SAMAC RESEARCH FRAMEWORK
2024

RISK MITIGATION		
PHYTOSANITARY / INVASIVE PESTS AND DISEASE		
Bark and ambrosia beetles	Crop susceptibility	Species of borers and symbionts identified, pathogenicity of symbionts underway
	Management strategy	Sanitation, phoretic mites, parasitoids, insecticide resins painted on bark, stress management
	Ecology within production areas	Link between macadamia felted coccid, Botryosphaeria and Phytophthora
Sap beetles	Ecology and management	Life cycle parameters, monitoring, when should control be applied and what type?
Mosquito bug	Biology and diagnostics	Feeds on the flush and nymphs are trapped after hardening off, of the flush - damage escalates. Only genus level identification to date
	Survey economic impact	In Africa for a very long time - not invasive. Impact of global climated change and host range shifts
	Management strategy	Parasitoids, pathogens, pheromones and insecticides. Pest with huge economic impact in Africa
	Crop susceptibility	Appears to be very polyphagous
Macadamia felted coccid	Control measures	Chemical, non-chemical and biological programs must be tested and guidance provided to growers
	Cultivar susceptibility	SAMAC cultivar evaluation trial in Barberton infested, ideal opportunity to quantify susceptibility
Rosellinia necatrix	Control strategy	Not common in macadamias but difficult to contain. Identification, quarantine and tree distruction
NEMATOLOGY		
Entomopathogenic nematodes	Application against pests	Initial research in place
	MNB	Combination with fungi and other control strategies in an IPM programe
Plant parasitic nematodes	Survey	Association with chlorotic and declining trees
PLANT PATHOLOGY		
Husk rot	Management strategy (e.g. insect damage)	Risk models for Colletotrichum, Diaporthe and Calonectra into SAMAC Integrator
	Effective fungicides and timing	*In vitro* screening of actives to be followed by field trials to test timing of infection and actives
Phytophthora	Management strategy	Rootstock susceptibility and control methods (application type, timing in phenology)
	Root health relative to disease	Biological soil ammendments such as Trichoderma under lab and field conditions
	Chemical control	Registrations lacking, nursery registration
Pestalotiopsis / Neopestalotiopsis	Identification of causative organisms	Research in place
	Management strategy	*In vitro* screening of actives followed by field trials
	Temperature based modelling	Risk models in SAMAC Integrator
Cankers	Botryosphaeria	Identification through Disease Diagnostic Clinic. Species identified, actives being trailled *in vitro* and in the field
	Tree dieback	Frequency relative to tree age
Cladosporium	Control strategy	Research for risk models in South Africa and field trials for control
Pythium	Management strategy	Research on species and pathogenicity currently underway, to be followed by work on control, supported by work on Phytophthora
Botrytis	How, what, why?	Low incidence initially but increasing. Research for risk models in South Africa and field trials for control
INTEGRATED PEST MANAGEMENT		
Stink bugs	Management strategies	New generation pesticides, inoculative releases of parasitoids under controlled conditions pathogen/insecticide combinations, volatile defensive compounds. Double spray after November
	Coconut bug	Parasitoid survey
	Monitoring methods	Spot spraying, pheromones, nut disection, e-nose, branch shaking and visual. Aborted nuts on the ground uring Dec, Jan and Feb
	Thresholds relative to damage	
Thrips	Scouting methods	Yellow sticky traps, beating sheet number of terminal branches with symptoms (small leaves)
	Thresholds relative to damage	Threshold in place, should be updated from time to time. Multi season effect of damage where thrips are treated and not - effect on quality and qantity of crop
	Management strategies	Effect and type of ground covers and reduction in contact sprays on thrip numbers
Pest monitoring methods	Economic thresholds	Applicable across pests and diseases
	Scouting methods	SOP in place, should be revised from time to time
	Indirect and direct monitoring methods	
Modelling and prediction	Day degree models	Nut borer complex, macadamia felted coccid. Current nut borer recommendations sufficient for initial spay but not follow-up sprays. Macadamia felted coccid work in lab but also ground truthed in field urgently needed
	The effect of climate on pest populations	Degree day models in SAMAC Integrator
Population biology	Population movement	Initial work in place for two-spotted stink bug, macadamia nut borer and thrips in Levubu
	Demographics	Definite shifts in dominance of moth borers and drivers are important to quantify, climate and long term area wide pheromone usage
Biological control	Pheromones and kairomones	Stink bugs, nut borers and macadamia felted coccid
	Parasitic wasps	Stink bugs, nut borers and macadamia felted coccid
	Viruses	Stink bugs and nut borers

	Entomopathogenic fungi	All pests, and especially soil applications
	Stink bugs	Combine in a program with and without registered chemicals
	MNB	Combine in a program with and without mating disruption and innoculative releases of Trichogrammatoidea and with and without registered chemicals. Soil applications.
	Macadamia felted coccid	Combine in a program with and without registered chemicals
	Bats and birds as predators	Initial work in place
Area wide control	Many pests infest more than one host plant. By coordinating control procedures of these oftentimes very mobile pests, a meaningful sustainable reduction in pest presure can be achieved	
CROP PRODUCTION PROGRAMME		
FLOWERING AND POLLINATION		
Bees and pollination	Pollination hives	Hive density, pollination period, crop set
	Bee safety - insecticides	Chemical and biological
	Cross pollination	Performance of cross pollinators, optimum density
	In hive pollen transfer	
	Feasibility of mechanical pollination	
Flowering	Basis and drivers of the variation in flowering time, intensity and patterns across regions in the same cultivars	Phenology tracker in SAMAC Integrator
	Feasibility and impact of flower thinning and the genetics of flowering density	Do we need so many flowers that do not translate to yield?
	Understanding the whole process of flowering from bud initiation through to nut set	Being addressed in new project in 2024
	Influence of pollen parents on kernel recovery, oil profile, quality, and shelf life (what makes a good parent?)	Kernel recovery work partially in place
	Understanding the level of self-incompatibility among cultivars and its implications for orchard design and breeding for self-compatibility	
	Pollen viability — mechanisms and associated pathogens	Initial work on storage and viability underway in 2024
	Effect of climatic parameters such as vapor pressure deficit, temperature and available carbohydrates on flower initiation, pollination, fruit set, kernel quality and nut drop	
	Effect of timing of nut removal on subsequent crops	
	Influence of nutritional composition of flowers and husk on pests and diseases	
SOIL HEALTH AND ORCHARD ECOLOGY		
Soils	Soil preparation	pH, Ca:Mg and P norms per cultivar and soil type
Cover crops	Increasing production	Measure the effect of soil health and heterogenous species composition on yield and insect and disease resistance
	Effects on pest management	Measure the number of beneficials: pests and damage / losses
	Effects of green manures and amendments	Soil health indicators - long term study
Soil carbon nitrogen ratio	Effects on soil ecology	Measure biological integrity of the soil
	Effect of compost with wrong ratios	N-deficiencies due to too early / wrong application of compost
	Optimal levels	What should it be for great N-uptake by the plant and sustainable biology?
Evaluation methods	Soil health parameters	Earthworms, micro-organisms like springtails, bacteria and the nematodes
	Soil health recommendations	Create a norm that is linked to good yield data across geographic and cultivar ranges. Standards/calibration for sap:leaf:soil ratios
Compost	Benefits of compost	Need to define quality and quantity
	New paradigm	Inorganic vs organic fertilizer, carbohydrate accumulation and storage
	Parameters and recommendations	Upper developmental threshold of macadamia felted coccid and compost temperatures
Orchard of the Future	Planning and design	
	Mechanization	
	Sustainability	Econmic and ecological
	Planting density	
Shade netting	Possible with dwarf rootstocks	
	Economic study	
Optimal planting areas	Optimal soils/cultivar	
	Climate	Site classification and climate modelling
Ant and termite control		Ideally non chemcial control
Weed management	Mulches	
Disease management	*Phytophthora and Pythium*	

CLIMATE AND CLIMATE CHANGE		
Modelling of effects	Impact of changing climate on tree performance	
PLANT BIOLOGY		
Cultivar selection	Climate, soil and elevation	
	Genetic traits linked to ID	
	Pest and disease resistance	
	Sensitivity to climate change	
	Cultivar evaluation in areas	In place
	Breeding	Research into marker-assisted breeding underway
	Dwarf rootstocks	SAMAC will trial when available
	Rootstock-scion interaction	Difference in tree health and stress of cultivars dependign on this factor.
Plant growth regulators	Reduce drop	Products, timing of application, rates of application, effects in subsequent years
	Increase yield	Products, timing of application, rates of application, effects in subsequent years
VPD	Effects on set and recovery	
Stick tights	Management and control	
Starch reserves	Effects on flowering	Initial research underway in 2024
	Alternate bearing	Initial research underway in 2024
Flowering and harvest	Estimate harvest time	
IRRIGATION AND NUTRITION		
Water requirements	Cultivar specific water requirements	
	Scheduling	
	Irrigation design	
	Irrigation requirements relative to soil types	
Nutritional requirements	Cultivar specific requirements	
	How, when and standards	
	Foliar sprays	Concentrations, timing and effectivity
	Application timing and scheduling	
BRIX	Manipulation	
	Correlation with pests and diseases, leaf nutrition, flowering and yield	
Irrigation types	Micro versus drip versus dry land production	
Application	Application of water research results	
Tree age effects	Age effects on irrigation and nutrition	
Canopy management	Yellowing	Underlying factors and management
MECHANIZATION		
Tree shakers	Design and cost	Best Practices. No damage to roots and tree stem: sustainable option
Harvesters		Best Practices. Initial work in place
PRECISION AGRICULTURE		
Remote sensing - drones	NDVI	
	Scouting	
	Mapping orchards	Yield prediction and tree age modelling. Current ree age model error 18 months
Soil maps	Mapping and orchard placement	
Climatic data	Large and small scale	
Precision application	Fertilizers	
Benchmarking	Data collection of production	Comprehensive database per area - SAMAC Integrator
EC monitoring	Fertigation	
	Nutrient management	
FT	Proactive irrigation	
Pruning	Technology	Development of pruning regimes
Crop estimation	Lidar and remote sensing	
Soil moisture probes	Improved water management	
Spray application	Improved spray application methods	Self levelling sprayers when spraying at a gradient (already possible for mechanical tea picking as well as automatic 155 mm cannon turret of the Olifant tank - fairly old tech) . Linking scouting results on an intelligent GPS map for precision pest and disease management. Sprayers that can automatically be adjusted to make provision for different sized trees.
	New technologies	Drones with fogging machines - already available and should be tested independantly
Irrigation	Low volume irrigation optimization	
Decision support	Scouting apps and literature	Already available but should be continually improved - ease of operation is very important
POST HARVEST PROGRAMME		
QUALITY MANAGEMENT		

Effect of postharvest treatment	Pasteurisation, cold plasma on shelf life, oil profile and taste	
Effect of on-farm practices such as ethephon on kernel shelf life and quality, pests	Initial work in progress	
Timing of nut removal on kernel quality, oil and sugar levels	Initial work in place	
Effect of cultivars and pollen source on shelf life	Follow-up on WMO project	
Effect of post-harvest handling on quality	SMAC	
Lack of global standard for unsound kernel, oil and NIS determination	WMO	
Mycotoxin contamination associated with kernel and NIS		Prevention and treatment
Tree health effect	On Brix, flavour and shelf-life	
Onion ring	Effect of climate on onion ring	Market onion ring and coloured nuts differently. Research to prove food safety and nutrional content?
Storage	Storage time and effect on quality	Improved tools for predicting shelf-life
Discolouration	Genetic and physiological basis of kernel dark staining	Market onion ring and coloured nuts differently. Research to prove food safety and nutrional content?
Analysis of defects	Systematic analysis of defects and causes	Industry database
HEALTH RESEARCH		
Health benefits	Inflammation	More focussed trials focussing on specific markers
EMERGING ISSUES AND TRENDS		
Tree stress	How to deal with tree stress	Climate change, dieback, yellowing, macadamia felted coccid
New pests	How to prevent introduction of new pests and diseases	Biosecurity framework, education
Reduction of pesticides	Reduction of pesticide usage	Integrated pest and disease management
e-nose and scouting	Developing e-noses for use in pest scouting	
International database	International database for pest and disease reporting	IMS R&D Centre
Cultivar identification	Diagnostic tools (genetic fingerprinting)	Available in South Africa, reference library currently being expanded