation and Research, Tissamaharama, Sri Lanka*
[2]*Department of Evolutionary Anthropology, University of Zürich, Zürich, Switzerland*
**Corresponding author's email; pruthu62@gmail.com*

Abstract. Community-based seasonal electric fences effectively prevent raiding of seasonal crops by elephants. However, their success is contingent on a number of inter-related factors such as community ownership and involvement, fence location and design, material quality, construction standards and maintenance. Farmers deploy the fences on the perimeter of cultivated fields when commencing cultivation, maintain them, dismantle them at harvest and store them till the next cultivation season. Farmers also bear part of the material cost and set up a maintenance fund for future exigencies. We describe the basic fence design, material specifications, how to prepare a bill of quantities and an effective implementation protocol, discussing relevant issues.

Introduction

Human-elephant conflict (HEC) is the principal challenge in conserving Asian elephants (*Elephas maximus*). Crop raiding by elephants is the most prevalent proximal cause of HEC and the main obstacle to human-elephant coexistence. Rice is the staple diet of most Asians and raiding of paddy (rice in cultivated form) is widespread. The issue is critical in Sri Lanka, where 70% of elephant range is shared with people (Fernando *et al*. 2021).

Methods of protecting crops from elephants can be divided into confrontational methods such as crop guarding and chasing elephants, and barrier methods such as fences and trenches (Fernando *et al*. 2008). Of the two, barrier methods are preferable, as – unlike confrontational methods – they do not cause reciprocal aggression by elephants, hence HEC escalation. Electric fences are arguably the most successful barrier (Fernando *et al*. 2008). However, to be effective they must fulfil three fundamental requirements; 1) proper location, 2) construction and 3) maintenance (Fernando 2020).

Using electric fencing to protect seasonal cultivations such as paddy is problematical. Paddy is a short-term crop of 3–4 months, usually cultivated once or twice a year. Permanent electric fences around paddy fields provide no benefit to people when the fields are not in cultivation. However, leftover-harvest is an important food source for elephants. They also use uncultivated fields as safe movement paths (Fernando 2020). Therefore, permanently fencing seasonal fields is detrimental to elephants and is likely to increase HEC, as elephants are compelled to seek alternate resources and routes (Fernando 2020).

'Exclosure' fences around agricultural fields and settlements are more effective than 'enclosure' fences around protected areas. This is mainly due to the consistent human presence next to exclosure fences and ease of maintenance by the beneficiaries (Fernando 2020). Farmer presence in paddy fields is high during cultivation and it is a simple task for them to maintain fences. However, farmers generally live away from paddy fields and engage in other activities in the non-cultivation period. The lack of human presence and fence maintenance in the non-cultivation period provides increased opportunities for elephants to learn how to break fences, resulting in high likelihood of fence failure.

Community-based seasonal paddy field fences protect cultivated fields from elephants, while providing a solution to these issues. Farmers deploy the fences at commencement of cultivation, maintain them, dismantle them at harvest, and store them in villages till the next cultivation season. Therefore, such fences are not detrimental to elephants, do not increase HEC by preventing elephant use of uncultivated fields, do not tax farmers to maintain them during non-cultivation periods and do not provide elephants easy opportunities to learn how to break fences.

We have developed, tested and refined community-based seasonal paddy field fences over the past 20 years and implemented over 50 such fences in different parts of Sri Lanka. We are now in the second phase where our goal is to institutionalise fence implementation in relevant government agencies and upscale implementation. Community-based seasonal paddy field fences have been identified as one of the main HEC mitigation initiatives in the 'National Action Plan for the Mitigation of HEC' (Fernando *et al*. 2020).

Currently we are engaging with the development sector, including donor agencies such as the World Bank and Asian Development Bank, and government agencies such as the Department of Agrarian Development, by providing technical know-how, conducting awareness programs, workshops, training of trainers and assisting implementation. Through this initiative, the Department of Agrarian Development has implemented over 200 community-based seasonal paddy field fences in 2024 and a further 200 are to be implemented in 2025.

We have also conducted awareness programs and study tours for a wide range of participants from Asia and Africa including India, Nepal, Thailand, Vietnam, Malaysia, Myanmar, Botswana, Cameroon, Gabon, Ethiopia, Mali, Malawi, Mozambique, Republic of Congo, Zambia and Zimbabwe. Following our model, seasonal fences have been piloted by a number of organisations in other range states such as Myanmar, Nepal and India (Jayasinghe 2015; Sampson 2018; Stewart-Cox 2024).

Here we provide information on aspects relevant for implementing community-based seasonal paddy-field electric fences.

Fence design

The basic fence design consists of two live wires strung between energised posts. Since the fence borders a paddy field, the ground moisture is sufficient for good earthing, hence an earth wire is usually not needed. GI pipes are used for fence posts. The live wires are borne by split metal washers welded to the post, thus also energising the post. The post is prevented from earthing by a 'ground insulator', which is a non-conducting sleeve sealed at the bottom.

Simplistic designs such as single wire fences with bamboo/wooden posts are unlikely to be effective or last multiple seasons. More complicated designs such as seasonal 'hanging fences' have also been developed and trialled successfully by us. However, the more complicated and technical a fence, the greater the cost, the more likely it is that defects will occur and more challenging the deployment by farmers, hence less the possibility of scaling up deployment. Therefore, what is recommended and is described here is a basic, robust fence, which is easy to install, maintain, dismantle, transport and store. It is adequate to prevent elephant raiding under most circumstances and will last for many seasons.

Protocol for implementation

1. Selecting a site for implementation

Some basic conditions need to be met, which can be assessed by talking to a few farmers on site and viewing the location on Google Maps (with 'satellite layer') or Google Earth, to gain an overview of the location (Fig. 1).

Figure 1. Paddy field on Google Earth.

Conditions to be met:

- Cultivation is only seasonal (not permanent)
- Site experiences regular raiding by elephants
- Farmers consider elephant raiding to be a major issue
- Farmers are willing to work together to overcome the problem
- Fields can be encircled by a fence (while 'open' or 'linear' fences maybe appropriate in some situations, it is advisable to start with 'enclosure' fences and explore other options once experience is gained)

If any of these requirements are not met, the site is inappropriate. If it is suitable, introduce the basic concept to the farmers present and ask them to discuss it with their peers.

2. Community awareness

Upon expression of interest in moving forward, a meeting is arranged with all the farmers (Fig. 2). Reluctant communities should never be compelled or persuaded to get a fence, as it will result in non-maintenance and fence failure. Following are the aspects farmers need to be made aware of, to make an informed decision.

Discuss the problems caused by elephants, how often damages occur, what the farmers currently do to prevent raiding, and their successes and failures. Explain how an electric fence functions, using simple diagrams. Stress the difference between a fence connected to grid electricity – which will kill any person or animal touching it, hence is a 'death-trap' and is illegal – versus an 'electric fence', which is powered by an energiser. Electric fences only use smooth wire and never barbed or concertina wire.

Figure 2. Explaining the procedure to farmers.

An electric fence carries a DC (direct current) pulse at a very high voltage (around 6,000 – 9,000 V) but very low amperage (less than 100 mA), therefore causes a 'shock' but does not cause burns or harm life. The main fence components are the energiser, battery, power input, earth system, fence posts and wires. The current material costs of a seasonal electric fence using high-quality materials is about US$ 1,500 (for energiser, solar unit etc.) + US$ 1,000 per km of fence length (wire, posts etc.). For example, material for a 2 km fence will cost around 1,500 + (1,000 x 2) = US$ 3,500 and a 5 km fence 1,500 + (1,000 x 5) = US$ 6,500. The cost per acre varies widely with fence length and geometry.

The effectiveness of a community-based seasonal electric fence in preventing raiding by elephants is contingent on its proper deployment and maintenance by the community. Therefore, its success requires a strong sense of community ownership, which is promoted by the following conditions:

Fence committee: A pre-existing farmer society can be co-opted or a 'fence society' formed. All farmers should be members, and the committee selected from the membership. The committee will be responsible for coordinating fence construction and management. Imposition of penalties by the committee, on individuals for non-compliance and non-participation in activities, ensures effective fence management.

Fence construction: The fence is to provide relief from a pressing problem of the community. Therefore, they should be the main stakeholders in its implementation. The implementers will provide technical know-how and the farmers construct the fence accordingly. Thereby farmers gain knowledge of its function and will be able to correct any defects that arise, without delay.

Contribution to the cost: The few hours an individual farmer will contribute to fence construction is insufficient to create a lasting sense of ownership. Contributing to material costs in addition to labour, promotes greater ownership. The amount of community contribution should be determined by discussion with the farmers. A minimum of 25% of the material cost is suggested. The greater the community contribution, the greater the likelihood of success. The contribution by individual farmers can be based on a per acre amount and prorated according to extent owned. Collected funds should be used for purchasing fence material.

Fence maintenance: An electric fence will be effective only as long as it is properly maintained. The maintenance requirements are simple and mainly consist of regularly clearing vegetation that may come into contact with the live wires and seeing that the components remain functional. The community-based approach and fence location facilitates maintenance, as the fence is at the perimeter of fields being tended by the farmers.

Maintenance fund: A fund is formally set up with a bank account and procedures for withdrawal and accounting specified. A 'fee' is collected from each farmer at harvest and credited to the fund each season. The fund should be of a sufficient amount to replace components such as a battery or energiser after a few years. This ensures sustainability, without the community having to seek additional aid.

Fence removal: It is mandatory that the fence is removed at harvest (Fig. 3) and stored till the next season of cultivation, even if the next cultivation season is commenced one or two weeks later. Failure to do so will encourage keeping it for longer periods between cultivations and being viewed as a permanent fence, leading to its failure and/or obstruction of elephant movement and increased conflict. If cultivation occurs throughout the year, a seasonal fence is not appropriate.

Figure 3. Taking down the fence after harvest.

Crop-guarding: A fence will deter most elephants, but some may try to break it. Human presence in the field makes breakage much less likely. Continued crop guarding is therefore essential but can be at a reduced level from before. The fence committee should draw up a roster for guarding and ensure compliance. If crops are not guarded currently, it indicates that raiding by elephants is not a major issue, and that the location is unsuitable.

Fence monitoring: Community participation consists of a farmer accompanying the monitoring officer (see step 8 below). The farmer will report deficiencies to the fence committee, which needs to attend to it. Alternatively, a few farmers could accompany the monitoring officer and attend to any issues immediately. The fence committee should draw up a roster for accompanying and ensure compliance.

Termination of fence: If the fence fails – usually from lax maintenance – the fence should be discontinued. An option for encouraging compliance to agreed conditions is to have the energiser in the implementing agencies' custody between cultivation seasons. Termination would be a last resort. Regular monitoring and maintenance will prevent getting to this end point, as it will identify deficiencies before they become critical.

Once the conditions are presented, the farmers should be asked to discuss among themselves and given time to decide whether they want to proceed.

3. Sign agreement

Once the farmers have understood the procedure, agreed to the conditions and have set up the fence committee, an official agreement can be signed. It should include:

- Conditions for obtaining the fence (from above)
- A maintenance mechanism and schedule
- Penalties for non-compliance in maintenance, crop guarding or contribution to the maintenance fund
- Conditions of fence termination
- List of all farmers, with signatures, accepting the agreement

4. Mapping the fence line

The next step is to map the fence line, which is the perimeter of the paddy tract. Mapping is done by walking the perimeter of the fields with the farmers, noting the number of fence posts as follows: Note down a 'corner post' at the start of the fence. Then walk in a straight line along the perimeter, measuring 15 m lengths from the starting post, using a rope pre-marked at 15 m intervals. Note down a 'middle post' at each 15 m interval until a point where the perimeter changes direction is reached. Mark another corner post there. Continue in the new direction, again noting middle posts at 15 m intervals from the last corner post, till the next corner post. Repeat this till you come back to the starting point. If trees are present along the fence line approximately where a corner or a middle post should be, they can be used instead of posts and marked as 'corner trees' or 'middle trees'.

At the end of mapping, add up the tallies to determine the total number of corner posts, middle posts, corner trees and middle trees. Each section between corner posts/corner trees is counted as a span. A handheld GPS can also be used in mapping and creating a map on Google Earth. If only a portion of a tract is cultivated in a particular season, the fence should only enclose that part.

5. Clearing vegetation

The fence line is cleared of vegetation to a width of 3 m. It also needs to be reasonably levelled as otherwise the wire may touch the ground. Any small, uncultivated patches falling inside the fence line are cleared to ensure the fence is visible to crop guarding farmers. The farmer society does the clearing manually or – if major clearing is required – by machine. Clearing should be supervised or afterwards the site inspected to check that the clearing is adequate. Where elephants have learned to break fences by toppling trees on to the fence, trees should be removed.

6. Bill of quantities (BOQ)

The information from mapping is used to determine material quantities that vary by fence length (and geometry) and those that are a fixed number per fence (Table 1). In addition, implementers require electric fence pliers, voltmeter and a pair of gum boots which can be used for multiple fences. Gates are not needed as farmers can simply go under the fence. Gates also add expense and create weak points.

7. Fence installation

All farmers should participate in fence installation (Fig. 4). With experience, farmers can be divided into groups and their participation staggered by section of fence and time.

Fence installation procedure:

- Mark corners with stakes.
- Prepare post-holes for corner posts. In moist /soft ground post-holes are dug by driving the pointed end of a 7.5 cm diameter stake (of strong wood or metal) into the ground with a heavy mallet and making a hole 45 cm deep and of adequate diameter to install the corner post. On firmer ground, a 7.5 cm diameter heavy GI pipe cut at an angle at one end can be used. It is driven in partway, pulled out, the soil plug in the pipe removed and repeated till the correct depth is reached.
- Install corner posts.
- Stabilise corner posts with guy-wires anchored by anchor stakes. The guy-wire is a length of fence wire tied securely to the post at one end and to an anchoring stake through a bullnose insulator at the other, thereby being energised. Guy-wires and stakes have to be placed to oppose the pull exerted on a post by the fence wires and 1–3

Figure 4. Farmers installing their fence.

may be needed, depending on the fence angle and load at a particular post.

- Tie 4 bullnose insulators to each corner tree with tying wire, so that they are aligned with the fence wires.
- Nail the tree hooks to middle trees at appropriate height.
- Place a roll of wire on the wire dispenser and feed it out by spinning the dispenser and pulling out one end of the wire, taking care that it does not drag on the ground, as that will damage the galvanised coating.
- Pre-thread the fence wire through a reel insulator per each tree hook (for middle trees) used, when the fence wire is being installed for that span.
- Secure the fence wire of each span to the corner posts or corner trees at each end of a span. In the case of corner posts, insert the fence wire through the corner post wire holders on posts and tie it securely to the post. In the case of corner trees, thread it through the bullnose insulator and tie it securely. When securing the fence wires at the end of a span, pull it and tie it so that slack is minimised.
- Connect the fence wires on either side of corner trees with a short piece of fence wire that circumvents the tree without touching it.
- Mark the locations of middle posts along the fence line at approximately 15 m intervals between corner posts, dig 30 cm deep holes,

Table 1. Preparing the BOQ. Quantities are based on the mapping information.

Factor	Description	Quantity
Fence length	Fence length (m)	= (# corner posts + # middle posts + # middle trees + # corner trees) x 15
	Corner posts with ground insulator	= # corner posts
	Middle posts with ground insulator	= # middle posts
	Bullnose insulators	= (# corner posts x 2) + (# corner trees x 4)
	Reel insulators	= # middle trees x 2
	Tree hooks	= # middle trees x 2
	Iron nails 2”	= # tree hooks x2
	Fence wire 1.6 mm (kg)	= fence length x 2 / 55
	Tying wire 2.5 mm (kg)	= (# bullnose insulators x 3 / 25) + 5
	Wire tighteners	= # spans x 2
	Anchor stakes	= # corner posts x 2
	Fence indicator light	= fence length / 1000
Per fence	Energiser with alarm	1
	Lightning diverter	1
	Earth rod with wire clamp	7
	Lead-out cable (2.5 mm)	5 m
	L-joint wire clamp	3
	Solar panel with mounting kit	1
	Solar charge controller	1
	Solar battery with accessories	1
	Cutout switch	1
	Energiser cabin	1
	Energiser cabin stand	1
	Wire tightener handle	1
	Wire dispenser	1
	Electric fence voltmeter	1
	Utility pliers	1
	Warning signboard	5

install posts and insert the fence wire into the wire holders on posts.
- Install a wire tightener on both wires on each span and tighten to remove slack.

The power unit should be installed in tandem with installation of posts and wires:

- Install the energiser cabin and mount the solar panel, controller, battery and energiser.
- Install the energiser, according to the manual.
- Set up the earth system and connect it to the energiser.
- Install lightning diverters.
- Once the fence is installed and energised, check the fence voltage with the voltmeter. Correct any current leaks.

If the fence installation cannot be completed in a day, start with the section closest to the energiser and switch on the completed fence section at the end of the day. Installed fence posts and wire left overnight without power might be damaged by elephants.

8. Fence monitoring

Weekly for the first month, then once a fortnight, an officer from the implementing agency needs to walk around the fence. The voltage is checked every 10 posts and the fence is inspected for shortcomings such as current leaks, vegetation touching live wires, posts at an angle, loose wires etc. Any issues should be shown to the accompanying farmers and corrected. Completing a data sheet at each visit by marking the observed faults, provides a record of fence status and provides early warning of lax maintenance. Frequency of monitoring can be reduced in subsequent seasons based on farmer competency.

9. Fence removal and storage

The fence is dismantled in sections and stored in a village. The fence removal procedure is as follows:

- Switch off power to fence.
- Release the tension from the wire tighteners.
- Cut the fence wires where they are tied to the corner posts and tree-bullnoses.
- Rewind the fence wire using the wire dispenser, taking out the reel insulators.
- Number each roll of wire with the related span number, so that it can be reinstalled for the same span.
- Untie bullnose insulators from corner trees and anchor stakes, at the farther end from the bullnose. They can be reused as is.
- Remove posts and ground insulators.
- If the ground is dry, watering the base of posts enables removal without damaging the ground insulator.
- Damaged posts should be discarded.
- Remove the individual components of the power unit.

The material is transported to a suitable location and stored until the next cultivation season. When storing the battery, reconnect the solar panel to the solar charge controller and connect it to the battery so that it is kept charged.

Important factors to consider

For successful fences the implementers should be knowledgeable of all aspects of community-based seasonal electric fences, work closely with the farmers, supervise construction and conduct regular fence monitoring. Constructing a fence and handing it over to farmers or providing the farmers with material and expecting them to do it by themselves will result in failure.

The sustainability of a fence over multiple seasons is contingent on proper communal maintenance hence sense of ownership. In smaller communities, fence ownership and community cohesion tend to be greater, making long-term sustainability more likely. Similarly, the shorter the fence length, the easier is its management. Therefore, limiting the length of seasonal fences to less than 5 km is advisable. Where cultivation tract perimeters are longer, having a cluster of small fences instead of one long fence would be better. If only a single long fence is possible, breaking it up into independently powered serial sections allied with any pre-existing grouping of farmers would be better than a single long fence requiring the coordination of multiple groups.

In embarking upon a community-based seasonal electric fencing program, at first farmers may be reluctant to invest labour and particularly funds, as they may doubt its effectiveness. Therefore, concessions may need to be made in the conditions identified here. Although per acre costs will be higher, it is best to start with a small fence of about 2 km that will serve as an example and scale up in subsequent seasons, so that the implementers gain experience and issues are identified and addressed.

Material specifications

Corner post with ground insulator

Post: GI pipe; 1¼" (32 mm) diameter – 1.8 mm wall thickness; 2.3 m in length; bottom end deburred/filed smooth; two flat metal washers (0.5 mm thick, 2.5 cm outer diameter, 1.3 cm inner diameter) welded to post as wire holders, at 4 cm and 1 m from the top, vertically oriented to carry the fence wire; welds cleaned and painted over with zinc-phosphate anticorrosive paint; washers cut across at the top; –top end of post sealed by welding a zinc-coated gauge 18 plate (end plate), to prevent rainwater inflow into the GI pipe (Fig. 5).

Ground insulator: Composed of 2 concentric layers; inner layer 1½" PNT 11 uPVC pipe, 66 cm in length, sealed at the bottom end by a PVC end-cup glued on with PVC solvent cement; outer layer 2" black HDPE (alkathene) pipe, 76 cm in length (Fig. 6). It is important to use uPVC pipes and fittings and not PVC, as PVC may have added lead (Pb), which leads to current leakage. The ground insulator described is fabricated with commonly available supplies. We are currently working on developing an injection-moulded unit to replace it.

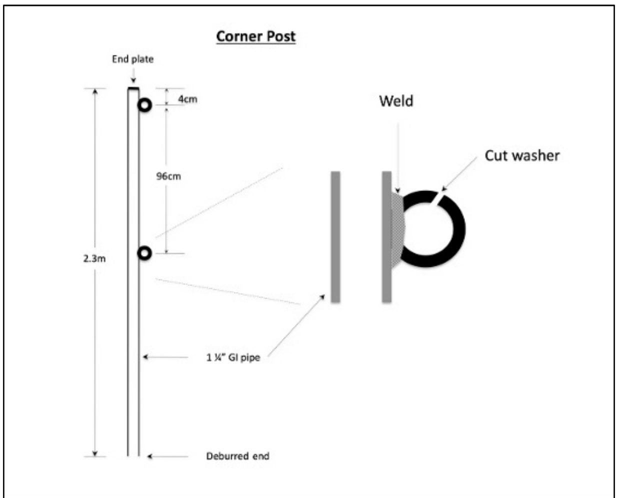

Figure 5. Detail of corner post.

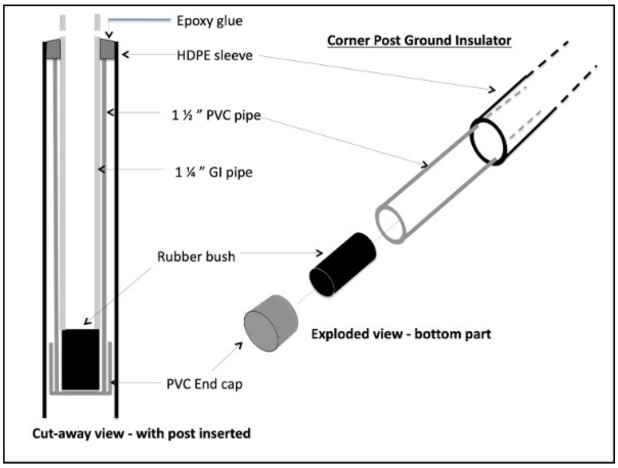

Figure 6. Detail of ground insulator for corner post.

Ground insulator assembly: A solid rubber bush, 2" long and 1.5" in diameter, tightly fitting the PVC pipe, is inserted into the 1.5" PVC pipe at its bottom end and sealed with the end cup; the assembled 1.5" uPVC pipe is inserted into the 2" HDPE sleeve, leaving 5 mm of the HDPE sleeve projecting at the top end (Fig. 6).

Post and ground insulator assembly: The 1¼" GI pipe (post) is inserted into the ground insulator and pushed to its bottom to contact the rubber bush; once post is inserted, the top end of the ground insulator is sealed by filling up the top of the HDPE sleeve lip with epoxy glue (Fig. 6).

Middle post with ground insulator

Post: GI pipe, – ¾" (20 mm) diameter – 1.8 mm wall thickness; 2.1 m long; bottom end deburred /filed smooth; wire holders and end plates same as for corner posts (Fig. 7).

Ground insulator for middle post: Composed of 3 concentric layers; an inner layer of 1" PNT 11 uPVC pipe, 66 cm in length, a middle layer of 1¼" PNT 11 uPVC pipe, 66 cm in length, sealed at the bottom end by a PVC end-cup glued with PVC solvent cement, and an outer layer of 1½" black HDPE (alkathene) pipe, 76 cm long (Fig. 8).

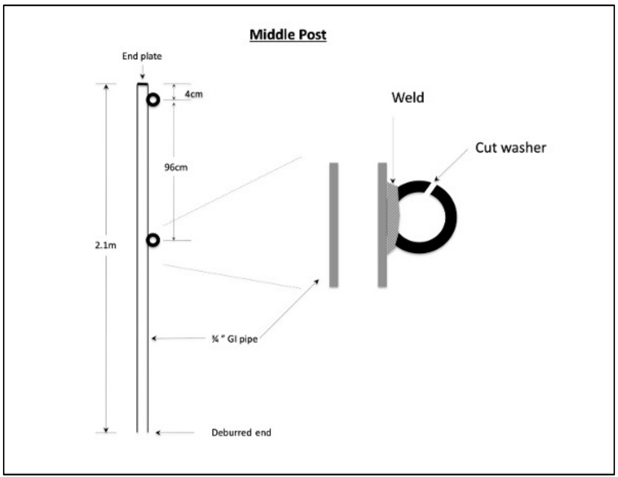

Figure 7. Detail of middle post.

Ground insulator assembly: A solid rubber bush, 5 cm long and 1" in diameter (tightly fitting the PVC pipe), is inserted into the 1" PVC pipe; then the 1" PVC pipe with rubber bush is inserted into the 1¼" PVC pipe and the bottom end of the 1¼" PVC pipe sealed with the end cup; next a 5 cm long piece of 1" PNT 400 pipe split vertically is inserted between the 1" and 1¼ " PVC pipes to fill the gap ('PVC socket' in Fig. 8); finally the assembled 1¼" PVC pipe is inserted into the 2" HDPE sleeve, leaving 5 mm of the HDPE sleeve projecting at the top end.

Post and ground insulator assembly: Same as for the corner posts.

Items to fix wire to the post

Bullnose insulator: Porcelain; able to be used with galvanised wire diameter up to 3 mm; can withstand a minimum 2 kN fence wire tension; high quality glaze finish and fire resistant with a life span of more than 10 years; minimum track distance of 25 mm; withstands up to 50°C temperature for a prolonged period of time.

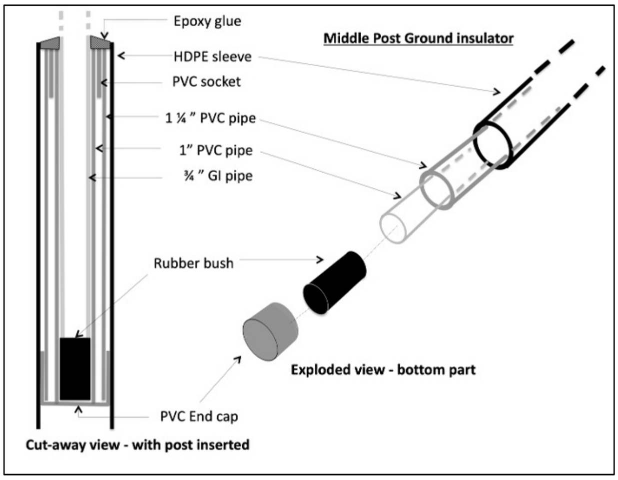

Figure 8. Ground insulator for middle post.

Reel insulator: Porcelain; diameter 40 mm; height 40 mm; glaze frame finished; withstands up to 50°C temperature for a prolonged period of time.

Tree hook: Made of 8 mm round iron bar (30 cm in length) with the end bent into a half round shape to securely hold a porcelain reel insulator; the other end welded onto a 15 cm, ¼" x ½" flat iron bar with two 3 mm holes drilled 1/2" from either end; completely painted with zinc phosphate anticorrosive paint (Fig. 9).

Fence wire: 1.6 mm diameter; hot dip heavy-galvanised high tensile steel; minimum zinc coating not less than 200 g/m^2; minimum tensile strength 1200 MPa and minimum breaking load 280–300 kg; DC electrical resistance not exceeding 70–100 Ω / 1000 m at 20°C temperature; supplied as 25 kg rolls.

Soft wire: 2.5 mm diameter; hot dip galvanised; minimum zinc coating not less than 60 g/m^2; minimum breaking load 250 kg.

Wire tightener: Designed to adjust the wire tension by tightening or loosening a wire; can be installed in line with the wire; non-corrosive.

Anchor stakes: Wooden poles around 1 m in length and strong enough to bear the strain from the posts, sharpened at one end or 1 m lengths of GI pipes one end cut at an angle.

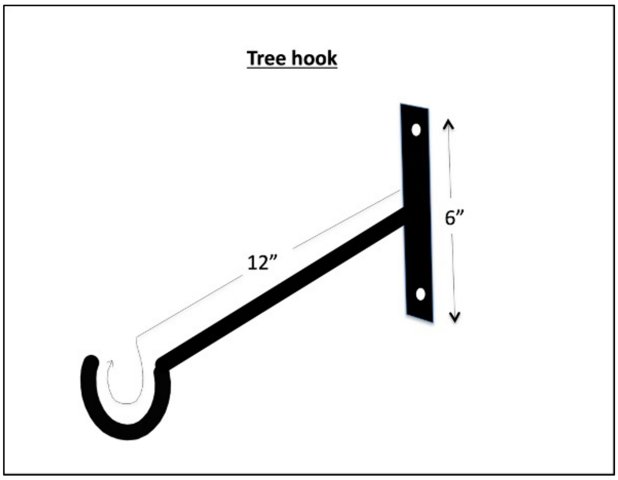

Figure 9. Detail of tree hook.

Fence indicator light: Attachable to the fence wires and lights up with each energy pulse.

Marker stakes: Small sticks about 1 m in length 2 cm diameter.

Items needed once per fence

Energiser with alarm: Complying with International Electromechanical Commission standards (IEC 60335-2-76 Ed.3.0) for current-limited electric fence energisers; powered by a 12 V DC battery; peak energiser output energy of 10 Joules; maximum energy delivered at a load of 500 Ω; resistance not less than 6.5 Joules; incorporate internal adaptive control, so that as the fence is more heavily loaded, the output energy is automatically increased to maintain pulses of a minimum of 6500 V at a load resistance of 250 Ω upwards; minimum interval between electric pulses not less than 1 second and pulse duration not exceeding 50 milliseconds; display indicating 'output pulse voltage' and 'working status'; activate an alarm when the fence is shorting (voltage drops under 6500 V) or the fence is disconnected and the battery under voltage; incorporate lightning protection as prescribed by IEC 60335-276 (2013V2.2)

Lightning diverter: Able to prevent lightning strikes on the fence from reaching the energiser and instead divert it to the earth rods; able to withstand multiple lightning strikes; manually adjustable at site to suit any fence voltage; UV resistant.

Earth rod with wire clamp: Earth rod made of 1.5 m long 50 mm diameter 2.3 mm thick hot-dip heavy galvanised G.I. pipe with one end cut at a 45° angle. Wire clamp made of a G.I. plate which is 2 mm or Gauge 14 thick and 25 mm wide; wire clamp secured to earth rod by two galvanised nuts and bolts on either side (13 mm long).

L-joint wire clamp: Heavy galvanised or stainless steel, non-rusting; suitable for securing various diameters of wire up to 4 mm diameter; able to hold multiple wires.

Solar panel with mounting kit: Solar array 100 Watt peak power; mono crystalline solar cell; short circuit current (Isc) above 5 Ampere; frame for mounting solar panel on a 1" GI pipe – when fixed, the panel should be at a 10° angle and able to be oriented to desired direction; solar wire 3 m.

Solar charge controller: MPPT type controller; capable of handling 16–20 Amperes at 12 V and compatible with other solar accessories and specified 12 V battery; battery-deep-discharge protection; protect load against short circuit conditions; include a visual charge indicator and a battery voltage indicator; manual boost charging facility; reverse polarity protection.

Solar battery with accessories: 12 V, 100 Ampere-hour (Ah); maintenance free; deep cycle gel battery; two terminal clips; heavy duty connecting wire 2 m.

Cutout switch: Able to isolate a fence voltage up to 15 kV; have clearly visible ON/OFF positions; protected contacts that eliminate electric shocks; sealed to be weather and insect proof.

Energiser cabin: Steel cabin ca. 45 cm wide x 75 cm high x 30 cm deep; weather proof; lockable door on front with durable hinges; ventilated for cooling; two 13-mm screws projecting out from the midpoint of the two sides of the floor, to fix the cabin to the stand; robust construction; able to carry the weight of a 12 V, 100 Ah solar battery, energiser and components.

Energiser cabin stand: Strong enough to support the energiser cabin with battery, energiser and components, and a 100 W solar panel; fabricated with 1" GI pipes; legs 120 cm high with pipes welded horizontally to brace the frame, 30 cm from the bottom; rectangular frame of 45 x 30 cm made of 1¼ "L-iron bars welded onto the top to receive the energiser cabin, with two holes drilled at the middle of the side bars, to receive the 13 mm screws of the cabin (see specs for cabin); a socket, closed at the bottom end, welded onto the outside of one leg to receive a 120 cm long, 1" GI pipe; a 120 cm long, 1" GI pipe for fixing solar panel to the stand (Fig. 10).

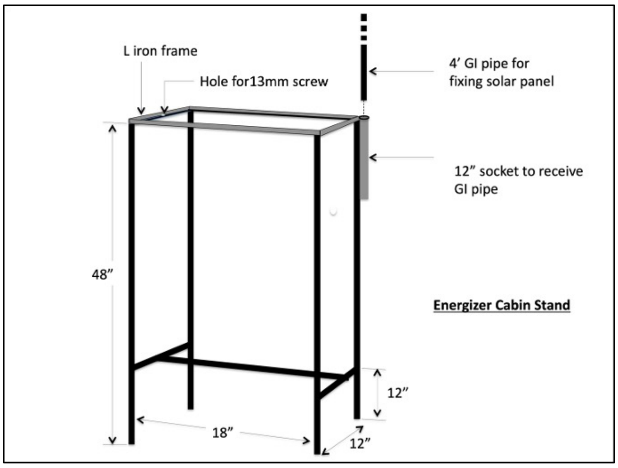

Figure 10. Detail of energiser cabin stand.

Wire tightener handle: Compatible with wire tightener.

Wire dispenser: Spinning-Jenny type; made of steel; able to hold up to 50 kg of fencing wire at a time; of robust design with six fixed (non-foldable) arms; tensioning system to control spinning speed; adjustable to handle wire rolls from 45–90 cm inner diameter; painted with anticorrosive paint (Fig. 11).

Electric fence voltmeter: Compatible with energiser used and able to measure up to 15 kV.

Utility pliers: Heavy duty utility pliers; able to cut and handle high tensile wire; rubberised grip.

Figure 11. Wire dispenser.

Warning signboard: Weatherproof signboard that can be hung on the wire with 'Warning – high voltage' message.

Acknowledgments

We are grateful to the Abraham Foundation, Shared Earth Foundation, Whitley Fund for Nature, Marjo Hoedemaker Elephant Foundation, TUI Care Foundation and Zoological Society of London for funding the development and implementation of our community-based paddy-field electric fencing program.

References

Fernando P, Kumar MA, Williams AC, Wikramanayake E, Aziz T & Singh SM (2008) *Review of Human-Elephant Conflict Mitigation Methods Practiced in South Asia*. WWF - World Wide Fund for Nature.

Fernando P, *et al*. (2020) *National Action Plan for the Mitigation of Human elephant Conflict. Presidential Secretariat, Sri Lanka*. <http://www.ccrsl.org/userobjects/2873_3122_Action-Plan-Final.pdf>

Fernando P (2020) *Guide for Implementing Community-Based Electric Fences for the Effective Mitigation of Human-Elephant Conflict*. The World Bank, Washington DC. <http://www.ccrsl.org/userobjects/2811_2557_FenceBook-VillageAndPaddy-English.pdf>

Fernando P, De Silva MKCR, Jayasinghe LKA, Janaka HK & Pastorini J (2021) First country-wide survey of the endangered Asian elephant: Towards better conservation and management in Sri Lanka. *Oryx* **55:** 46-55.

Jayasinghe N (2015) WWF Areas HEC workshop report. *Gajah* **43:** 50-51.

Sampson C (2018) Living with giants. *Perspectives* **2018(8):** 5-19. <https://biodiversity.tamu.edu/files/2018/12/PS8-lo.pdf>

Stewart-Cox B (2024) *Facilitating Human-Elephant Coexistence*. Darwin Initiative. <https://www.darwininitiative.org.uk/news/2024/01/12/facilitating-human-elephant-coexistence/>