Fighting macadamia pests naturally

SALLnet: South African Limpopo Landscapes Network
Policy Brief

Retaining natural habitats significantly benefits natural pest control in macadamias

Contact

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Executive summary

The South African macadamia industry is currently highly lucrative and it is estimated that ±6000 ha of land is cleared each year for new plantings. Exclusion experiments by SALLnet demonstrated that the loss of natural habitats of vertebrate insect predators (bats and birds) has significant negative effects on macadamia nut quality and yield. Excluding bats and birds results in losses of up to 60% of yield, and these effects are greatest in orchards that border on natural habitats, demonstrating the value of retaining natural habitats around macadamia orchards.

What's the issue?

Losses to macadamia industry from stink bugs amount to R100 million/year.

Exclusion of vertebrate insect predators from macadamia trees results in up to 60% reduction in nut yield

To be sustainable,the rapid expansion of macadamia orchards should not compromise natural habitats

The macadamia is currently the most expensive nut in the world, with nearly double the price of almonds. The industry is projected to have a compound annual growth rate of 6.8% between 2020 and 2025 (APNEWS, 2020). **The largest producers of macadamia nuts are** currently **South Africa** and Australia, followed by Kenya.

In South Africa, macadamias have been one of the **fastest growing tree crop industries** in the last decade, providing seasonal and permanent employment for over 10 thousand people each. The value of the annual production was 4.8 billion ZAR or about 330 million USD in 2019 (SAMAC, 2020). Main growing areas in South Africa are the provinces of Limpopo, Mpumalanga, coastal KwaZulu-Natal and the Eastern Cape. **About 51,000 hectares of land** are currently being used as macadamia orchards in South Africa, while about 6,000 hectares were planted in 2019 alone (DAFF, 2019). This **annual growth is projected to be ongoing until 2030**, with about 1,000 additional seasonal and permanent farm workers employed yearly (SAMAC, 2020). However, the ongoing expansion of macadamia orchards often at the **loss of natural vegetation** or other fruit orchards also **leads to**

great farming management challenges. Monocultures, the excessive use of insecticides and habitat loss in general are associated with the **loss of natural enemies of crop pests such as bats, birds, beneficial insects as well as the loss of wild pollinators** (Tilman et al., 2001; Tscharntke et al., 2012). Furthermore, the increased and incorrect use of pesticides has led **to resistance to chemicals in pests such as stinkbugs** (Hemiptera: Pentatomidae) (Schoeman, 2018). Stinkbugs currently cause damage of R100 million per year to the industry.

A recent study comparing bat communities in three land use types: a nature reserve, macadamia orchards with and without adjacent natural habitat patches in northern Limpopo shows that **specialist bat species**, like the horseshoe bats, have **already been nearly excluded from macadamia orchard**s and their services lost, but **even generalists are likely to be threatened** if food resources and roosting sites become scarce (Weier et al. 2021). In turn, **ecosystem services like pest suppression may become likewise highly threatened**. Biodiversity loss and agricultural intensification are **threatening the sustainability of crop production**.

Up to 60%
of macadamia yield is lost when birds and bats are excluded from orchards

Why does it matter

Loss of natural pest predators has significant impacts on nut quality and yield, as our research demonstrated in the case of vertebrate insect predators, using both avoided cost models and predator exclusion experiments. **An economic model** for the avoided cost of bat predation on stinkbugs, **estimated this ecosystem service at approximate 0.53-1.29% of the annual economic value of the national crop**. This amounts to US$57-139/ha/yr of bat predation services to the South African macadamia industry (Taylor et al. 2018). However, these estimates seem to be under-estimates. A later study compared the impact of biocontrol, provided by bats and birds, with that of crop raiding by vervet monkeys on yield in South African macadamia orchards, through exclusion experiments in different landscape settings (Linden et al. 2019). This study has shown that crop raiding occurred only close to natural vegetation and caused yield losses of about 26% (see Figure 1). Biocontrol by bats and birds was higher near natural vegetation and prevented biocontrol through the exclusion of bats and birds resulted in yield losses of up to 60%. Based on these exclusion experiments, **the effects of biocontrol by bats and birds (USD ±5,000 ha/year)** were economically much more important than the losses of crop raiding by vervet monkeys (USD ±1,600 ha/year).

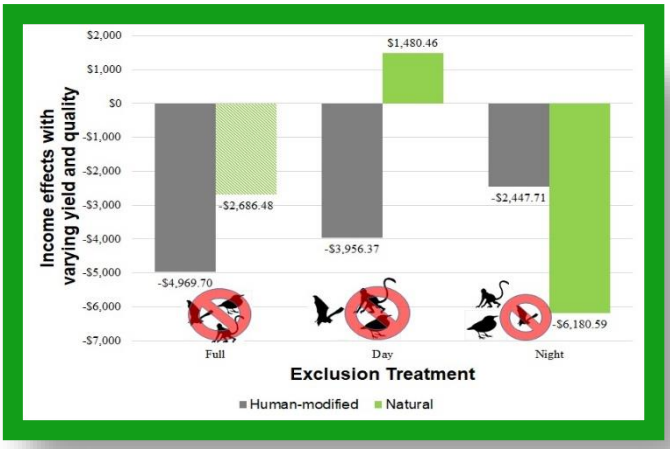

Figure 1. Income effects relative to control plots of exclusion of bats and night birds (night exclusion), monkeys and birds (day exclusion and all vertebrates (full night and day exclusion). Negative values represent net economic losses due to increased insect damage when predators are excluded.

What should be done?

Macadamia growers should view biodiversity and nature not as an inconvenience but as a critical and indispensable partner in integrated pest management. Both ecosystem services and disservices are linked to the vicinity of natural bush patches, which means that **the removal of natural vegetation to limit monkey abundances would also limit biocontrol service provision**. Macadamia farming practices should therefore **retain substantial reserves of unplanted natural or semi-natural habitat patches** to maintain bat and other biodiversity. All of our results from SALLnet relating to insectivorous bats in macadamias highlight the importance of a **heterogeneous landscape in and around macadamia orchards**, which provides connectivity, foraging and roosting sites through natural and semi-natural edge vegetation to promote the diversity of bat species and their ecosystem service provision but also that of birds and beneficial insects, including parasitoids, predators and pollinators. Adding roosting opportunities, e.g. bat houses, might further improve biocontrol services, especially in areas where many old trees have been removed

already. Furthermore, **the timing and application of pesticide sprays should be modified based on ecological and biological principles**, such as a day-degree models of stink bug development, or based on regular monitoring that informs decision-making by economic thresholds. Peak activity times of bats and birds should be considered when chemical insecticides are applied, to mitigate the ecological impact of these pesticides.

References

AGTAG, 2018. 63% of global macadamia crop forecast to come from China by 2025. https://www.agtag.co.za/category/3/post/21247. Accessed 21 July 2021.

APNEWS, 2020. Worldwide Macadamia Market (2020 to 2025) - Growth, Trends and Forecasts. https://apnews.com/press-release/business-wire/ Accessed 15 May 2021.

DAFF, 2019. A profile of the South African macadamia nut market value chain. https://www.daff.gov.za. Accessed 22 June 2021.

De Villiers E., Joubert P. 2003. The Cultivation of Macadamia. ARC-Institute for Tropical and Subtropical Crops, Nelspruit, South Africa.

Green & Gold Macadamias, 2018. International Macadamia Symposium wrap up. https://www.greenandgoldmacadamias.com/. Accessed 21 May 2021.

Linden, V.M.G., Grass, I., Joubert, E., Tscharntke, T,. Weier, S.M., Taylor, P.J. 2019. Ecosystem services and disservices by birds, bats and monkeys change with macadamia landscape heterogeneity. *Journal of Applied Ecology, 56*, 2069–2078, https://doi.org/10.1111/1365-2664.13424.

SAMAC, 2020. Industry Statistics. https://www.samac.org.za/industry-statistics. Accessed 12 April 2021.

Schoeman, P.S. 2018. Relative seasonal occurrence of economically significant heteropterans (Pentatomidae and Coreidae) on macadamias in South Africa: implications for management. *Afr Entomol* 26:543-549.

Taylor, P.J., Grass, I., Alberts, A.J., Joubert, E. and Tscharntke, T. 2018. Economic value of bat predation services- A review and new estimates from macadamia orchards. *Ecosystem Services*, 30:372-381.

Tilman, D., Fargione, J., Wolff, B. et al. 2001. Forecasting agriculturally driven global environmental change. *Science* 292:281-284.

Tscharntke, T., Clough, Y., Wanger, T.C. et al. 2012. Global food security, biodiversity conservation and the future of agricultural intensification. *Biol Conserv* 151:53-59.

Weier, S.M., Linden, V.M.G, Hammer, A., Grass, I., Tscharntke, T. and Taylor, P.J. 2021. Bat guilds respond differently to habitat loss and fragmentation at different scales in macadamia orchards in South Africa. *Agriculture, Ecosystems & Environment*, *320*:107588.