



# What have we learnt?



Crop protection		
Project	Outcome	Future work
Macadamia felted coccid surveillance in Mpumalanga and KwaZulu-Natal	243 farms and 7 953.6 hectares were inspected in the Mpumalanga lowveld and KZN. The macadamia felted coccid was present on 23 farms and absent on 220 farms. 19 commercial nurseries and 13 grower nurseries were inspected, and the macadamia felted coccid was not present in any commercial or grower nurseries. The macadamia felted coccid has not spread uncontrollably from sites where SAMAC were aware of infestations.	Surveillance activities will be re-instated if needed based on continuing monitoring by Dr Schalk Schoeman.
White root rot in macadamias	White root rot ( <i>Rosellinia necatrix</i> ) can cause disease in macadamias. Root rot develops 4 weeks after infection, and leaf wilt and dieback by 6 weeks post infection.	Although white root rot does not seem to be prevalent in macadamia orchards, monitoring is ongoing through the Disease Diagnostic Clinic. All samples tested for Phytophthora also undergo testing for white root rot.
Evaluation of potential entomopathogenic fungi as biocontrol options against stink bugs	A number of different fungal groups ( <i>Aspergillus</i> , <i>Fusarium</i> , <i>Bionectria</i> , <i>Purpureocillium</i> , <i>Chaetonium</i> and <i>Scopulariopsis</i> ) known to contain species which act as entomopathogenic fungi were tested on stink bugs, but none performed better than a <i>Beauvaria bassiana</i> species currently undergoing field trials.	Current work focuses on <i>Beauvaria bassiana</i> .
Nut borers associated with macadamias in South Africa	The macadamia nut borer is the dominant species found in macadamia nuts, but these results did not always correspond to what was found in traps. Macadamia nut borer populations from different provinces are not separated genetically, thus the specificity of pheromone blends are likely not affected by the presence of genetically diverse populations. A diagnostic tool capable of differentiating between the four species in the nut borer complex was developed and decreases turnaround times for nut borer identification.	Current research focusses on characterizing the sex pheromone of the macadamia nut borer, comparing the attraction of males to various commercial products and testing different pheromone baited traps.
Screening for tolerance against polyphagous shot hole borer-associated <i>Fusarium euwallaceae</i> in macadamias	The fungal symbiont spread by the polyphagous shot hole borer (PSHB), <i>Fusarium euwallaceae</i> can cause disease in macadamias. However, the severity of disease is low, and the restricted growth of the fungus in macadamias means that the PSHB cannot reproduce in macadamias. Heavily invested trees should be cut down and disposed of by burning/ solarizing and chipping, while minimising movement of infected plant material in orchards.	Monitoring for the presence of the PSHB in macadamia orchards is ongoing through the Disease Diagnostic Clinic.
The effect of artificial damage to macadamia nuts on the egg-laying preference of nut borers	There was no significant difference in the number of eggs present on nuts between nuts which were not damaged artificially, nuts damaged lightly and nuts damaged heavily. The average number of eggs was the highest on nuts damaged lightly, followed by the undamaged nuts and the nuts damaged heavily. Nuts damaged heavily did not develop any further and either died or were weaned. Heavy damage to nuts may sever the vascular tissue, disrupting the supply of nutrients and water to the husk.	The absence of significant differences in egg-laying suggests that macadamia trees may not produce a chemical cue upon wounding which attracts nut borers, and thus this will not be pursued further.
Sampling and evaluation of entomopathogenic fungi for the control of the two-spotted stink bug	The isolate of <i>Beauvaria bassiana</i> isolated from stink bugs performed better than commercially available products, and although chemical insecticides had a quicker knock-down effect, the EPFs were able to achieve the same level of control 12 to 18 days after inoculation.	Future work includes optimizing factors such as UV intensity, registration trials and compatibility tests with registered insecticides for an IPM strategy.
Evaluation of potential EPFs as biocontrol options against stink bugs	Other fungal families known to also act as EPFs identified in the study above were evaluated for their ability to kill stink bugs. None of these fungi performed better than the native <i>Beauvaria bassiana</i> isolate discussed above.	These fungi will not form part of further studies.
Stink bugs and egg parasitoids in macadamia orchards in South Africa	Twenty stink bugs species were identified in three provinces, with the two-spotted stink bug dominant, but <i>Boeris</i> species also prevalent in KZN. A molecular diagnostic test capable of distinguishing between the 20 species was developed, together with a photographic database, thus stink bugs and especially their nymphal stages can now be identified more accurately and rapidly. Two parasitic wasps of stink bug eggs were identified.	The damage potential of <i>Boeris</i> spp and the other lesser known species must be determined. The two stink bug egg parasitoids will be studied further.
Crop production		
Project	Outcome	Future work
Honey bees, pesticides & pollination	Cross-pollination increases yields by 52% when compared with open pollination. Honeybees remain active on macadamias throughout the flowering period, and although they forage for pollen as well, they are predominately nectar foragers. Colonies can be introduced at the beginning of flowering based on the number of open flowers, and can remain in orchards for the duration of flowering. At least two two hives per hectare is recommended to maximise cross-pollination, and in single cultivar blocks the introduction of cross-pollinizers through grafting can be considered.	How many hives are required per hectare, best cultivar combinations for cross-pollination and the role of in-hive pollen transfer in cross-pollination.
Evaluation of floral rewards of different macadamia cultivars and the effect of honeybee pollination on crop yields in these trees	Cross-pollination increases yields by 48.5%, and improves nut quality (size and kernel weight). The amount of nectar and nectar sugar concentrations in macadamias is sufficient and inside the preferences of bees.	Pollination standard for hives, hive placement and measuring pollination efficiencies.
Determination of climatically suitable growth areas in South Africa for macadamias under present climatic and projected climate change conditions	There are four climate zones in South Africa suited to macadamia production: Am, Aw, Cfa and Cwa. Modelled changes include expansion of areas suited to macadamia production along the coast of the Eastern and Western Cape, an expansion inland in KZN and the Eastern Cape and the replacement of certain zones by others also suited to macadamia production in Mpumalanga, Limpopo and Eswatini.	Predictions will be updated periodically with the latest bias corrected climate models as they become available.
Macadamia water usage	An average of 510 l of water is required to produce a kilogram of macadamias. The water use efficiency of macadamias is relatively low as they accumulate oils and not sugar and have a low water content compared to fleshy fruits. In contrast, the water use productivity is high due to the high prices of macadamias. Macadamias are conservative water users and can switch off transpiration under conditions where water loss through transpiration exceeds water supply from the roots. Evaporation can be high in macadamias, and and this needs to be considered during irrigation scheduling. Macadamias appear to be less sensitive to water stress in comparison to other horticultural crops when considering yield but water stress during flowering and nut set can affect quality.	Evaluating the most efficient way to water trees (for example drip vs microjet) and differences between cultivars in terms of water use.
Health Research		
Project	Outcome	Future work
Macadamia nut oil supplementation	Macadamia nut oil supplementation significantly lowered lipase and CRP levels, which contributes to pancreatic health and reducing inflammation in the body, which has a cardioprotective effect. Macadamia nut oil supplementation showed more beneficial effects for human health when compared with coconut and olive oil.	Awaiting results of international collaborative health research before other projects are initiated.