To net or not to net that is the question! But is it the answer?

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ABSTRACT

Flying-foxes are considered by the fruit industry to be the main vertebrate pest in coastal areas of New South Wales and South East Queensland. From 1995 to 2000, the annual average gross market losses to the market value of fruit due to flying-foxes, in New South Wales, was estimated at $10.4 million per year. Exclusion netting has proven to be the most effective method of protecting fruit crops from flying-foxes. However, concerns regarding the economic viability of netting have prevented its use in areas where market returns are relatively low, such as the Camden district of NSW. To test the viability of exclusion netting in the Camden district, an economic model, developed for the North Coast was applied under local conditions. The model showed that to obtain a greater than 5% return on the capital invested in netting, crop losses needed to average 15%-30% annually over a ten year period at current gross market returns of $6.00 - $8.00 per tray. For returns greater than 10%, losses needed to be in the 20% - 30% range. The average annual crop loss from flying-foxes in the Camden district is estimated at 10% - 12%. Cheaper crop protection methods are needed for coastal fruit producers that cannot economically justify the high cost of exclusion netting. The methods need to be scientifically assessed and implemented as part of a sustainable strategy.

Intoduction

Flying-foxes, *Pteropus* spp, can cause considerable losses to deciduous and sub- tropical fruit crops in coastal areas of New South Wales and South East Queensland. They are considered by the fruit industry to be the main vertebrate pest in these regions, and affect several horticultural crops (Table 1).

Financial losses to horticultural industries by flying-foxes are not well documented. In June 2001, a survey of NSW Agriculture district horticulturists in coastal fruit growing areas, estimated that between 1995 and 2000 the annual average gross market value losses from flying-foxes was $10.4 million. When an economic factor of x 2.5[1] is applied to take into account losses to affiliated industries such as packaging, employment, transport, marketing etc, the true financial loss to the community is estimated at approximately $26 million annually (Table 2).

The Grey-headed Flying-fox, *P. poliocephalus*, is the main species responsible for crop losses in New South Wales. They roost and feed in agricultural and urban areas and establish camps where regular food is available. Otherwise, annual or occasional camps are established based on seasonal food sources (Eby 1995).

Flying-foxes cause crop losses by puncturing fruit with their teeth and claws, soiling fruit with their droppings, removing fruit from the orchard and damaging trees by breaking limbs, particularly new growth carrying next season's fruiting buds. Conflict between flying-foxes and fruit producers in Australia dates back to early European settlers who introduced exotic fruits like apples, pears, citrus and stonefruit. In 1863 the British naturalist John Gould wrote of the Grey-headed Flying-fox "…no one of the native animals is more troublesome to the settlers than this large Bat, which resorting to the fruit-grounds by night…commits the most fearful havoc." (Dixon 1976).

Table 1. Crops affected by flying-foxes in New South Wales.

Apple	Mango
Australian paradise pear	Nashi pear
Banana	Nectarine
Cherry	Papaw
Citrus	Peach
Custard apple	Persimmon
Coffee	Plum
Fig	Rambutan
Logan	[Ornamentals]
Lychee	

Pages 70 - 76 in *Managing the Grey-headed Flying-fox as a Threatened Species in New South Wales*, edited by Peggy Eby and Daniel Lunney, 2002. Royal Zoological Society of New South Wales, Mosman NSW.

Table 2. Estimates of damage to commercial fruit crops from flying-foxes in coastal areas of New South Wales and South East Queensland. The estimates cover different seasons and different locations. Losses are presented as "market value loss" (i.e. gross market loss to fruit producers) and "economic" values (e.g. loss to the community calculated as market value x 2.5, see text).

Year	Location	Market value loss ($ million)	Economic loss ($ million)
1992[1]	Camden Windsor Gosford	1.52	3.8
1998[2]	S-E Qld Northern NSW	10.0	25.0
1995 - 2000[3]	Coastal NSW	10.4(annual average)	26.0

[1]Ullio 1992 [2]Rigden *et al.* 2000 [3]NSW Agriculture survey of coastal district horticulturists, 2001.

Fruit crop protection

Over the last 150 years, fruit producers have used a wide range of crop protection methods in an effort to reduce or prevent damage to their fruit. During the late 1890's, such methods included community 'bat shoots', poisoning and a bounty system (Lucas 1896; Anon 1890).

More recent deterrent methods used by fruit producers include a mixture of both visual and sound technology in combination with some selective shooting. Information on current and past deterrent practices has been gathered by observation and discussion with NSW Agriculture District Horticulturists and fruit producers over the last 20 years. Some of the deterrent systems used over the last twenty years in Australia include:

- flashing and rotating lights;
- electronic distress sounds;
- gas operated bird scare guns;
- electric grids;
- smell and taste deterrents.

Unfortunately, most deterrent systems used in orchards are used in isolation and their effectiveness is not correctly evaluated using control blocks and adequate data collection and analysis. Information on their effectiveness is mostly based on anecdotal evidence provided by fruit producers. Results have been mixed with most systems discarded after a few seasons' use and not widely adopted by industry.

The two most widely used crop protection methods in coastal New South Wales are site-specific shooting and permanent exclusion netting.

Night patrols with shooting to scare or cull still remains the main deterrent used by many producers. When the number of flying-foxes in crops is low, this method has proven to be mildly effective in reducing crop losses, particularly if early scouts are prevented from leading others to the orchard. In general, shooting is not effective when animal numbers are high. It's time consuming, exhausting to produced and often can be a source of conflict with the community and regulatory agencies.

Flying-foxes are protected species in New South Wales under the National Parks and Wildlife Act (1974). A culling licence is required from NSW National Parks & Wildlife Service (NPWS) to shoot flying-foxes. Licences are granted for a nominated period of time and a strict limit is placed on the number of animals that can be harmed under each licence.

On 4 May 2001, the New South Wales Scientific Committee made a final determination to list Grey-headed flying-fox as a vulnerable species under the NSW Threatened Species Conservation Act 1995 (TSC Act). The final determination means that Grey-headed Flying-foxes are protected under the TSC Act. Any action likely to harm a vulnerable species, such as shooting to protect commercial fruit crops by orchardist, must be licensed under section 91 of the Act.

According to NPWS, site specific culling licences will still be issued to fruit producers for the 2001/02 season under TSC Act rather than the National Parks and Wildlife Act 1974 as occurred previously. The new system will introduce some minor changes to the licensing process (Waples 2002).

Producers will still need to show NPWS officers economic crop losses in their orchards from flying-foxes before a licence, with a number limit, is issued. Under the new licensing arrangement, a ceiling will apply on the total number of Grey-headed Flying-foxes that can be harmed throughout the state, and the number of animals associated with each licence will be restricted accordingly. The ceiling will be set at one percent of the lowest estimate of the population (Waples 2002). This quota system will increase pressure on producers that totally depend on shooting as their main deterrent method, particularly during seasons when flying-fox numbers in orchards are high.

Exclusion netting has been used for over twenty years to protect fruit crops from flying-fox damage. It has proven to be effective and is widely promoted by government agencies and interest groups as the preferred method to minimise crop losses from flying-foxes in New South Wales. Much of the available information on netting is based on the experience of the early stonefruit industry on the North Coast of New South Wales during the late 1970's and 1980's (see contributions by Slack 1990).

The north coast experience

Exclusion netting to minimise crop losses from flying-foxes was commercially used on the North Coast of New South Wales from the late 1970's onwards following the introduction of low chill stonefruit varieties from the University of Florida by NSW Agriculture.

These new varieties made it possible for the first time to grow peaches and nectarines in a subtropical climate. This allowed earlier production (by 6 to 8 weeks) of stonefruit for the main southern markets. Returns per tray were often twice that of traditional temperate stonefruit growing areas. Average returns for peaches from the North Coast in the early 1980's and 1990's were in the range of $10.00 - $12.00 per tray with larger fruit returning over $15.00 per tray.

During this time, NSW Agriculture, together with suppliers of netting and individual producers, undertook considerable research on exclusion netting technology. By the early 1990's, netting standards such as mesh size, cable strength and support post spacing were established and widely promoted to the fruit industry.

The cost of erecting netting in 1990 on the North Coast was approximately $25,000 per hectare, depending on orchard layout and terrain (Slack 1990). This represents a considerable outlay for orchards on small holdings.

An economic model was developed by NSW Agriculture (Slack and Reilly 1990) to determine the level of crop loss to stonefruit on the North Coast that had to be sustained before exclusion netting was economically viable. The parameters used at the time were for 5-10% returns on capital invested over a 10-year period. Gross market returns were estimated at $10.00 - $12.00 per tray.

The model showed that netting was economically viable if the annual average loss of marketable fruit over a 10-year period was greater than 5% of the crop. The average crop losses at the time were in the 20-30% range. Given this information, together with improved netting technology, the stonefruit industry on the North Coast adopted netting as a flying-fox control management strategy. By 2000 up to 90% of stonefruit orchards were netted.

Uptake of exclusion netting for flying-fox mitigation by fruit producers outside the North Coast has been low. Following heavy crop losses from flying-foxes in the 1997/98 fruit season in the central coast and Sydney fruit growing areas, the State Government announced on 13 April 1999 that exclusion netting would be included in the Special Conservation Scheme administered by NSW Rural Assistance Authority (information on the loan scheme is available on the RAA web site, www. rural.assit@raa.nsw.gov.au).

This scheme allows commercial fruit producers to apply for a low interest loan to erect exclusion netting. Interest is fixed for 10 years at 25% below the NSW Treasury Corporation 10 year bond rate (5.0% as of 19/07/01). The maximum advanced is 90% of the cost of the works with a ceiling of $100,000. The maximum term of the loan is 10 years. Other conditions apply.

As at the end of the 2000/01 financial year, only twelve applications for loans have been approved, eleven on the North Coast and one in the Camden district (NSW Rural Assistance Authority, Orange, August 2001). This is a low number considering that up to 500 coastal fruit orchards remain unnetted and are regularly affected by flying-fox predation (records of NSW Agriculture).

Factors preventing the adoption of netting

A survey of fruit producers in the Camden district was undertaken in June 2001 to identify possible reasons for the low adoption of netting. The results showed that there were several factors that inhibited the adoption of exclusion netting by fruit producers to mitigate losses from flying-fox.

Land use issues

Recent regulatory changes by government have produced an atmosphere of uncertainty for long-term investment in coastal fruit growing. Reforms introduced by governments such as water reform, water supply catchment regulations, new pesticide use regulations, etc, have caused concern amongst producers over their continued access to natural resources such as water storage in farm dams, irrigation water and land clearing, and use of agricultural chemicals.

In addition, there are inconsistencies between local government planning regulators on the erection of permanent structures such as netting. Some producers believe that applications to erect netting may not be approved by local government.

Microclimate issues

Netting over and around fruit trees can modify the microclimate within an orchard to the detriment of fruit production, particularly if hail netting is used on top and flying-fox netting on the side. Flying-fox netting and hail netting differ in mesh dimension and configuration. Flying-fox netting is 20-45mm square mesh, while hail netting is 10-12mm diamond mesh with quadruple cross-stitching. Generally, light reduction from flying-fox netting is 5% -10% and for hail netting 12%-20%. Reduction in light from structures such as hail netting can reduce photosynthesis levels in fruit trees and affect fruit colour, maturity and tree growth (Middleton 2000).

Netting can modify or restrict the movement of bees within an orchard. Bees are essential for pollination in crops like apples and pears. Consequently, changes to their patterns of movement can affect both fruit yield and fruit quality.

Some research has been undertaken on the effect of netting on apple production (Middleton 2000) but not in stonefruit. Some producers have expressed concerns on the lack of research on managing stonefruit under netting.

Financial issues

The government's low interest rate offered under the Special Conservation Scheme did not appeal to fruit producers in the Camden district. Most considered it just another loan on top of existing loans, and there were concerns in meeting the extra repayments.

The means test on assets (maximum of $1.2 million net assets) also excluded several larger, younger and more progressive producers committed to long-term investment in their orchards from obtaining a loan.

The one producer who was successful in obtaining a loan from the scheme admitted that he regretted taking up the offer and this was well known within the district.

Viability issue

The most common reason given by producers for not investing in netting on their orchards was that they had a "farmers gut feeling" that netting was not a viable option for them under local conditions and with recent poor returns for their produce. However, most could not verify this view with economic data.

Road testing the model

To verify the district's perception of exclusion netting viability, the economic model developed for the North Coast in 1990 (Slack and Reilly 1990) was applied under local conditions using average gross returns for peaches for the 1999/00 season (Figure 1). Other parameters used in the

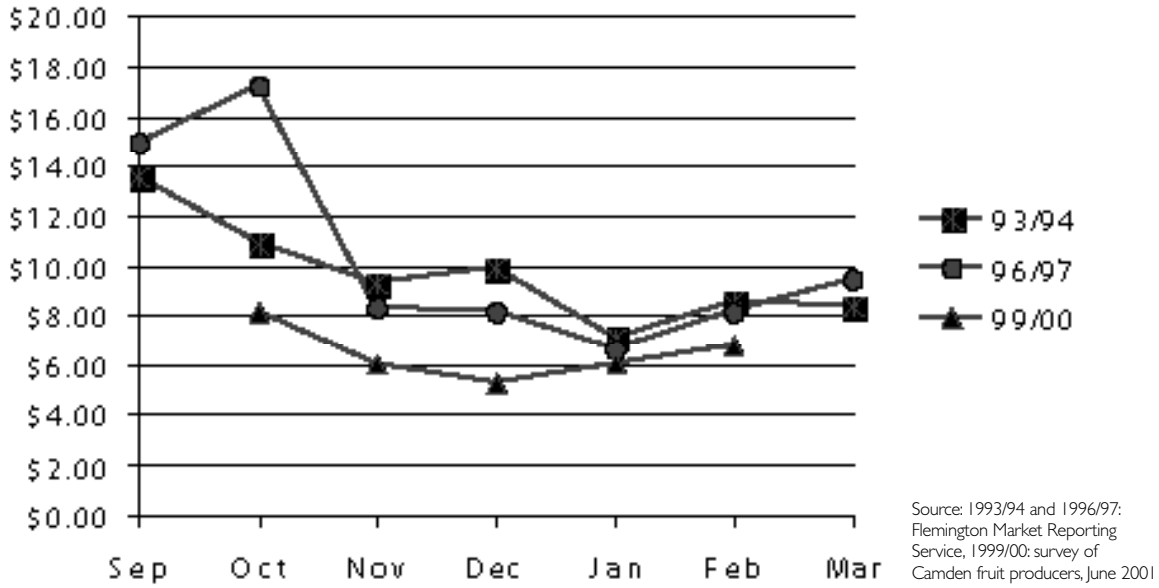

Figure 1. Monthly average gross market returns for peaches produced in the Camden district of NSW in the 93/94, 96/97 and 99/00 seasons ($/tray).

Table 3. Values of parameters used in the model to determine the economic viability of exclusion netting for protecting commercial fruit crops from damage by flying-foxes in the Camden district of NSW.

• Crop - 5 year old bearing peach trees	• Planting density - 500 trees / hectare
• Average yield -10 trays of fruit per tree	• Gross market return - $6.00 to $8.00 per tray (from 1999-2000 season)
• Production costs (from Farm Budget Handbook 2000)	• Marginal tax rate - 30%
• Cost of netting - $26,000 / hectare	• Netting installed in year 1
• Depreciation of netting and structure included in calculations	• Salvage value of netting in year 10 - $5,400
• Cost of servicing a loan for netting not included in calculations	

Table 4. The percentage after-tax return on capital invested in full exclusion netting for flying-foxes as calculated using a model developed by NSW Agriculture (see text for details). Results of the model are presented for rates of crop loss (i.e. % unsaleable fruit) from 5% to 30% per annum and for a range of market returns ($/tray) pertinent to the Camden district of NSW. Combinations that produce a return on capital of 5% to 10% are indicated by a single line border. Combinations that produce a return on capital of greater than 10% are indicated by grey shading and a double line border. Note the rapid decrease in return on capital invested in netting as the market price of fruit decreases.

	Gross market price		
% crop loss	$6.00 / tray	$7.00 / tray	$8.00 / tray
5	-8	-6	-5
10	-4	-1	1
15	0	3	6
20	3	7	11
25	6	11	15
30	8	14	19

Camden district model are listed in Table 3.

A return on capital invested in exclusion netting of between 5% and 10% was sought. Variable production costs used were from the NSW Agriculture Farm Budget Handbook 2000 (Slack and Ullio 2000).

The model showed that to obtain greater than a 5% return on capital invested in exclusion netting in the Camden district, crop losses needed to average 15%-30% annually over a ten year period. For more than10% return, losses needed to be in the 20% - 30% range (Table 4). The average annual crop loss in the Camden district from flying-fox is only 10% - 12%. This result supports the view of producers that exclusion netting is not a financially attractive management option.

Conclusion

The model showed that for the Camden district, much higher annual crop losses were needed to obtain the desired returns on capital when compared with North Coast.

Exclusion netting in the Camden district is marginal at best and economically not viable at worst when gross market returns are less than $8.00 per tray and the required return on capital invested in netting is greater than 5%.

Gross market returns for peaches from the Camden district need to be sustained within the $8.00 - $10.00 per tray range before producers will consider investing in exclusion netting to protect their crops from flying-fox damage. Indications are that this may not happen given the expected increase in production from new plantings in New South Wales and other states.

Cheaper alternative crop protection methods to exclusion netting are needed. They need to be scientifically assessed and implemented as part of a sustainable strategy for coastal fruit producers that cannot economically justify the high cost of exclusion netting.

Greater integration and "cooperation between researches, fruitgrowers and government agencies at a national level." (Tidemann *et al.* 1997) is needed if an effective strategy to minimise present and future conflicts between fruit producers, coastal communities, government agencies and interest groups over flying-foxes is the desired outcome.

Acknowledgements

I would like to thank NSW Agriculture district horticulturists for providing crop loss estimates from flying-fox in coastal districts; the fruit growers in the Camden district for providing me with their estimates of crop losses, returns for the last few seasons and their "farmers gut feeling" on the economics of netting their orchards; Netpro Protective Canopies Pty Ltd, Stanthorpe Queensland for quotations on erecting flying-fox netting in the Camden district; and John Slack, district horticulturist, Orange, formally of Alstonville, for the use of the economic model and for entering local data in the model to identify crop loss thresholds levels for netting in the Camden district.

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[1] This is a factor that agricultural economists apply to calculate the flow-on benefits to the community of raw agricultural products. Source: NSW Agriculture.

QUESTIONS & ANSWERS

LEN MARTIN: Len Martin, (UQ). Under vertebrate pests, you didn't include birds such as lorikeets and silver eyes. I understand that these can cause substantial losses and they would be excluded by netting. Would it affect the economics?

LAWRENCE ULLIO: Well, they probably cause just as much damage as a flying-fox. But whether loss of production is due to flying-foxes or birds, it still has to be pretty high up in our area to justify netting.

CHRIS DICKMAN: Are there any further questions?

JEANETTE GOUL: My name is Jeanette Goul and I just wanted to ask if you think that the losses of only 10 to 12 percent extrapolates to the north coast as well.

LAWRENCE ULLIO: No, I was only referring to the Camden district.

QUESTIONS & ANSWERS

JEANETTE GOUL: What I'm alluding to is that the previous statements by the farmers seem to suggest that the losses are in the range of 30 per cent or up at that level. Can you explain why they're not netting if that is the case?

LAWRENCE ULLIO: The 10 to 12 per cent was the average over ten years for the Camden area. You have good years and bad years.

JOHN ROGERS: I mentioned 30 per cent in the Northern Rivers area and I need to emphasise that that was last year. In the nine years before we had minimal or no damage.

CHRIS DICKMAN: Thank you, Lawrence. Time again to move on.