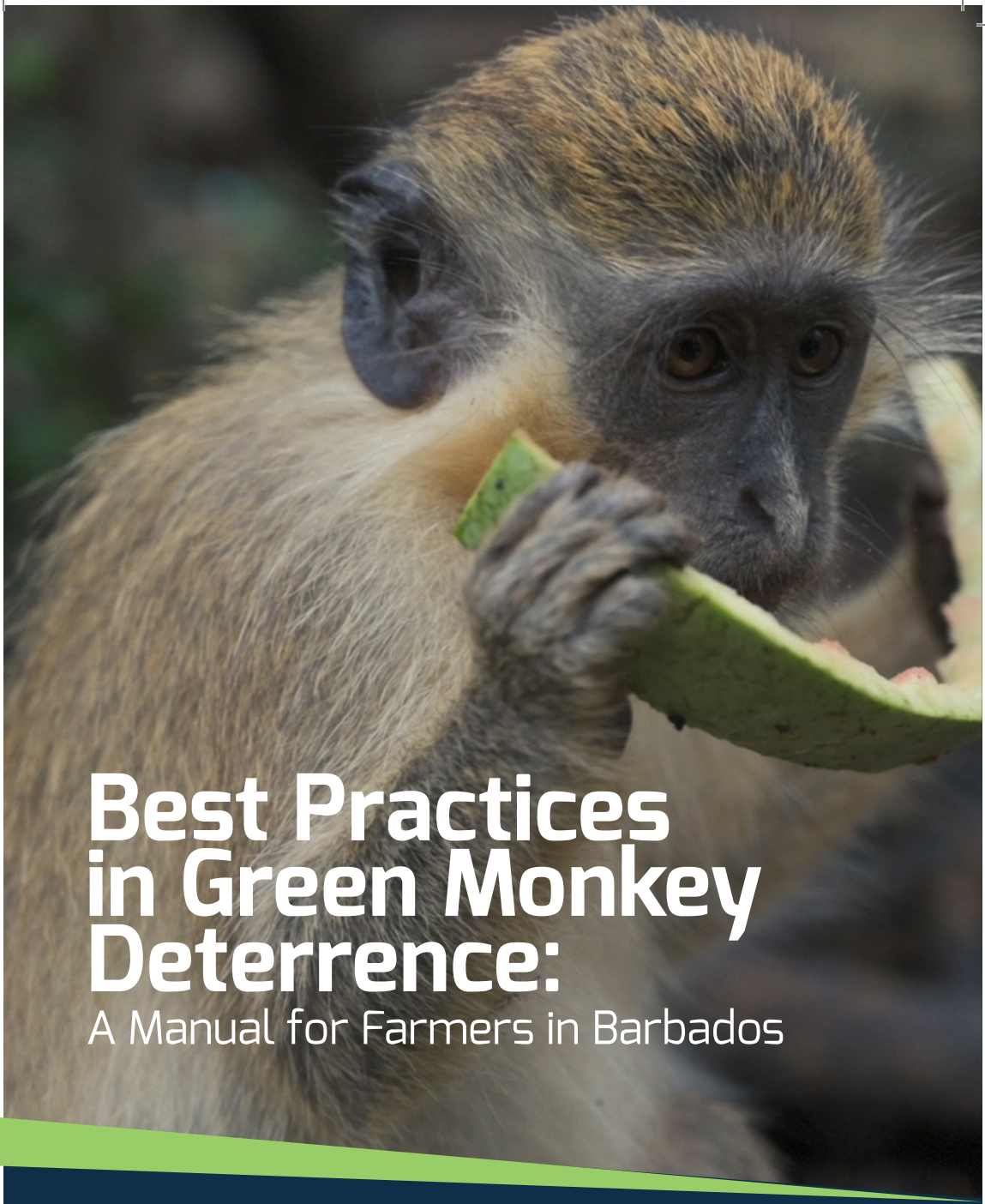

Best Practices in Green Monkey Deterrence:

A Manual for Farmers in Barbados

MOSAIC
ECO CONSULT

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For: The Government of Barbados:
The Ministry of Environment and National Beautification

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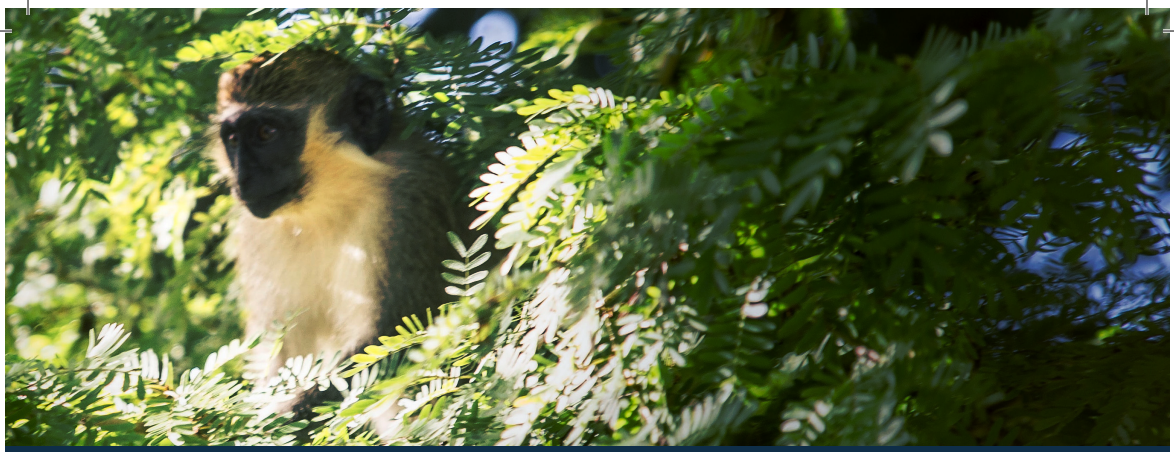


Rationale

This manual was commissioned upon the recommendation of The African Green Monkey Sub-committee of The Biodiversity Conservation and Management Section of The Ministry of Environment and National Beautification, with the aim to provide information for farmers experiencing losses from crop raiding Green monkeys *(Chlorocebus sabaeus).*

The manual consists of a review of techniques used both locally and internationally to deter monkeys from raiding cultivated foods. The aim of the manual is to describe methods that farmers can try to reduce crop damage, not to describe methods to reduce monkey numbers. It is envisioned that Barbadian farmers can try the various methods, according to their situation, to gain relief from monkeys affecting crop production.

Introduction

The Green monkey *(Chlorocebus sabaeus)* was first introduced to Barbados in the early 1600's, and an Act for Destroying Wild Monkeys and Raccoons was passed for the first time in 1680 because of their crop raiding behaviour. The monkey population has risen and fallen several times since the bounty was introduced, but a recent increase in crop raiding activity has been creating significant challenges for the agricultural sector.

Monkeys are particularly challenging crop pests because they are intelligent and quickly learn. Several traditional techniques have been utilised to deter monkeys from crop raiding over the past few hundred years in Barbados, and others have also been used in Asian and African countries to control this behaviour amongst native monkey populations. The purpose of this manual is to provide a review of some of these techniques as options for farmers in Barbados.

In the manual, the term 'deterrent' is used to refer to any technique intended to protect crops from damage by monkeys. The manual aims to inform farmers and empower them with options that they may not be aware of, bearing in mind that each farmer's situation is different and there is no "one size fits all" solution.

What is the Green Monkey?

(Chlorocebus sabaeus)

- Green monkeys are medium-sized primates; with golden/ green fur and grey hands and feet.
- Adult males are larger than females, weighing up to 6.5 kg, with a pale blue scrotum. Adult females weigh up to 4.5 kg.[9]
- Green monkeys live in troops of 10-50 individuals; troop sizes varying in different habitats.

Where do Green Monkeys come from?

- Green monkeys come from West Africa.
- In Africa, they live in grassland and forest areas.[5]
- In Barbados, Green monkeys mainly live in wooded areas, especially gullies.[8]
- They are territorial, meaning that a troop defends an area in which it moves and forages. Territories may overlap.
- They forage during the day and sleep in trees at night.

Figure 1. Geographic distribution of the Green monkey in Africa.
Source: https://en.wikipedia.org/. IUCN Red List.

What do Green Monkeys eat?

- Monkeys are omnivores; they have a varied diet that includes grasses, leaves, seeds, lizards, insects, birds and birds' eggs. They also eat cultivated fruits, vegetables and root crops.

When and how did Green Monkeys arrive in Barbados?

- Monkeys were brought to Barbados in the 1600's after Barbados was settled in 1627.
- They were brought to the Caribbean from West Africa on ships involved in the slave trade.

Why are Green Monkeys a challenge in Barbados?

- Green monkeys in Barbados lack natural predators other than dogs and humans, unlike in Africa where monkey populations are controlled by a variety of predators including leopards, wild dogs, snakes, and eagles. They can avoid dogs by climbing out of range.

- They have a generalised digestive system and can adapt their diet to what is available.
- They will eat almost all crops grown in Barbados including tree crops, vine crops, and root crops.
- Monkeys are clever and quickly learn techniques used to deter them.
- The way that they assess fruit ripeness is by taste and they often damage more fruits than they eat.
- They have cheek pouches to store food to chew and digest in safety.
- They can also carry multiple food items, like carrots, to trees to consume in safety.
- They take birds' eggs and fledglings, and small reptiles, and so can have a negative impact on native biodiversity.
- They may attack people and dogs, but rarely and usually only if cornered.
- Monkeys are primates and the way in which they are controlled should address animal welfare concerns.

Standard Reference Key

VARIABLE	LEVEL		
LEVEL OF EFFECTIVENESS	LOW	MEDIUM	HIGH
SEASON	DRY	WET	
COST	LOW	MEDIUM	HIGH
TESTING LOCATION	LOCAL	INT'L	
PERIOD	SHORT	LONG	

The Standard Reference Key for Deterrent Strategies provides manual users with a quick method to assess each deterrent strategy according to five (5) specific variables including the level of effectiveness, season, cost, testing location and period. Consideration is given to the reality that every farmer is different and experiencing varied circumstances and conditions (farm size, financial status, geographical location, and technical ability). The key allows the user to examine each variable and identify the strategy that might work best for their particular context. Variables are discussed as follows:

Level of effectiveness:
This defines how effective a strategy is, based on research and/ or reports from farmers. The three variables utilised to assess efficacy ranged from Low – High or Inconclusive; which means that the strategy has not yet been fully tested and more research is required.

Season:
Barbados has two seasons: Dry (January - June) and Wet (July - December). Some methods may work better in one season than the other, in which case only one season is shown.

Cost:
The costs of methods vary. LOW, MEDIUM and HIGH are indicative of relative costs.

Location:
This refers to the specific location where the method was tested, whether internationally or locally.

Period:
This refers to the time period for which the strategy is effective (Short – Long) and is based on anecdotal reports and research.

From the Farmers' mouths

Quotes from interviews...

" I find all these visual things are only good for a week, because when the monkey figures it out they come back."

"THE ONLY GOOD MONKEY IS A DEAD MONKEY"

> ***"You know how many people come out of farming because of monkeys? "***

"We have limited options when it comes to keeping monkeys away."

"Hanging monkeys they take long to come back"

"Dry season is harder damage"

"One time monkeys came in the 10's now they come in the 30's"

"Monkeys have kept Barbadians in fear and trepidation for a long time."

STRATEGIES TO REDUCE CROP RAIDS

The following section describes strategies that can be utilised to deter Green monkeys. How effective each method is will be dependent on the specifics of each particular scenario. Research suggests that certain methods may be more effective when combined.

There are FOUR main types of deterrent:

- Guarding (by people or dogs)
- Barriers
- Visual and acoustic deterrents
- Repellants

GUARDING

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
GUARDING (PEOPLE)	**HIGH**	**DRY**	**WET**	**HIGH**	**LOCAL**	**SHORT**

Guarding (people)

In many countries, people with or without dogs, guard their cultivated fields from a variety of pests, including monkeys. These persons are usually family members or persons paid a small amount to guard.

Monkeys can wait for hours, even most of the day, for an opportunity to raid. Farmers indicate that monkeys will watch human movement and arrive before persons are present on the farm and after departure of human presence on farms, so effective guarding requires presence from pre-dawn to post-dusk.

Monkeys tend to be more afraid of men and persons with weapons, than of women, children, or persons who are unarmed, so if chasing is conducted persons should ensure they have a weapon in hand e.g. catapult, stick, rock, to ensure a higher level of effectiveness.

Guards must be proactive and react to monkey presence quickly, consistently and effectively. This will provide the greatest level of deterrent to the monkeys.

Guards must proactively patrol perimeter areas to deter monkeys from entering farm areas at problematic points.[6]

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
GUARDING (DOGS)	**MEDIUM**	**DRY**	**WET**	**MEDIUM**	**LOCAL**	**LONG**

Guarding (dogs)

Barking dogs that alert people to a monkey raid can help to reduce crop damage. Their presence may also deter monkeys from going to the ground. Dogs will naturally tend to bark at and chase monkeys. Monkeys may be more afraid of larger breeds but smaller breeds can also be effective. The research suggests that the response of a dog to monkeys varies according to pedigree, temperament, and characteristics of the specific dog. It is important that the dog chosen is an active breed, with a high desire to give chase.

Monkey habituation can pose a challenge when dogs become accustomed to monkey presence and cease to bark or chase.

NB: Dogs cannot protect tree crops very effectively.

CAUTION: Aggressive dogs may pose a risk to small children and visitors. Pay attention to dog locations and place appropriate signage around the property.

Figure 2. Medium to large mixed breeds can be used to deter monkeys; this breed was reportedly mixed with pit-bull.

Figure 3. Small breeds can be effective monkey deterrents, stationed at strategic locations to alert larger dogs of monkey presence.

Figure 4. Working dog breeds like Jack Russell Terriers are proven highly effective as monkey deterrents.

An effective monkey deterrent setup is to locate dogs at fixed locations around the field; each dog can be chained to a line that runs along the field perimeter at a fixed distance from the adjacent dog. This allows the dogs to form a linked network and effective barrier between the monkey entry points e.g. gully and the crop (See Figures 5 and 6). Jack Russell Terriers are used to form a barrier between a gully and christophene field. This technique has been effective for crop protection where monkeys have been a long-term challenge in Sturges, St Thomas.

Figure 5. Network of Jack Russell Terriers on chains attached to line. The dogs are located between the gully (left) and the christophene field (right).

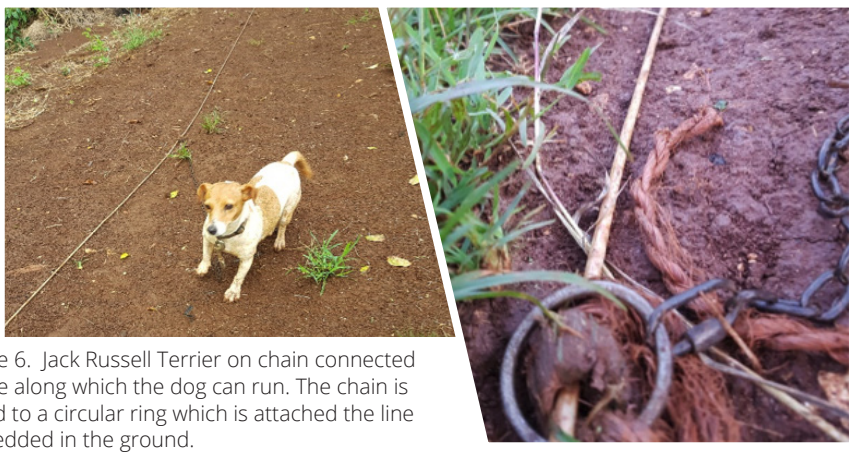


Figure 6. Jack Russell Terrier on chain connected to line along which the dog can run. The chain is linked to a circular ring which is attached the line embedded in the ground.

Using a chain reduces the chance of the dogs getting entangled in the line. However, dogs should be provided with food, water and shade and be checked regularly.

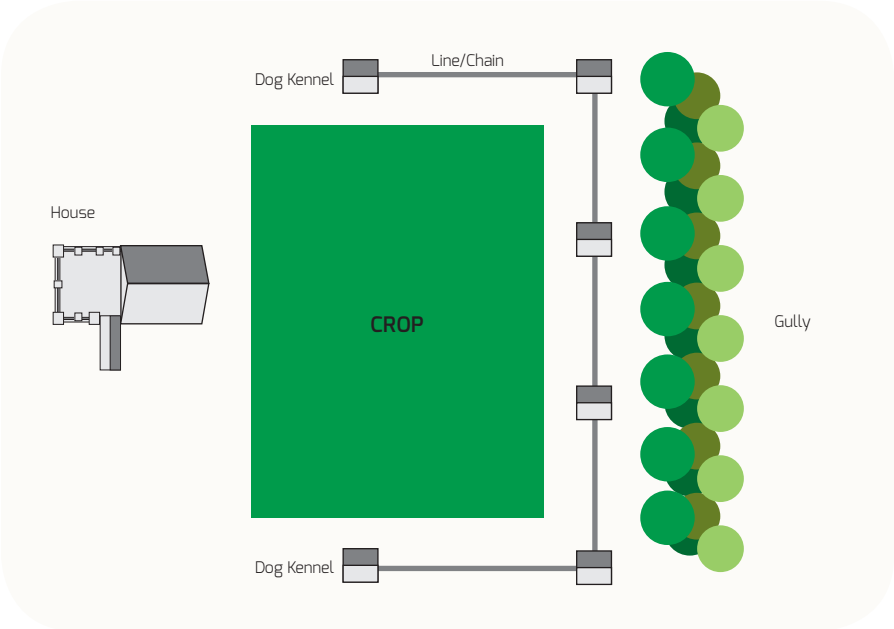


Figure 7. Diagram of dog distribution network forming a barrier between the crop and the gully.

BARRIERS

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
ENCLOSURES	**HIGH**	**DRY**	**WET**	**HIGH**	**LOCAL**	**LONG**

ENCLOSURES

"The fence enclosure works once it is secure, once the monkey cannot get in, it will work."

Full enclosures (top and sides enclosed) can be utilised to protect and secure crops from monkey damage. These can be made of a combination of various materials including wooden posts and chicken mesh wire and/ or saran netting.

It is important to ensure that enclosures are well secured along all edges. Monkeys will manipulate fences in attempts to gain entry.

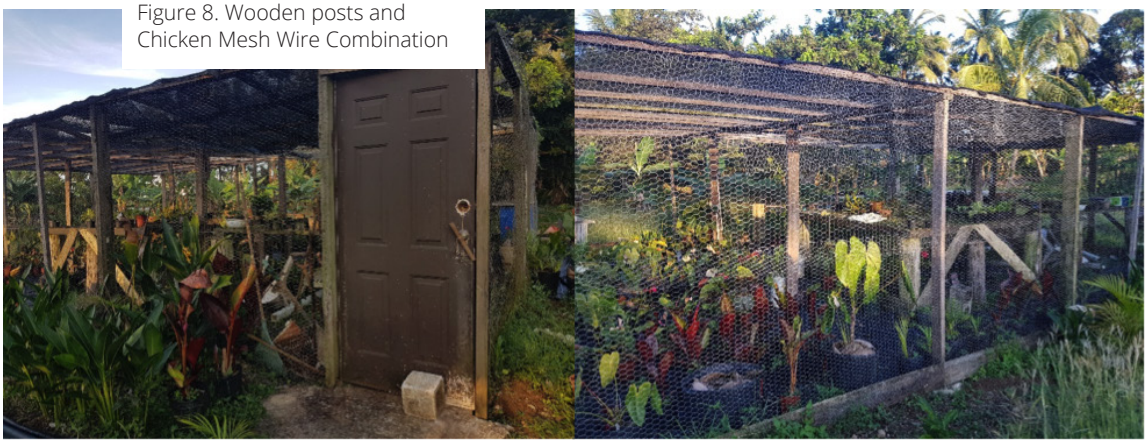
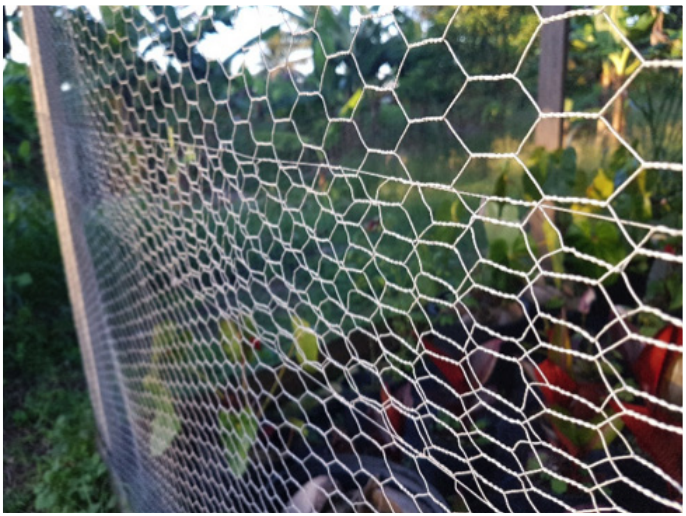


Figure 8. Wooden posts and Chicken Mesh Wire Combination

Figure 9. Wooden Post and Chicken Mesh Wire.



Careful attention must be given to ensuring that the wire mesh overlaps to prevent manipulation of the wires and entrance through holes.

Figure 10. Rectangular wood and mesh enclosure used to cover rows.

Small wood and mesh enclosures can be utilised and placed over rows, however the base must be secured to the ground to ensure monkeys cannot dig under the wire (See Figure 10).

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
ROW COVERS	HIGH	DRY	WET	MEDIUM	LOCAL	LONG

Row Covers

Figure 11. Row covers utilising PVC plastic pipe and saran netting.

Row Covers/ crop shields can be used to cover and protect crops from insect pests and monkey damage.

They have been used extensively in temperate countries as a safeguard for unexpected drops in temperature. More recently, they are being used to grow pest-free crops.[18]

They can be constructed using a combination of PVC pipe and a range of cover material including: saran netting, insect screen, and fish netting.

Figure 12. Fish netting is very durable and can be an effective crop shield against monkeys.

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
TREE NETS	**HIGH**	**DRY**	**WET**	**LOW**	**INT'L**	**LONG**

Tree Nets

- To prevent monkeys from raiding fruit trees, barrier nets of 5 x 5cm square mesh nylon rope, or bird netting can be placed in the tree canopy.[3]
- The net must be secured to the ground or tree base to prevent monkeys getting inside.
- The barrier nets can close off travel pathways through the trees that monkeys would ordinarily use.
- The net could enclose the entire tree canopy (See Figure 13) or part of the tree canopy depending on the position of the focal tree with respect to other trees nearby.

Figure 13. Tree net covering tree.
Source: https://www.plantra.com

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
FRUIT COVER BAGS	**MEDIUM**	**DRY**	**WET**	**LOW**	**LOCAL**	**SHORT**

Fruit Cover Bags

Some fruits can be covered at specific vulnerable stages of maturity.

- Strong protective bags e.g. Animal feed bags (Pinnacle, Roberts, onion bags) can be used to cover bunches of bananas.
- These have proven to be more effective than the commercial banana fruit cover bags.
- The protective cover bags can be placed over banana bunches in early development stages and remain for 2 months until maturity.

Figure 14. Pinnacle feedbag utilised over banana bunch, the top of the bag is tied with wire.

Figure 15. Roberts Manufacturing price saver dog food bags made of hard plastic are effective banana covers and have assisted in reducing monkey damage.

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
ELECTRIC FENCING	**HIGH**	**DRY**	**WET**	**HIGH**	**INT'L**	**LONG**

Electric Fencing

Traditional fencing is not a deterrent. However, adding electrified wires to a metal chain link fence can be effective.[16] Farmer experiences indicated that electric fencing is an effective method to deter monkeys, but it has significant start-up costs. Additionally electric fences may present safety concerns as it relates to children who may be unaware of the electric shock it produces.

CAUTION: Erect appropriate signage to caution persons against touching the fence.

Figure 16. Electrified wire (four strands) are installed horizontally above a chain link fence.

Figure 17. Electrified wire strands are installed horizontally above a chain link fence (detail).

- It is also recommended that 3-4 strands of electrified wires are mounted above the chain link fence to restrict monkey access (See Figure 17).

Several points must be noted when building this type of fencing:

- When electrified wire is mounted above a chain link fence, a horizontal metal pole should be fixed across the top of the chain link fence, ensuring that the chain link is rigid, so as to prevent monkey access (See Figures 16 and 17).
- The chain link fence must be earthed to ensure that if the monkey stands on the chain link fence while touching the electrified wire it receives a shock.
- The base of the fence must be securely fastened to the ground to prevent monkey access from bending the wires or digging under the fence.
- **Buffer zones** should be created around the fenced area, ensuring that vegetation is maintained at a lower level than fencing to prevent monkeys from using trees and/or vegetation to scale the fence and enter the property. A vegetation clearing of at least five (5) feet should be maintained around the fenced area.
- A wide variety of fence chargers are available internationally and in Barbados, with options for both alternating current and solar-power.

Solar Powered Fence Chargers

Parmak Solar Powered Electric Fence Chargers can be utilised to charge electric fences. Models include the Deluxe Field Solar Pak 6 and Magnum Solar Pak 12 (See Figures 18 and 19). These can be sourced from ***www.parmakusa.com*** or from ***www.amazon.com.***

A complete electric fence system is comprised of a charger, ground system, wire, posts, and optional accessories, which can be sourced from ***www.parmakusa.com***.

Figure 18. Parmak Solar Pak fence solar powered fence charger options
Source: www.parmakusa.com.

Figure 19. Fence chargers can be situated on wooden fence posts in well-exposed areas to ensure effective sun light charges the battery

Alternating Current Fence Charger

The Zareba Unit (See Figure 20) is available in Barbados. The device can charge 50 miles of wire under optimal conditions.

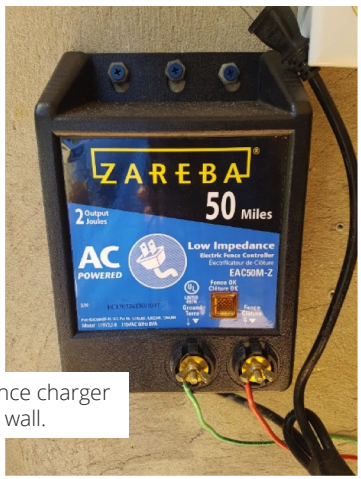


Figure 20. Zareba Fence charger situated on concrete wall.

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
XCLUDER FENCING	**HIGH**	**DRY**	**WET**	**HIGH**	**INT'L**	**LONG**

Xcluder Fencing

The Xcluder™ "Kiwi" Fence has proven an effective exclusion mechanism against Javan macaque monkeys.[4]

- This method effectively forms a barrier that prevents the monkey from scaling the structure.
- The fence design consists of a 2m high base fence, backing wires and wooden posts.
- Wire mesh is affixed up the entire length of the base fence and a >300 mm wide mesh skirt facing the pests is pinned to the ground and buried under the soil.
- A sheet of 600 mm wide steel is folded, rolled to form a 'hood' that is mounted at the top of the fence and extended 330 mm horizontally.
- The steel hood is mounted on custom-built brackets, to offer stability when animals jump on it.
- The monkeys are unable to grip the smooth surface of the hood and can not pull themselves around to the top of the fence.

Figure 21. Xcluder 'Kiwi' Fencing
Source: www.lincolnecology.org.nz

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
LIVING FENCES	**HIGH**	**DRY**	**WET**	**LOW**	**INT'L**	**LONG**

Living Fences

- Living cactus fences are effective deterrents to pests because of their sharp needle-like spines.[10,28]
- Plant species such as San Pedro Cactus *(Trichocereus Pachanoi)*, Pipe organ cactus *(Pilosocereus royeni)*, Mexican Pipe organ cactus *(Stenocereus griseus)* and Prickly Pear *(Opuntia sp.)* can be effective fences and are widely used in Bonaire and Aruba.[10,28]
- These plants are drought tolerant and therefore require minimal water, which makes them ideal for locations where regular irrigation is a challenge.

Figure 22. Cactus Hedge - San Pedro Cactus *(Trichocereus Pachanoi)*
Source: www.suculentasminhas.blogspot.com/

Figure 23. Prickly Pear *(Opuntia sp.)*

VISUAL & ACOUSTIC DETERRENTS

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
CAUTION TAPE	**LOW**	**DRY**	**WET**	**LOW**	**LOCAL**	**SHORT**

Caution Tape

- Caution tape is reportedly an effective visual deterrent to monkeys when stretched adjacent to crops and vegetables.
- The tape must always be hanging in the air and must not touch the ground.

Figure 24. Caution Tape erected around the field perimeter.

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
PENNANT BANNERS	**HIGH**	**DRY**	**WET**	**LOW**	**LOCAL**	**LONG**

Pennant Banners

Figure 25. Pennant Banners

Multicoloured pennant banners are reportedly effective monkey deterrents because of several characteristics they exhibit:

- Constant movement in the wind;
- The sound released when moving;
- Light reflection.

Pennant banners can be hung amongst standing crops from two vertical poles.

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON	COST	TESTING LOCATION	PERIOD
NEWSPAPER	**MEDIUM**	**DRY**	**LOW**	**LOCAL**	**SHORT**

Newspaper

Newspaper is a traditional method of deterring monkeys from crops. It is not clear why they are scared to walk on newspaper, but it may be because it is not solid and they cannot see what is underneath.

- Newspaper must be dry and secured in place with rocks.
- Newspapers should overlap to form an effective barrier.
- Wet newspaper is not effective, and requires replacement after rain.

Figure 26. Newspaper must overlap and rocks can be used as weights.

Figure 27. Newspaper must overlap and can be secured by using rocks as weights.

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
CONWAY MONKEY REPELLER	**HIGH**	**DRY**	**WET**	**HIGH**	**INT'L**	**LONG**

Conway Monkey Repeller

Figure 28. Conway Monkey Repeller Model JWP-315M
Source: www.conwayexports.com

The Conway Monkey Repeller Model JWP-315M is an acoustic deterrent that utilises sound frequencies that affect the neurological function of monkeys causing pain and discomfort. The device is reportedly effective against rhesus macaque monkeys in India.[27]

- The device produces high intensity ultrasonic sound waves between 10 - 65 kHz.
- The device automatically changes frequency 1–60 times per second covering acoustic frequencies monkeys are sensitive to.

- This ultrasonic frequency is emitted over an effective distance of 6000 square feet.
- It needs to be placed in a waterproof structure.
- The efficacy of this method against Green monkeys is yet to be fully tested.

CAUTION:
The ultrasonic sound can also affect children, young adults and other animals e.g. dogs.

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
SOLAR POWERED ULTRASONIC DEVICES	**INCONCLUSIVE**	**DRY**	**WET**	**LOW**	**INT'L**	**LONG**

Solar Powered Ultrasonic Devices

Solar powered ultrasonic devices can be effective pest deterrents by releasing ultrasonic sound frequencies that affect the nervous system. They have effectively deterred squirrels, foxes, raccoons and cats. Local testing on Green monkeys requires further research.

The devices have the following capabilities:

- Motion Activated: Passive Infrared Sensors detect moving objects to trigger alarm sounds.
- Multifrequency: Multiple modes release a frequency that affects a particular animal species.
- Alarm and flashing lights to scare animals.
- Solar charging capability and rechargeable batteries.
- Waterproof
- Detection range: 8-9 metres.
- Coverage Area: 8 metres at 110° angle = 70 square metres.

Devices are available from Fudodo© and can be sourced from www.Amazon.com.

Figure 29. Solar Animal Repeller from Fudodo©. Source: www.amazon.com

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
PROPANE SCARE CANNONS	**INCONCLUSIVE**	**DRY**	**WET**	**HIGH**	**INT'L**	**LONG**

Propane Scare Cannons

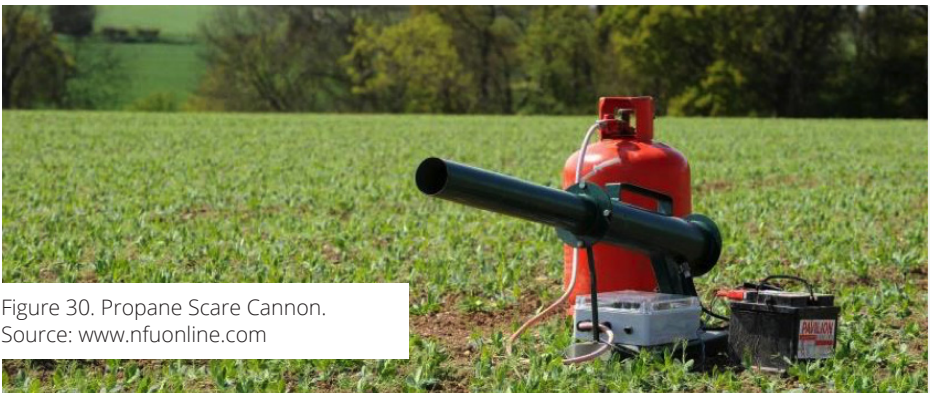


Figure 30. Propane Scare Cannon.
Source: www.nfuonline.com

Propane scare cannons produce a periodic explosion that can reach volumes in excess of 150 decibels, causing a flight reaction in birds. Cannons are commonly utilised to scare birds across Europe and America.[21]

Animals can become habituated to the sound of regular cannon fire, especially if it does not vary in its magnitude, pitch, or timing. Several methods can be utilised to avoid habitation:

- Moving the cannon
- Utilising on-demand firing options, associated with when monkeys are actively raiding crops
- Combining cannons with other deterrent strategies

CAUTION: Propane scare cannons are loud and can be disruptive to people living in surrounding areas.

DID YOU KNOW?

Neem seed oil is an effective insecticide and monkey deterrent. The oil can be extracted by crushing and soaking neem seeds in water. The oil floats to the top and can be skimmed off before application.

REPELLANTS

Taste Deterrents

A variety of chemicals and liquids have components that impart a negative taste when consumed. These can be used as repellants.

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
PEPPER SPRAY	**HIGH**	**DRY**	**WET**	**LOW**	**LOCAL**	**SHORT**

Pepper Spray

Figure 30. Scotch Bonnet Pepper and Spray can.

Pepper spray is an effective repellant because of the burning sensation created in the mouth on consumption. Pepper spray contains a mixture of water, pepper, onion and vegetable oil. Hot pepper varieties are recommended including: scotch bonnet, gold, and/ or chocolate habanero peppers.
During the wet season, more frequent spraying is recommended (2-day intervals).

Instructions:

- Chop onion and pepper.
- Boil with hot water.
- Add and stir a small amount of vegetable oil.
- Strain with cheesecloth.
- Spray onto crop surface.

CAUTION: Crops should be washed thoroughly to remove residual spray before human consumption.

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
NEEM-X 0.4 SL	**HIGH**	**DRY**	**WET**	**MEDIUM**	**LOCAL**	**LONG**

Neem-X 0.4 SL

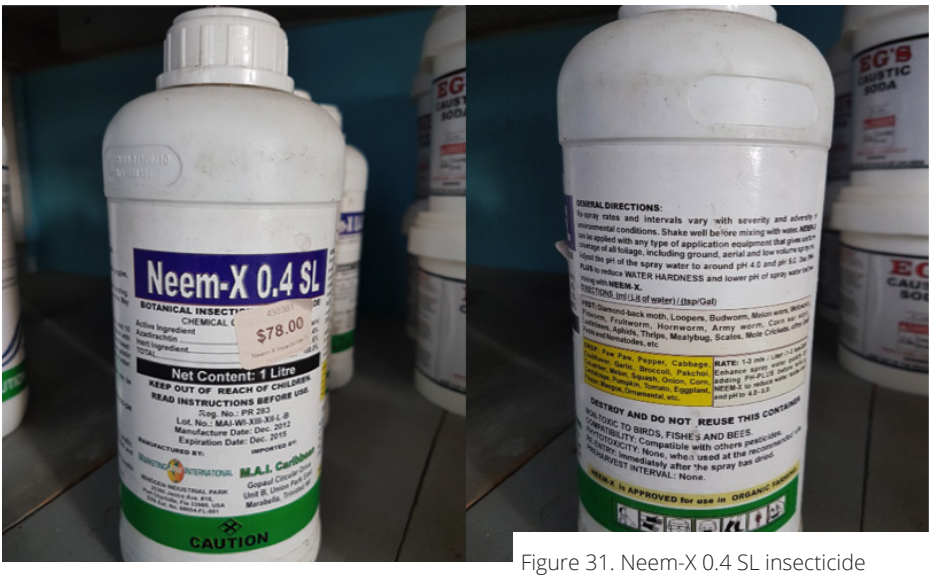


Figure 31. Neem-X 0.4 SL insecticide

- Neem-X 0.4 SL is a broad-spectrum insecticide with active ingredient ***Azadiracthin*** derived from the Neem tree *(Azadirachta indica)*; which has a toxic effect on insects.[15]
- Neem-X 0.4 SL is reported to be an effective deterrent against Green monkeys and can be applied via spraying on the surface of the specific crop eg. Cucurbits (cucumbers, pumpkins) and Brassica, bulb and leafy vegetables.

- Aerial and hand application methods may be used to uniformly spray Neem-X 0.4SL onto the surface of the target area of focal plants.

CAUTION: Follow instructions on dilution and harvesting times after application.

Scent Deterrents

Scent deterrents include methods that involve substances that have an unpleasant smell.

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON	COST	TESTING LOCATION	PERIOD
CHICKEN MANURE	**HIGH**	**DRY**	**LOW**	**LOCAL**	**SHORT**

Chicken Manure

When applied in the correct time and pattern, chicken manure can be an effective short term deterrent.

- Chicken manure must be applied while fresh from the chicken farm, when the ammonia content is high and the smell is pungent.
- The chicken manure can be spread via a spreading machine at a width of approximately twelve (12) feet around the perimeter of the agricultural field.
- This ensures that the diameter of the manure is wide enough to prevent monkeys from jumping over the manure.
- Chicken manure can be effective for approximately 2 weeks; depending on rainfall, which reduces ammonia content and dissipates intense scent.
- The odour is intense and it attracts flies.

Figure 32. Tractor with spreader releasing animal manure: Source: www.fginsight.com

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON	COST	TESTING LOCATION	PERIOD
SARGASSUM	**HIGH**	**WET**	**LOW**	**LOCAL**	**SHORT**

Sargassum

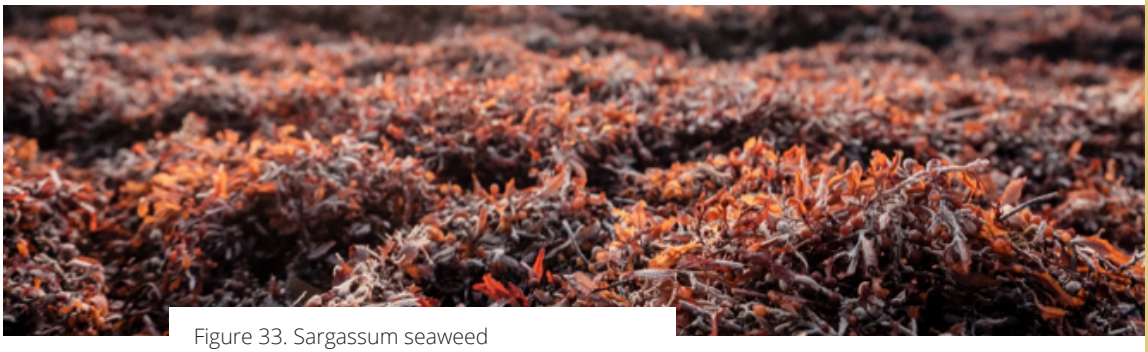


Figure 33. Sargassum seaweed

Fresh sargassum is reportedly an effective deterrent due to the intense scent of hydrogen sulphide released during decay.

- Sargassum can be placed around the perimeter of the field which requires protection.
- The method is more effective during the rainy season when the rainfall consistently moistens the sargassum.

CAUTION: Sargassum should be leached of excess salt before field application. Additional research is required to assess the potential impacts of sargassum on food crops.

CROP PLANTING STRATEGIES

These strategies can be employed based on behaviours exhibited by monkeys; the choice of a specific strategy depends on the area, time of year, and market demand.

Previous research in Barbados has shown that tree crop damage is significantly higher than ground level and sub soil crops, with high levels of crop raiding associated with easily picked crops with high caloric content.[1,7] This is because monkeys prefer to consume crops in the safety of a tree than on the ground, where they are more vulnerable to attack from predators.

Farmers in areas susceptible to monkey damage can:

- **Grow more food that is less preferred by monkeys:** e.g., monkeys prefer yellow, soft-skinned crops (bananas, mango, papaya) to tougher skinned green crops (breadfruit, golden apple).[7]

- **Plant more palatable vulnerable crops near to the home** (or guarded areas) where monkeys will have to take greater risks to raid them.[7] Crops that are less preferred and or are more difficult to harvest e.g. root crops with tougher skins (cassava, potato, and yams) can be planted in more remote locations further from the farmer's residence (See Figure 34).

Scenario:

A farmer who lives in an area in close proximity to a gully and dense tree cover, may desire to plant mangos, papaya and sweet potatoes. The farmer can plant the mango and papaya closest to his home and sweet potato further away from his home and closer to the gully (See Figure 34).

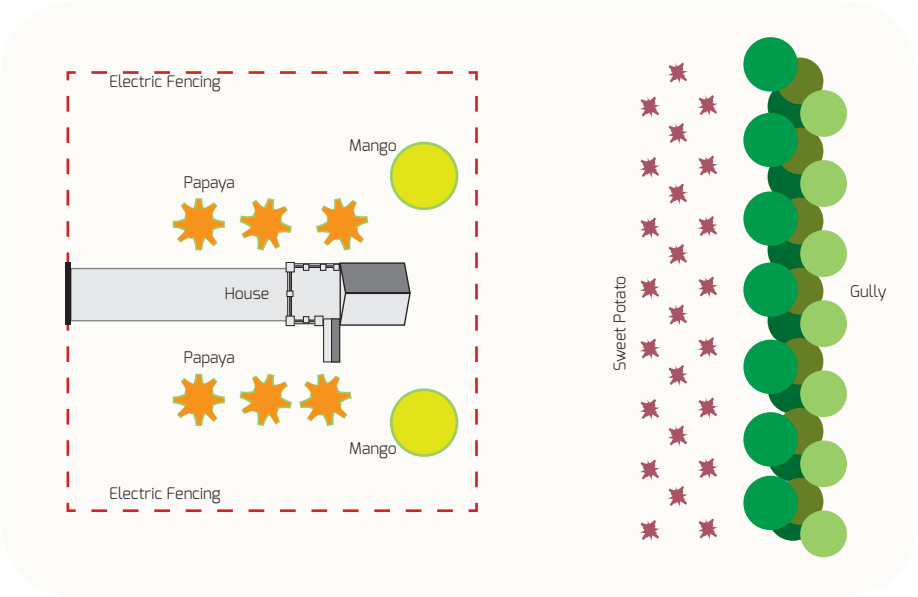


Figure 34. Diagram of crop planting patterns using various strategies.

- Monkeys prefer tree cover, create buffer zones around the field perimeter by clearing surrounding vegetation.
- Plant small quantities of crops which are highly preferred by monkeys but have low economic value, adjacent to crops which are less preferred by monkeys, but are of higher economic value.[7]
- Harvest tree crops prior to the point where ripening makes them a target e.g. avocado pears, bananas, papaya and mangoes can be harvested before there are fully ripe and placed in safe secure areas for ripening.
- Cultivate crops that are most preferred by monkeys during the wet season (June – September), when naturally growing food alternatives are most abundant in the gullies.
- Change from traditional crops, which are generally consumed by monkeys, to crops such as aloe vera, ginger, garlic, turmeric, medicinal and aromatic plants, which are less preferred by monkeys.

DID YOU KNOW?

Green monkeys do not like flat open spaces. Farms located closer to wooded areas are more likely to be raided by monkeys than farms further away.

FARM LOCATION

Monkeys tend to live in areas with more tree cover as trees provide protection, food and opportunities to move safely. Farm size, location in relation to wooded areas, and distance between other farms all affect the likelihood of crop raiding. [11,12]

Farmers in flat open areas such as “The Land Lease Project”, St Lucy far from gullies experienced little to no monkey damage when compared to farmers in the densely wooded parish of St Thomas.

If possible, farmers should grow crops away from woodland/ forest edges, as monkeys will have to take greater risks traveling away from cover to damage crops.

NEW TECHNOLOGIES

Blink XT1 Motion Sensing Camera

A novel approach is the combination of motion sensing cameras with other deterrent strategies e.g. acoustic deterrent.

- The Blink XT1 camera has a built in motion sensor, and can be monitored remotely via a mobile application.
- The camera connects via Wi-Fi and once triggered sends a notification to the owner's phone via a mobile application.
- The device can assist in property surveillance and when monkeys are observed other methods such as voice or other deterrents like acoustic deterrents can be triggered remotely.

Figure 35. The Blink XT1 Motion Sensing Camera
Source: www.amazon.com

Predator Images and Alarm calls

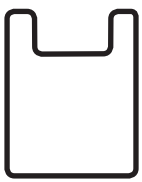
- In Africa Leopards are natural predators of green monkeys. Research shows that Green monkeys in Barbados are afraid of leopard images.
- Recordings of West African green monkey alarms to leopards trigger a similar flight response in Barbados Green monkeys (run into trees).[2,17]
- There is potential use for predator images and monkey predator alarms as part of a combination of other deterrent techniques.

Locally tested deterrent strategies with limited short-term effectiveness:

Scarecrows

Hanging CD's

Plastic bags



Jeyes Fluid[20]

Appendix

Table 1. Strategies utilised to deter crop raiding primates internationally and their efficacy

DETERRENT STRATEGY		PRIMATE SPECIES
ACOUSTIC	Non-projectile firing noisemakers. Hand-held bamboo firecracker cannons.[3]	Orangutan.
	Ultrasound Monkey Repellent emitting high frequency sound waves of 10 - 60 kHz.[27]	Rhesus macaque.
SCENT	Animal manure i.e chicken manure is spread in fields near crops or around field perimeter.[16]	Green monkey.
	Gumbe (mixture of bone meal).[16]	Green monkey.
TASTE AVERSION	Neem essential oil *(Azadirachta indica)*[14]	Sulawesi crested macaque.
	Camphor Basil *(Ocimum kilimandscharicum)* essential oil.[14]	Sulawesi crested macaque.
	Spent coffee grounds (SCGs) were mixed with food items.[14]	Sulawesi crested macaque.
EXCLUSION/ BARRIER	Tree nets – Barrier nets (5 x 5 cm) square mesh nylon rope placed in tree canopy to block pathways and restrict arboreal travel.[3]	Orangutan.
	4 strand barbed wire fence.[6]	Baboon, Blue monkey, Chimpanzee, Red -tailed monkey.
	3 row Camphor Basil *(Ocimum Kilimandscharicum)* hedge with/ without 1m high 12mm mesh fence.[6]	Baboon, Blue monkey, Chimpanzee, Red-tailed monkey.
	1 row Camphor Basil (*Ocimum Kilimandscharicum)* hedge with 1m high 12mm mesh fence.[6]	Baboon, Blue monkey, Chimpanzee, Red-tailed monkey.

	LOCATION	EFFICACY	COMMENT
	Sumatra	Yes	Limited effect (3% change) in crop raiding incidents.
	India	Yes	Effective as monkeys avoid areas exposed to frequencies. Humans also negatively affected.
	Barbados, St Kitts & Nevis		Effective for (1 - 2 weeks) until scent dissipates.
	St Kitts & Nevis	Yes	
	Cornwall, UK	Limited	Neem feeding stations were frequented 50% less than stations without neem.
	Cornwall, UK	Yes	Time spent at Ocimum feeding stations were lower (35%) than at the stations without ocimum.
	Cornwall, UK	Yes	Time spent at the SCG feeding station was 90% less than at the station without SCG.
	Sumatra	Yes	Effective: Decline in crop raiding frequency.
		Yes	Effective. Reduced crop raiding events frequency
	Uganda	Yes	Ocimum hedge alone not effective at reducing crop raiding frequency, but effective when combined with mesh fence.
	Uganda	Yes	Effective. Reduced crop raiding frequency

Appendix Continued

DETERRENT STRATEGY		PRIMATE SPECIES
WARNING SYSTEM	Net with bells. A 110 m net fence enclosed field on 3 sides. A bell was attached to each section of net, which sounded when a potential raider interacted with the net, alerting the farmer and indicating point of attempted entry.[6]	Baboon, Green monkey, Chimpanzee, Red-tailed monkey.
GUARDING & CHASING	Full-time/part time guarding.[6]	Baboon, Green monkey, Chimpanzee, Red-tailed monkey.
CROP DESIGN	Adjusted crop design patterns. Buffer crops between forested areas and crops e.g. rice and tea.[13]	Macaque, Langur.
REPELLANT	Rope fence and chilli paste. Fence comprised wooden posts and four strands of sisal rope. Rope and posts were coated with chilli paste twice weekly.[6]	Blue monkey, Red-tailed monkey.

	LOCATION	EFFICACY	COMMENT
	Uganda	Yes	Effectively reduced crop raiding frequency
	Uganda	Yes	Effective: Full time guarding was more effective than part time guarding in reducing crop raiding frequency.
	Sri Lanka	Yes	Effective. Reduced crop raiding frequency
	Uganda	Yes	Chilli paste was prepared by mixing 3 parts chilli powder, or 5 parts crushed whole chillies, with 1 part water by volume. Design of fence ensured primates had to touch and climb the ropes or posts to enter the field

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STANDARD REFERENCE KEY FOR DETERRENT STRATEGIES

VARIABLE	LEVEL		
LEVEL OF EFFECTIVENESS	LOW	MEDIUM	HIGH
SEASON	DRY	WET	
COST	LOW	MEDIUM	HIGH
TESTING LOCATION	LOCAL	INT'L	
PERIOD	SHORT	LONG	

DETERRENT STRATEGY	LEVEL OF EFFECTIVENESS	SEASON		COST	TESTING LOCATION	PERIOD
GUARDING (PEOPLE)	HIGH	DRY	WET	HIGH	LOCAL	SHORT
GUARDING (DOGS)	MEDIUM	DRY	WET	MEDIUM	LOCAL	LONG
ENCLOSURES	HIGH	DRY	WET	HIGH	LOCAL	LONG
ROW COVERS	HIGH	DRY	WET	MEDIUM	LOCAL	LONG
TREE NETS	HIGH	DRY	WET	LOW	INT'L	LONG
FRUIT COVER BAGS	MEDIUM	DRY	WET	LOW	LOCAL	SHORT
ELECTRIC FENCING	HIGH	DRY	WET	HIGH	INT'L	LONG
XCLUDER FENCING	HIGH	DRY	WET	HIGH	INT'L	LONG
LIVING FENCES	HIGH	DRY	WET	LOW	INT'L	LONG
CAUTION TAPE	LOW	DRY	WET	LOW	LOCAL	SHORT
NEWSPAPER	MEDIUM	DRY		LOW	LOCAL	SHORT
CONWAY MONKEY REPELLER	HIGH	DRY	WET	HIGH	INT'L	LONG
SOLAR POWERED ULTRASONIC DEVICES	INCONCLUSIVE	DRY	WET	LOW	INT'L	LONG
PROPANE SCARE CANNONS	INCONCLUSIVE	DRY	WET	HIGH	INT'L	LONG
NEEM-X 0.4 SL	HIGH	DRY	WET	MEDIUM	LOCAL	LONG
CHICKEN MANURE	HIGH	DRY		LOW	LOCAL	SHORT
SARGASSUM	HIGH		WET	LOW	LOCAL	SHORT
PEPPER SPRAY	HIGH	DRY	WET	LOW	LOCAL	SHORT
PENNANT BANNERS	HIGH	DRY	WET	LOW	LOCAL	LONG