



Stakeholder workshop on netting and management of fruit bat damage to orchards in Mauritius

August 15-16 2017,
Farmers Training School, FAREI, Wooton, Mauritius

Report and Recommendations



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Background

The Mauritius fruit bat is an endemic, threatened species which causes damage to lychee, mango and longan fruit harvests on the island, in orchards as well as mature garden trees across the island. It is also perceived by many as a messy, noisy menace by many members of the public. In the face of increasing public pressure and concern from orchard owners over the loss of their fruit crop, two culls of the species were implemented in 2015 and 2016. This caused major concern among international conservation organisations seeking to protect the bat species. However, effective and realistic solutions to the problem remain difficult to find. The Government of Mauritius' Ministry of Agro-Industry and Food Security via its Food and Agricultural Research Extension Institute (FAREI), have gone to great lengths to try to resolve this issue, and since 2009 have provided substantial subsidies to growers in order to facilitate the purchase of nets to protect their fruit. FAREI's commitment to this initiative is demonstrated by the figures: by 2015, nearly Rs30 million had been provided to nearly 4500 applicants in order to purchase protective nets. While this scheme is no doubt the most important step in the right direction so far, the logistical details of correctly and efficiently netting trees remains a major challenge.

Following the 2016 bat cull, the International Union for the Conservation of Nature (IUCN), acknowledging the difficulty of this situation, offered support to the Mauritian Government through provision of advice from its expert network, in particular its Task Force on Human-Wildlife Conflict and its Bat Specialist Groups. In early 2017, representatives of the IUCN SSC Human-Wildlife Conflict Task Force and Chester Zoo visited Mauritius to discuss this issue with the Mauritian Wildlife Foundation, FAREI, and also the National Parks and Conservation Service (NPCS). During this visit, the issue was discussed in great detail with many stakeholders from fruit exporters, small-scale farmers, large orchard owners and members of the general public, to hear their views, ideas and concerns. Together with the Deputy Permanent Secretary of the Ministry of Agro-Industry and Food Security it was agreed that a workshop should be held in Mauritius before the next lychee harvest, to bring together representatives from the range of stakeholders, including fruit growers and traders, netting importers and distributors, researchers, and government extension officers.

The objective of this workshop was to bring together stakeholders in the process of jointly identifying solutions, to create a forum for ongoing discussion and to jointly discuss and design a future action plan. This report summarises the workshop and its conclusions and sets out recommendations towards a long-term and sustainable strategy for reducing fruit bat damage to orchards in Mauritius.

Participants

The Ministry of Agro-Industry and Food Security and FAREI hosted this meeting at the FAREI Farmers Training School in Wooton, Curepipe, and provided the workshop facilities, lunch and refreshments throughout the two-day meeting, along with transport for participants to visit orchards. Approximately 35 participants attended the workshop including small orchard owners, commercial orchard managers, netting importers and distributors, regional extension officers and research staff from FAREI, researchers and staff of NPCS, MWF, fruit exporters, and fruit traders. In addition to the Mauritian participants, five specialists from overseas participated: lychee farmers with successful experience in netting against bats in Australia, an expert in fruit bat ecology and bat damage prevention from Thailand, and human-wildlife conflict experts from the IUCN SSC Task Force on Human Wildlife Conflict, and Chester Zoo.

Workshop Summary

The two-day programme on 15 & 16 August 2017 consisted of presentations by participants and guest specialists, visits to two orchards to discuss netting in situ, de-briefs and discussions, and working groups to develop ideas and recommendations in detail.

Presentations:

Mr Ramesh Rajcumar (Director, FAREI) opened the workshop with a brief welcome to all participants. **Dr Alexandra Zimmermann** (Chair, IUCN SSC Human-Wildlife Conflict Task Force; Head of Conservation Science at Chester Zoo) provided opening remarks about the challenge of protecting fruit trees and orchards from bats, and explained the process and aims for the workshop. All participants in the room then briefly introduced themselves, after which **Dr Vikash Tatayah** (Conservation Director, Mauritian Wildlife Foundation; Member, IUCN SSC Bat Specialist Group) moderated the presentations to follow.

Mr Prakash Goolaub (Principal Extension Officer, FAREI) gave a comprehensive introduction to the current state of the fruit growing and bat crop-raiding situation in Mauritius. Key points from this included: Mauritius produces around 43,000 tonnes of fruit per year on around 3000 ha of land. Increasingly there is a move from backyard growing to orchards. There are around 31,000 lychee trees on Mauritius, as well as 100,000 mango trees and 13,000 longan trees (2011 census). The Non-Sugar Sector Strategic Plan 2016-2020 includes recommendations that abandoned sugar cane fields be re-deployed for fruit production, and this has begun already in several parts of the island, particularly in the north. A number of specific measures have been proposed to support this, including incentives for financing, equipment, subsidies and support for freight costs etc. FAREI has 32 extension officers to assist with such initiatives. FAREI has observed that

repellent attempts (e.g. burning tyres, lights, firecrackers, bagging fruit, repulsive smells, displaying dead bats, etc.) do not work to keep bats off lychee trees. They also found that well-maintained and pruned trees suffer less damage. The current government support scheme (2016/2017) in place is as follows: for longan, lychee and mangoes, there is a 75% discount on purchases of nets, and a maximum of 10 nets per person. To date, Rs55 million has been disbursed from this subsidy, with a steady increase and uptake year on year. The 2016/2017 scheme involved a maximum of 5 nets/person for individuals, and a maximum of 50% of trees in an orchard of less than 2 arpents (0.68ha). Last year (September – November 2016), the demand for these vouchers was so high that a condition had to be added which stipulated that anyone who had benefitted from the scheme in the previous two years, could not do so again for a third year. This is also to encourage maintenance and re-use of the nets. FAREI found that 2487 fruit growers took advantage of the scheme in 2016/2017, which cost the government Rs16.7 million, and some suppliers ran out of nets.

Ms Yogeeta Devi Luchoomun, (Research Scientist, FAREI), then spoke briefly about the benefits of pruning and rejuvenating fruit trees, showing diagrams regarding how this is best done. Thus, FAREI is able to provide technical guidance on this as needed. **Ms Houshna Naujeer**, (Scientific Officer, NPCS), gave a presentation on the use of non-lethal methods to control fruit bat damage in Mauritius, explaining background on fruit bat biology and behaviour, what research has been done and what knowledge is still lacking. **Dr Ryszard Oleksy**, a researcher currently working with NPCS presented results from studies of bat and bird damage to lychees, showing how to identify damage, including that from other causes such as fungi or splitting of the fruit. He showed data that demonstrates significant prevention of crop damage when trees are netted properly.

Dr Sara Bumrungsri, (Faculty Member, Prince of Songkhla University, Thailand, and Member of the IUCN SSC Bat Specialist Group), an expert in fruit bat and preventive measures for crop damage by bats, showed the collective experience from Thailand. He presented results from trials including repellents, none of which worked well, which eventually led to netting of trees being deemed the best option. Dr Bumrungsri showed that pruning lychee trees to a maximum height of 2.5m, and then netting the trees or orchards, was deemed the best option in Thailand. He advised also that trees must be netted one month before the fruit ripens. He noted, however, that in Thailand bat damage is less extensive than in Mauritius and planters are more concerned about damage by insects (fruit flies, borers), but that the shade netting that they use helps to reduce insect damage too.

Mr Ian Groves and Mrs Sandi Groves, (Owners, Groves Grown Tropical Fruit, Queensland, Australia), presented detailed information about netting and pruning of lychee trees at their farm. Mr Groves was the President of the Australian Lychee Growers Association between 2006 and 2012 and he and Mrs Groves have over 30 years of experience with crop-damaging fruit bats. The Groves have developed ways to eliminate damage by bats, birds

and insects almost entirely, while increasing lychee productivity substantially through effective pruning. In Australia in the past, the bat issue caused considerable conflict between stakeholders, and the damage by the two local species of fruit bat in their area are substantial. With photos and videos, the Groves were able to show exactly how lychee tree orchards are planted (spacing, sun aspect, etc.), how they are pruned (height, shape, high-tech and low-tech machinery options), and different structures and types of nets that they have tried. When planting new orchards, bat and bird damage should be planned for and mitigation incorporated into the design. When managing older orchards, there are a number of modifications that can be made – such as pruning, or even removing some trees that and re-planting with others in order to considerably improve productivity, netting and harvesting efficiency.



Figure 1: Participants examine different kinds of net used in Australia and Thailand

Orchard visits

The workshop group visited two orchards: the Medine lychee orchard at Beau Songes and a small planter orchard in Bassin, where sugar cane was replaced with lychees about 10 years ago. This was an excellent opportunity for visiting experts to see how lychees are grown in Mauritius, to get a more in depth understanding of the challenges that growers face and for the workshop participants to discuss shared problems and experiences.



Figure 2: Workshop participants in the lychee orchard that was converted from a sugar cane field.

Discussions:

Day two began by Mr Groves giving his feedback on the orchard visits from the previous day and was asked to advise on two separate scenarios; in summary:

1) How best to improve **existing orchards:**

Netting is very difficult in current Mauritian lychee orchards mainly due to the height of trees. Nets must, however, be UV-treated to make them durable; strong nets with small mesh size are more expensive but more effective. Nets must be tensioned correctly to avoid slack which can entangle bats. The gaps between the trees need to be increased in order to increase canopy surface area and light interception – this will increase yield. This means that trees should be pruned correctly and with the correct equipment– the crop potential, for unpruned trees of surface area 1 hectare, is simply 1 hectare because of the flat canopy. If the surface area is increased then the potential yield is increased. Large trees need to be pruned and managed – netting trees is much easier on smaller trees, but this pruning needs to be done regularly and properly.

2) How to plan and plant a **new orchard:**

Newly planted trees will take four to five years to produce fruit but this is the best option for the sustainable management and harvest of lychee trees whilst simultaneously protecting the yield from fruit bats and birds. Selecting the right variety of lychee that can cope with regular pruning is important. Regularly spaced lychee trees in single rows can then be

managed to not exceed 4m in height (his own are actually only 2m high); this enables a much easier system of netting placed in 'tunnels' along the rows of trees (Figure 3). Wooden frames are then erected over the crops in order to support the nets. Managing the crops in this way also facilitates easier harvesting. With the trees arranged in this way the yield is estimated at approximately 8 tonnes per hectare at a density of 625 trees per hectare. The cost of the frames and nets over a hectare was estimated to be comparable to the value of yield from one lychee tree. In order to export lychees in larger volumes e.g. to Europe, it will be essential to meet expected standard of ethics demanded by these consumer groups, which includes employment and labour standards as well as environmentally-friendly orchard management, including non-lethal control of wildlife. International importers are likely to be concerned about importing produce from countries where bats are culled.



Figure 3: A selection of images from Mr Groves illustrating netting, harvesting and pruning procedures. More images available at Groves Grown Tropical Fruit: <https://www.instagram.com/grovesgrowntropicalfruit/>

Working Groups:

The participants of the workshop were asked to identify some of the aspects of Mr Groves' advice for further discussion, and a long list of topics were proposed by many people in the room. These were clustered into five main key questions, and the participants arranged themselves into five working groups to discuss each in detail and report back to the full group. Below we summarize the key findings and recommendations of each working group.

1) How should we improve orchard management?

Model Farms: The implementation of 'model' farms was suggested, where Mr Groves' advice could be put into practice and all aspects of planting, netting, pruning and harvesting could be implemented. These would serve as demonstrations and also a place from which training could take place. It was suggested that State Land under the Multi-Annual Adaptation Programme (or similar) that is no longer in sugar production could be made available for this.

Netting subsidy: The current netting subsidy scheme could be improved by incorporating conditions associated with guidelines concerning best practice pruning, this could be facilitated by the current equipment grant provided by the Government in order to produce a package of assistance (perhaps start-up packages) aimed at a more inclusive, long-term management strategy for management of orchards. An issue was raised with the current system of importing nets; those responsible for importing nets asked for an earlier announcement from the Government (July) regarding the planned subsidy for each year so that they had enough time to import the appropriate nets.

Pruning and management: It was recognised that there is a lack of technical experience of pruning and management of orchards in Mauritius and this could be improved by knowledge exchange visits between Mauritius and Australia for example. It was also suggested that large machinery could be hired through the Mauritius Cane Industry Authority (which merged the ex-Small Planters Mechanical Pool Corporation).

2) What are the needs and recommendations for support with netting, pruning and required equipment?

Nets: The current netting subsidy allows the purchase of nets of size 12 x 15 m but nets of 20 m wide are often required to cover a single tree. White, 40% UV treated nets with a small mesh size are best. In future, netting importers require a go-ahead for the announcement of the subsidy scheme by July in order to source the nets from overseas.

Frames for netting: Permanent frames could be constructed as Mr Groves' suggested using material sourced in Mauritius by using either galvanised steel or wooden poles, these could be adapted to suit the local topography. Alternatively, a flexible 'build your own' design

made from plastic tubes may be an option. The financing for such structures could be provided by soft or low interest loans. The establishment of a dedicated team of netting engineers or fixers, tasked with constructing these frames as a service could be adopted.

Support for pruning and required equipment: More emphasis is required on training and management and perhaps the standardisation of techniques could be adopted. Equipment could be owned collectively by a cooperative. Access to water could be improved during fruiting periods.

3) What is the cost and return on investment for netting?

The costs and gains using the tunnel-netting system proposed by Mr Groves was calculated by the group, using Mauritian figures. The material (including nets) and labour required to erect permanent netting structures over correctly spaced lychee trees would be in the region of Rs233,000 (for steel structure) or Rs433,000 (for a wooden structure) to cover one arpent. This would be expected to last for approximately 10 years and the cost would be equivalent to the yield from one tree per year. These could be removed and stored to prevent cyclone damage. There was general agreement that the cost of erecting the structure could be easily recovered. There was a suggestion that some kind of insurance scheme against damage would be welcomed for such structures.

4) What opportunities are there for further markets and how should we market the fruit for both export and the domestic market?

Currently, approximately 10% of lychee harvest is exported, which leaves much scope for increase. The fruiting season is relatively short but this could be expanded by identifying different varieties of lychee that fruit either earlier or later than current varieties. There are several free markets (i.e. non-quarantine markets) available to Mauritius, the most optimal of which may be Europe, as shipping is possible via direct flights of less than 12 hours. This market could be exploited by investing in improved cold-chain facilities in Mauritius. Additionally, there may be benefits in marketing indirect products better such as juices and the canning of surplus fruit. Ideas were shared around innovating the packaging, for example highlighting the healthy benefits of the fruit (or 'local', 'fresh' and 'trust') and making them a bit more unique to Mauritius. Quality certification and 'bat friendly' lychees could also be explored to create unique selling point and/or add value.

A suggestion was made to decentralise the ownership and perceived monopoly of 'middlemen' by taking fruit directly to market and consumers or perhaps developing a cooperative to facilitate this. It was also recognised that auctions exist only in Port Louis and this is a potential barrier to improved marketing. Schemes such as 'pick your own' were also suggested as marketable opportunities. Mr Groves mentioned that in Australia there is a tax for each 5kg box of lychees sold, payable by the vendor, that goes towards such marketing ventures.

5) What are potential solutions for backyard trees and growers?

Backyard trees account for 30-50% of production. Trees in backyards are much more difficult to protect with nets, as these trees are usually very large. The interests and needs of backyard tree owners are much more diverse. For example, some people sell their trees to a middleman to earn some extra money, while others simply harvest the fruit and share it among family and friends. Also, backyard growers' negative perceptions towards fruit bats is not only (and sometimes not at all) focussed on the loss of fruit, but rather on the significant nuisance factor of the bats' presence, as they are very noisy and leave behind a mess of droppings and dropped fruit.

Therefore with the backyard-grower community, incentives for netting trees will go only partially towards resolving the issue, as it only partially addressed their concerns. In order to address the issue more effectively, a strategy is needed that gets to the root of these obstacles. Education (also referred to as sensitisation locally) in the form of distribution of information, is known *not* to be effective in such cases. Instead, peer-enforced incentives for changes behaviour in a community, is far more effective. One such approach is called social marketing – this uses social norms (peer behaviour) as motivations for communities to adopt different practices. For example, if the objective is to get backyard owners to prune and net their trees, then such a social marketing campaign would focus on devising incentives that make it relatively easy, affordable and beneficial to do so. Once a certain number of backyard owners adopt these measures, the effects of peer norms catalyse its uptake more widely. Such strategies are entirely possible and probably the best option for backyard growers, but require specialist advice – which is available and can be provided to the collaborating partners in this initiative.

Conclusions and Recommendations

The five key questions discussed by the working groups captured accurately the most important aspects for a productive way forward in resolving the challenge of damage to fruit trees by bats. The discussions went beyond the original focus of netting and set the issue into a much more holistic context that considered related issues such as improving lychee productivity and efficiency of orchard management, cost-benefit analyses, and longer-term directions for diversification of incomes, including fruit export markets. Details of these productive discussions are reported above, and summarised here into the following key points, which form the basis of the workshop groups' recommendations to the Ministry of Agro-Industry:

1. **Nets and netting:** Provision of white, 40% UV-treated small mesh-size nets. Good quality and well-maintained nets will last 10 years. Nets constructed over frames, which can be retracted in the event of extreme weather, are best. Assistance with the materials and/or construction of such frames is needed, and should go hand-in-hand with optimized pruning of orchards.
2. **Pruning of fruit trees:** there is substantial potential for orchards of any size to increase their productivity through improved pruning management. Very old trees may be rejuvenated, and smaller trees pruned as to maximum 4m (ideally 2m) to increase surface area exposure to sun and more efficient harvesting.
3. **Equipment and training:** Assistance with equipment hire or purchase, potentially through cooperatives, would provide increased access to appropriate equipment. A series of training events on model orchards would be important. For the development of high-yield orchards for export, training visits for Mauritian orchard managers to Australia would be very beneficial.
4. **Model orchards:** Two types of model orchards would be beneficial: a) existing orchards which have been modified to improve production and ease of netting; and b) new orchards planted to specifications that provide optimum production, ease of harvest and netting. Such model orchards also serve as training and demonstration venues from which FAREI and collaborators can facilitate peer-to-peer exchange and collaboration.
5. **Development of export markets for tropical fruit:** There is potential for Mauritius to diversify its agricultural production to include lychees at much larger scale and for export. To do so, development of new orchards designed as recommended in this report, to include bat netting, will be essential. Furthermore, overseas importers are concerned about ethically-sourced food, which includes labour guidelines, and environmentally friendly practices including non-lethal damage control of wildlife.
6. **Backyard growers:** addressing backyards growers' reluctance to net trees, and their largely negative perception of bats requires NOT education or sensitisation, but peer-behaviour incentive measures. This is achieved through different strategies such as social marketing, which develops social peer norms as a way to change people's perceptions and practices. Specialist advice to design such a strategy is available.
7. **Continued dialogue and collaborative action:** The workshop generated a very positive sense of cooperation and willingness to work together, which is essential for the continuation of what promises to be a successful and productive way forward. It is essential that communications and dialogue continue. Open training events (e.g. for pruning) can serve to facilitate this.

With this positive conclusion of Mauritius' first stakeholder workshop on netting and management of fruit bat damage to orchards, the workshop participants and organisers recommend that support measures from the Ministry, such as subsidies, incentives and extension efforts, should provide holistic approaches that address several of these recommendations together.



Figure 4: Lychee orchard at Groves Tropical Fruit Farm in Queensland, Australia

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