Hort Innovation

Final Report

Developing a Macadamia Industry Tree Stock Standard

Project leader:

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Delivery partner:

Nursery & Garden Industry Australia Ltd

Project code:

MC17001

Project:

Developing a Macadamia Industry Tree Stock Standard – MC17001

Disclaimer:

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Content

Summary

Macadamia tree stock nursery production 'standards', and schemes to assess compliance to their requirements, are recognised internationally as an important foundational step in supporting the macadamia nut production industry. Selection of macadamia tree stock represents a long-term investment for an orchardist. Purchase and establishment of poorly produced stock can cause significant productivity issues in an orchard that only materialise later in the tree life and can reduce harvest volumes and tree longevity.

The overall objective of this project was to, in consultation with key macadamia stakeholders, develop Australian macadamia nursery production tree stock specifications to improve macadamia orchard productivity through improvements in nursery production and macadamia tree stock physiology and health.

The Nursery & Garden Industry Australia (NGIA), Australia's peak body supporting nursery production, produces the *NIASA Best Management Practice Guidelines* (the 'Guidelines') for production nurseries which is underpinned by the Nursery Industry Accreditation Scheme Australia (NIASA). A key component of the NIASA Guidelines is focused on product quality and meeting customer expectations.

Under this project, the NIASA Guidelines were found to provide an excellent platform on which to produce and deliver a macadamia tree stock standard, with the existing Guidelines being utilised to support general production nursery best practice and improvement, and a specialist macadamia appendix to the Guidelines to be added to directly support industry specific matters.

A critical review was undertaken on Australian and international macadamia nursery production literature and best practice advice to address macadamia specific areas and develop a modern best practice standard to support ongoing production of macadamia tree stock. Where gaps were found, modern best practice advice was sought and guidance given to address those gaps.

The standard has now been completed for inclusion as part of the next edition of NGIA's *NIASA Best Management Practice Guidelines*.

The standard provides a foundation to continually improve and support on-farm non-commercial production of tree stock, and will also allow for auditing and accreditation of a production nursery as meeting the *NIASA Macadamia Nursery Stock Specifications* standard to give the macadamia industry a clear guide when making decisions around sourcing planting stock with the highest potential to perform.

The Guidelines are reviewed annually, and in partnership with the Australian Macadamia Society (AMS) and Guideline users, can be updated to take advantage of outcomes in ongoing investment in macadamia tree stock improvement and address practical application of the guidance provided.

Keywords

Macadamia; nursery production; standard; NIASA; Australia; best practice; quality; accreditation.

Introduction

As early as December 1979 in its' Macadamia Bulletin, the AMS raised discussion on the *'desirability to establish a code of procedures by which commercial nurseries should operate*' and proposed that specifications be approved for the production of quality macadamia nursery stock.

Prior to initiation of this project, the macadamia industry voiced this ongoing concern that the industry has no clearly defined tree stock standards and that this has the potential to put their cropping systems at risk. As a result, the industry agreed that macadamia nursery stock specifications be developed. The major areas identified to be addressed were the production of:

- quality rootstock;
- sound grafts;
- trueness to type plants;
- adequate tree form and structure; and
- production nursery management and quality control.

Prior to this project there was limited to no documented modern best practice advice on quality control on seed sourcing or trueness to type, and very little in the way of pest and disease prevention. There was also a lack of documented advice on modern rootstock management, seedling transfer process from germination bed to pot/bag and the importance of thinning out poor performing seedlings and grafted trees.

There was also a lack of agreed protocols for the preparation, taking and handling of scion wood with some using cincturing and others not, with some nurseries ensuring completion of grafting within 24 hours and others taking up to a week to graft effecting tree stock quality. These issues can result in high graft failure.

Trueness to type has been an ongoing issue with no specific guidelines available for nursery stock to measure against. A large amount of scion wood is collected from commercial orchards with varying levels of documentation/mapping of varieties within the orchard resulting in misidentification of nursery stock. This problem is compounded if the misnamed variety is then used for future propagation which simply is perpetuating the overall issue. This is a significant problem that has the potential to get worse and requires a robust identification system.

Tree form and structure required to produce a well-formed mature macadamia tree requires appropriate management to ensure the end result meets growers expectations. Inappropriate growing media, irrigation water and crop nutrition management programs contribute to reduced root structure.

Production nursery management and quality control guidance has been lacking across key areas such as thinning out underperforming nursery stock, using quality growing media, record keeping and varietal identification across the cropping system. Quality trees require appropriate high health standards for growing surfaces, irrigation systems, irrigation water quality and disinfestation, site drainage and pest, disease and weed management structure and records.

Through the NGIA's best practice nursery production scheme, NIASA, the project provider in consultation with relevant macadamia stakeholders has the capacity to provide best practice standards addressing these issues and provide appropriate advice within its NIASA Best Management Practice Guidelines.

Methodology

Overarching framework

Project methodology was directed at developing project outputs that represented a mutually acceptable and durable process for NGIA, through the NIASA Accreditation system, with NGIA assuming the role of administrator for compliance assessment to the NIASA macadamia standard, in the manner it normally deals with the administration of other accredited wholesale/production nurseries nationally.

The legacy maintenance of the project outputs is to be through an authorised oversight committee with AMS representing Australian macadamia growers' interests through the inputs of a senior AMS staff member and a designated member of its Board and a representative of NGIA.

The project was broken into two specific phases, with investigation and drafting of potential macadamia nursery stock standard content being Phase 1, and Phase 2 directed at building the content into the Nursery Production FMS including its electronic auditing platform (web based) to capture audit and compliance information.

Phase 1 – Investigation, review, development of draft materials and oversight

Methodology to be employed for Phase 1 of the project was directed at establishment of a sound project foundation and draft framework with the project team to:

- Establish a Technical Advisory Group (TAG) made up of key industry stakeholders, with AMS and NGIA to provide content review and agreement on the macadamia nursery stock standards mated to the NIASA Guidelines.
- Review Australian and international best practice nursery production programs, tree stock standards and published literature.
- Map outcomes against the NIASA Guidelines and identify gaps in NIASA guidelines relevant to macadamia nursery stock.
- Develop a draft macadamia tree stock standard, as an appendix to NIASA Guidelines, with emphasis on tree and rootstocks, that validates 'trueness to type' including through genetic assessment where required, includes geospatial mapping of motherstock locations to trueness to type data, applies methods for durable varietal and rootstock labelling, specifies controlled conditions with emphasis on nursery management, hygiene and high health practices and meets industry expectations for appropriate plant physiology criteria.
- Work with the TAG to review draft macadamia nursery stock standard material and amend as required.
- Investigate alignment to existing Nursery Production Farm Management System (either added to existing guidelines or added into a specific (new) stand-alone Appendix) following industry consultation and acceptance of content with NGIA, SIAP and AMS.

Phase 2 – Material development and project extension and delivery

Building on the outcomes of delivery of Phase 1, Phase 2 methodology required the project team to:

- Revise and update the Nursery Production FMS (NIASA Guidelines).
- Develop Governance & Administration guidelines that detail the process for macadamia production nurseries to attain NIASA Accreditation in consultation with AMS and the TAG and determine the quantum and availability of resources required for macadamia-specific administrative, auditing, sampling and diagnostic work which maybe additional to that required for current NIASA accreditation.
- Develop a legacy framework and the potential membership of an expert panel able to inform deliberations on changes to processes (macadamia nursery stock standard) ranging from new technologies, reacting to emergent problems and processes of appeals and dispute resolution.
- Develop and test electronic auditing templates and provide necessary updates to the auditing software. The electronic auditing platform currently used for all NIASA audits will require software upgrades to allow the system to recognise a business seeking an audit under NIASA plus a macadamia nursery stock standard as well as develop the electronic compliance checklist, within the auditing platform, to allow auditors to use portable electronic hardware to capture audit data in the field.
- Develop and deliver NIASA/macadamia nursery stock standard extension material as the project progressed to be delivered through group activities (e.g. workshops) and on-farm through face to face engagement in both visual, written and oral formats and communicate to wider macadamia nut growers and nursery industries through existing communication channels, electronic, hardcopy and on-farm with NGIA targeting nursery production and AMS addressing the macadamia nut growers.

Outputs

Mapping and gap analysis of existing international program material against NIASA BMP Guidelines

In the order of 40 research papers and other publications were identified as holding some relevance to macadamia nursery production as a result of the literature review. The majority of macadamia specific publications identified were produced in South Africa, Hawaii and Australia, however other reference materials published in other African nations, New Zealand, the United Kingdom and Mainland United States were also considered.

Only one relevant macadamia production 'standard' was identified as part of the literature review – that being the SAMAC Nurserymen's Code of Practice and its associated protocols. The SAMAC protocols are presented as 'dot point' requirements with little explanatory information. SAMAC is an established accreditation program developed in South Africa that is widely used by large scale production nurseries. Some elements of the Australian Standard *AS2303 – 'Tree Stock for Landscape Use'* were also considered as part of the review.

Key themes identified across most reference documents were nursery hygiene, inputs including growing media and water, beds/benching, propagation material sourcing and collection and storage, seedling propagation/selection/culling/transplanting, container management and grafting. The SAMAC Code of practice was identified as the only reference material to comprehensively address all criteria and specify finished product 'plant quality' requirements.

The method used to map literature review outcomes was to initially review each requirement included within the NIASA Guidelines against the SAMAC Nurserymen's Code of Practice then review against other literature where 'gaps' or deficiencies were noted. The gap analysis is provided as Appendix 1. Mapping and gapping of best practice literature against the NIASA Guidelines.

Macadamia nursery stock standard Appendix and auditing framework

On completion and consideration of the literature review findings, mapping and gapping findings against NIASA, and TAG recommendations and consultation, a complete appendix to the NIASA Guidelines (with audit checklist) was developed – the *Macadamia Nursery Stock Specifications* (see Appendix 2. NIASA Guidelines APPENDIX 15 - Macadamia Nursery Stock Specifications & Audit checklist) and has been incorporated as Appendix 15 of Edition 8 of the NIASA Guidelines to be published this year (2019).

In accordance with project requirements, the appendix specifications address validation of 'trueness to type', allow for geospatial mapping of motherstock locations to trueness to type data, apply methods for durable varietal and rootstock labelling, provide advice to ensure stock are grown and maintained in specified and controlled conditions with an emphasis on nursery management, provide requirements on hygiene and high health practices, and allow for finished product quality requirements to meet industry expectations for appropriate plant physiology criteria.

Audit Management System (AMS) upgrades have been made to allow electronic data management and auditing for the project to allow auditors to use portable electronic hardware to capture audit data in the field. To accommodate project integration into the NGIA's AMS, the System was modified by upgrading the DevExpress components from v12.1 to v18.1. This was necessary to enable the developer to use components only available in more recent versions of DevExpress providing a better user experience. This required a significant amount of "code refactoring", essentially reworking code and fixing a large number of breaking changes.

Other changes include:

- Businesses may now be assigned to one or more programs (e.g. NIASA/*Macadamia Nursery Stock Specifications*, and BioSecure HACCP if desired).
- There is now provision to add /delete sub-programs (e.g. *Macadamia Nursery Stock Specifications* will fall under NIASA Production).
- Businesses can belong to more than one sub-program.

- Sub-programs (e.g. *Macadamia Nursery Stock Specifications* accreditation) can now store their own Business Document requirements (as per Programs).

The electronic audit checklist has been developed (used electronically by the auditor on a tablet) and will support project auditing, data capture and reporting within the NGIA AMS. Additional functionality will ensure that modifying an Audit Checklist will not affect previous completed audits (versioning).

The NIASA *Macadamia Nursery Stock Specifications* Audit Checklist criteria are incorporated into the *Macadamia Nursery Stock Specifications* included as Appendix 2. NIASA Guidelines APPENDIX 15 - Macadamia Nursery Stock Specifications & Audit checklist to this report.

Governance and Administration Guidelines

Governance and administration requirements have been developed and documented in detail within a NIASA *Macadamia Nursery Stock Specifications* Accreditation Administration and Resourcing Plan (the 'Plan') (see Appendix 3. NIASA Macadamia Nursery Stock Specifications Administration and Resourcing Plan).

The Plan includes and details governance and administration policies, the quantum and availability of resource requirements for administrative arrangements, implementation, analytical testing and requirements made on accredited businesses. The Plan also includes requirements for an Authorised Oversight Committee and Technical Advisory Group to validate and ratify processes (noting the Technical Advisory Group has already been established as part of this project).

Resourcing details are included within the Plan. The Plan identifies arrangements for scheme administration, fees and charges for scheme administration, accreditation process, suppliers of goods and services, fees and charges for analytical services, auditing services and significant business costs other than for scheme administration. An indicative cost estimate summary is also included.

Future oversight of the initiative is documented within the Plan. The requirements contained within the NIASA *Macadamia Nursery Stock Specifications* appendix are to be determined based on consultation between NGIA and AMS. For this purpose, decision making on technical content / production requirements is provided through NGIA and AMS as part of an Authorised Oversight Committee. Where specialist technical advice is required it has been determined that this should be provided through a supporting Technical Advisory Group. This Committee will provide the final 'sign-off' of the *Macadamia Nursery Stock Specifications* appendix in consideration of advice (where sought) from the Technical Advisory Group. If the Technical Advisory Group are deadlocked on an issue the committee has the final say.

The National Biosecurity Manager NGIA will then take the approved criteria to the NGIA National Governance Committee and seek ratification and inclusion into the NIASA Guidelines in accordance with its governance and administration procedures.

Stakeholder engagement, communications, extension resources, workshops and on-site visits

NIASA/*Macadamia Nursery Stock Specifications* extension material was developed as the project progressed and delivered through group activities (e.g. workshops) and on-farm through face to face engagement in both visual, written and oral formats and production nursery on-site visit and assessment to *Macadamia Nursery Stock Specifications* standard.

Communication to the wider macadamia nut growers and nursery industries has occurred through existing communication channels, electronic, hardcopy and on-farm with NGIA targeting nursery production and AMS addressing the macadamia nut growers. Full details are included within Appendix 4. Extension and Communication.

Project workshops delivered are listed below:

- Macadamia nursery production workshop presentation – 3 September 2018
- AUSMAC2018 Industry Conference - Nurseries: Management & Standards Forum - 15 November 2018.
- AUSMAC2018 Industry Conference - *Your Levy at Work Forum* - 15 November 2018.

- AMS Nursery workshop for growers (QLD) – 19 March 2019.
- AMS Nursery workshop for growers (NSW) – 20 March 2019.
- AMS Nursery workshop for nursery operators (NSW) – 21 & 22 March 2019.

General communications outputs were delivered as the project progressed and are listed below:

- AUSTRALIAN MACADAMIA SOCIETY LTD NEWS BULLETIN | SUMMER 2018 – November 2018.
- AUSTRALIAN MACADAMIA SOCIETY NEWS – Macadamia nursery workshop a success - 26 September 2018.
- NGIA NEWS & NATIONAL NURSERY NEWS– Macadamia high health nursery stock certification – 22 November 2018.
- MACADAMIA GROWER AND NURSERY PRODUCER COMMUNICATION MATERIALS AND FEEDBACK SURVEYS – Supporting March 2019 workshops.
- AUSTRALIAN MACADAMIA SOCIETY LTD NEWS BULLETIN | WINTER 2019 – 1 June 2019

Direct communication and extension with nursery producers by email and telephone was undertaken during April 2019. Approximately 40 macadamia production nurseries were identified and contacted during the week commencing 22 April 2019 in order to further promote the project and arrange draft NIASA manual distribution and seek interest in on-farm site visits/consultation. Feedback on the initiative was overwhelmingly positive during phone discussions.

Post communication by telephone, further correspondence was distributed by email including a project circular - *Nursery & Garden Industry Australia (NGIA) - NIASA Macadamia Nursery Stock Specifications for macadamia production nurseries*. Circular 19/04-01.

Under this project, **on-farm site visits** were included as a critical measure to assess, promote, educate and consult with private and commercial macadamia tree stock nursery producers on the nursery production standards developed. It was estimated that the target audience for on-farm site visits would be approximately 30 businesses, however approximately 40 businesses were identified. Of these, a total of 32 businesses sought to take advantage of the visits offered. Printed draft manuals will be provided during each visit.

Localities across Queensland and New South Wales to be visited include Alstonville, Bargara, Beerwah, Broadwater, Bucca, Bundaberg, Caboolture, Clunes, Dunoon, East Wardell, Elliot, Eureka, Goomborian, Mcleans Ridges, Moorlands, Oakenden, Pioneers Rest, Rosebank, Stuarts Point, Talegalla Weir, Tiaro, Wallaville, Welcome Creek, Wollongbar and Wolvi.

Initially, visits were to be conducted prior to 10 June 2019 however, as a result of significant delays in comprehensively identifying macadamia production nurseries and locked in non-project related commitments by the project extension officer, on-site extension and engagement visits will occur by in and around the following regions as follows:

- Sunshine Coast/Wolvi. 27 and 28 May 2019.
- Bundaberg. 10 to 14 June 2019.
- Northern NSW. 24 to 28 June.

As of the date of this report, 7 visits have been undertaken, with the remainder of visits to occur by 28 June 2019. Feedback has been generally positive with minor suggestions for improvement which will be addressed prior to the issue of the standards within the NIASA 8th Edition Guidelines later in 2019.

Outcomes

Minimising losses in nursery productivity through improved nursery stock quality, disease avoidance and crop management, and losses to field (orchard) productivity

In the establishment of the new macadamia nursery stock standards under this Hort Innovation project, and in consideration of discussion and recommendations made by the project TAG, growers and other stakeholders, macadamia production nurseries (both private and commercial) are now provided an opportunity to greatly benefit from modern best practice nursery production procedures. These procedures have been documented within a new *Macadamia Nursery Stock Specifications* appendix to NIASA and summarised in the production nursery checklist (see Appendix 2. NIASA Guidelines APPENDIX 15 - Macadamia Nursery Stock Specifications & Audit checklist).

The NIASA Best Practice Guidelines focus strongly on prevention and monitoring for problems - in addition to steps taken in disease avoidance. Addition of a user group specific macadamia appendix under this project now allows a macadamia production nursery to identify tree health and quality problems early to provide the best opportunity to correct those issues, minimise losses and increase productivity.

It is clear that improvement in commercial field production of macadamia nuts relies on improvement in the production of quality nursery stock source materials. Macadamia trees represent a long-term investment by producers. This project has highlighted the benefit of establishment of mutually beneficial arrangements between peak industry bodies who contribute to outcomes within the same horticultural production supply chain. Through collaboration with AMS as the customer representative, customer requirements and expectations are now clearly identified.

Improving productivity through a national partnership between AMS and NGIA and durable, transparent and mutually advantageous nursery accreditation policy and procedures

The documentation of a 'NIASA Macadamia Nursery Stock Specifications Accreditation Administration and Resourcing Plan' (see Appendix 3. NIASA Macadamia Nursery Stock Specifications Administration and Resourcing Plan) establishes the basis for an ongoing national partnership in ongoing development of the *Macadamia Nursery Stock Specifications* standard.

The Plan documents a clear delineation of roles and responsibilities under the shared arrangement with no duplication of resources necessary by using the NIASA framework. It establishes a mechanism for ongoing consultation and industry improvement in the long term.

A recognised continuous quality improvement process reactive to progressive and emergent industry needs and a recognized industry tree stock certification program

The Nursery Production Farm Management System, including NIASA, is a recognised quality improvement scheme that provides a set of guidelines that ensure an accredited plant production business can operate according to industry best management practice and commits to a continuous improvement cycle (Plan, Do, Check & Review).

As documented within the 'NIASA Macadamia Nursery Stock Specifications Accreditation Administration and Resourcing Plan', an Authorised Oversight Committee including both NGIA and AMS representatives has been established for the new scheme arrangements. Further, a 'Technical Advisory Group' was established to provide technical support to the Authorised Oversight Committee where requested. This arrangement allows ongoing and shared decision making to support and be reactive to emergent industry needs. Further, the NIASA Guidelines are updated at least annually, to allow for significant flexibility in the incorporation of new requirements.

Monitoring and evaluation

Monitoring and evaluation of the project was conducted in accordance with Hort Innovations agreed approach (specified in the executed Research Agreement), that is, through monitoring and evaluation of milestones detailing achievement criteria and deliverables.

On all occasions, milestone reports evidencing achievement criteria and deliverables were accepted without amendment. Table 1 - Milestone and deliverable criteria below details project milestones, deliverables and outcomes delivered during the project period.

Table 1 - Milestone and deliverable criteria

Milestone Number and Description	Due Date	Achievement Criteria	Outcome
101	10/06/18	**Agreement Signed. IP Arrangements in place.**	The project was established on 07/06/2018.
102 Phase 1. Draft Materials Developed	30/11/18	1. Establish a Technical Advisory Group (TAG) made up of key industry stakeholders, AMS and NGIA to provide content review and agreement on the macadamia nursery stock standards mated to the NIASA BMP Guidelines. 2. Review Australian and international best practice nursery production programs and tree stock standards. International and domestic literature review for information on macadamia nursery stock standards. Map international and domestic standards information against NIASA BMP Guidelines. Identify gaps in NIASA guidelines relevant to macadamia nursery stock. 3. Develop a macadamia tree stock standard, as an appendix to NIASA BMP Guidelines, with emphasis on trees and rootstocks that; validates 'Trueness to type' through genetic assessment; and requires geospatial mapping of motherstock locations to genetic trueness to type data; and applies methods for durable varietal and rootstock labelling; and have been grown and maintained in specified and controlled conditions with emphasis on nursery management, hygiene and high health practices; and meets industry expectations for appropriate plant physiology criteria (tree form). Draft NIASA macadamia nursery stock standard appendix in consultation with the Technical Advisory Group. 4. Technical Advisory Group review draft macadamia nursery stock standards. Investigate alignment to existing Nursery Production Farm Management	Report submitted 30/11/2018 and accepted without amendment. 1. A TAG was established for this project on 07/11/2018 to support the project and maximize industry engagement. 2. Review, mapping and gapping of existing literature/ resources against modern best practice standards facilitated production of draft materials. 3. A draft macadamia tree stock standard, as an appendix to NIASA BMP Guidelines, was delivered on 14/11/2018 and distributed to the TAG for review. 4. TAG convened on 23/11/2018 to discuss outcomes of review and discuss opportunities for improvement. Confirmation of durability of NIASA to include the standard as an appendix to NIASA and supported ongoing project outcomes. 5. Workshops were conducted between 03/11/2018 and

Milestone Number and Description	Due Date	Achievement Criteria	Outcome
		System (either added to existing guidelines or added into a specific (new) stand-alone Appendix) following industry consultation and acceptance of content with NGIA, SIAP and AMS. Two TAG meetings. 5. Three workshops and two communications outputs.	15/11/2018. Communications outputs appeared within the AMS Summer Bulletin, the AMS Society news, the National Nursery News and the NGIA News. Workshops and communications during this phase provided wider industry knowledge, acceptance and involvement in this initiative.
103 Phase 2. Final Materials Developed	01/05/19	1. Pending completion of Phase 1, revise and update Nursery Production FMS (NIASA BMP Guidelines), develop nursery and auditing protocols and procedures for validation by NGIA and ratification by Technical Advisory Group for the additional macadamia nursery stock standards. 2. Develop Governance & Administration guidelines that detail the process for macadamia production nurseries to attain NIASA Accreditation in consultation with AMS and the Technical Advisory Group. Determine the quantum and availability of resources required for macadamia-specific administrative, auditing, sampling and diagnostic work which may be additional to that required for current NIASA accreditation. Develop a framework and the potential membership of an expert panel able to inform deliberations on changes to processes (macadamia nursery stock standard) ranging from new technologies, reacting to emergent problems and processes of appeals and dispute resolution. 3. Develop and test electronic auditing templates and provide necessary updates to the auditing software. The electronic auditing platform currently used for all NIASA audits will require software upgrades to allow the system to recognise a business seeking an audit under NIASA plus Macadamia Nursery Stock Standard as well as develop the electronic compliance checklist, within the auditing platform, to allow auditors to use portable electronic hardware to capture audit data in the field.	Report submitted 01/05/2019 and accepted without amendment. 1. A complete Appendix to the NIASA Guidelines (with Audit Checklist) was developed – the *Macadamia Nursery Stock Specifications* and has been incorporated as Appendix 15 of Edition 8 of the NIASA Guidelines to be published this year (2019). 2. Governance and administration requirements have been documented in detail within a *NIASA Macadamia Nursery Stock Specifications Accreditation Administration and Resourcing Plan.* The Plan includes and details governance and administration policies, the quantum and availably of resource requirements for administrative arrangements, implementation, analytical testing and requirements made on accredited businesses. The Plan also includes requirements for an Authorised Oversight Committee and Technical Advisory Group to validate and ratify processes.

Milestone Number and Description	Due Date	Achievement Criteria	Outcome
		4. NIASA/Macadamia Nursery Stock Standard extension material will be developed as the project progresses and delivered through group activities (e.g. workshops) and on-farm through face to face engagement in both visual, written and oral formats and production nursery on-site visit and assessment to Macadamia Nursery Stock Standard. Communication to the wider macadamia nut growers and nursery industries will occur through existing communication channels, electronic, hardcopy and on-farm with NGIA targeting nursery production and AMS addressing the macadamia nut growers.	Establishment of an administration, governance and resourcing plan clarified and addressed scheme resourcing requirements. 3. An electronic audit checklist was developed (used electronically by the auditor on a tablet) and will support project auditing, data capture and reporting within the NGIA AMS. Additional functionality will ensure that modifying an Audit Checklist will not affect previous completed audits. 4. High level communication and engagement has occurred throughout the life of the project. Despite this being a relatively short-term project (extending only 12 months), numerous circulars, workshops, surveys and communications materials have been conducted and/ or distributed.
190 Final Report	10/06/19	**Final Report Received by Horticulture Innovation Australia and final Statement of Receipts and Expenditure received.** 1. A final report that includes word versions of the Macadamia Stock Standard including NIASA appendix, templates, and checklist. 2. Reporting on 30 on-site farm visits and outputs by NGIA and AMS on project findings through communications channels and extension.	1. Report and statement of expenditure submitted 10/06/19. 2. Almost all nursery stock producers identified under this project have been engaged directly by phone and email with on-farm site visits in progress and to be completed by 28 June 2019. Notably, project progress and outcomes have been reported to wider macadamia nut growers through AMS quarterly published Bulletins – the latest article to be published being present in the Winter 2019 Bulletin.

Recommendations

The following recommendations are made in relation to ongoing maintenance and continual improvement of project outcomes.

1. As is often the case with the delivery of any new system, testing of the system through implementation by production nurseries will provide opportunities for consideration of further improvement to the scheme after project completion. It is recommended that both AMS and NGIA maintain records of feedback provided by scheme users and customers for the project's Authorised Oversight Committee's ongoing consideration and decision.
2. It is recommended that NGIA continue to work with NIASA Accredited businesses, and encourage new business uptake after final project completion.
3. It is recommended that AMS consider the NIASA Macadamia Nursery Stock Specification Appendix as a platform to further improve outcomes for industry members through consideration of and inclusion of beneficial outcomes of relevant ongoing macadamia production nursery pest and disease research and development initiatives.

Intellectual property, commercialisation and confidentiality

Project IP arising from this project includes a macadamia nursery stock standard Appendix which will become a component of the Nursery Production FMS Program through the NIASA program which is offered the Australia nursery industry under a commercial auditing program. The Nursery Production FMS program, resources and supporting technologies and systems such as the National Audit Portal and Audit Management System (AMS) were provided to this project as background IP. NGIA has an agreed national market access (movement of nursery stock within and between jurisdictions) scheme in place through BioSecure HACCP with Governance and Administration documents and processes developed and operational. NGIA is the sole owner of the Nursery Production FMS programs and systems. The macadamia nursery stock standard Appendix will reside with NGIA as the sole owner of the IP. NGIA will provide Microsoft Word copies of all materials developed that support the macadamia nursery stock standard to Hort Innovation.

Acknowledgements

The new NIASA Macadamia Nursery Stock Specifications developed under this project were produced by Grant Telford (NGIA) and Dr Chris Searle (MacAvo Consulting) in consultation with John McDonald (NGIA), Leoni Kojetin (Australian Macadamia Society), Johan Jacobs (Grower and consultant), Kim Wilson (Consultant and SIAP member), Dr John Wilkie (Principal Horticulturist, Department of Agriculture and Fisheries) and Dr Anthony Kachenko (Hort Innovation).

Appendices

Appendix 1. Mapping and gapping of best practice literature against the NIASA Guidelines

<table>
<tr><th>NIASA GUIDELINE</th><th>RELATED SAMAC TECHNICAL CRITERIA</th><th>COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW</th></tr>
<tr><td>1 CROP HYGIENE</td><td>Related Chapter</td><td></td></tr>
<tr><td>1.1 The prevention of root diseases</td><td>Related section</td><td></td></tr>
<tr><td>1.1.1 Water
Reticulated (town) water and water from bores and clean roof catchments should not require disinfestation treatment.

However, if water from such sources is stored in a way that allows contamination, for example an unlined earth dam or uncovered tank, then it must be treated as for surface water supplies. Note: town water in some country areas is not treated by the supply authority and may require disinfestation.

Water sourced from non-contaminated sources or disinfested and stored for subsequent use must be stored in such a way as to prevent contamination by pathogens.

Table 2 - NIASA approved water disinfestation methods
<table>
<tr><td colspan="5">Chemical Disinfectants</td></tr>
<tr><td>Name</td><td>Residual level after contact time (ppm)</td><td>Contact time (minutes)</td><td>Effective water pH range</td><td>Comments</td></tr>
<tr><td>Chlorine</td><td>2.5</td><td>20</td><td>5.5 – 7.5</td><td>Decreased efficacy at higher pH</td></tr>
<tr><td>Chloro bromine</td><td>3</td><td>8</td><td>5.5 – 9.0</td><td>Increase contact time at higher pH</td></tr>
<tr><td>Chlorine dioxide</td><td>3</td><td>8</td><td>5.0 – 10.0</td><td>Increased efficacy with higher pH</td></tr>
<tr><td>Ozone</td><td>1.4</td><td>16</td><td>Nil</td><td>Requires complete mixing into water</td></tr>
<tr><td>Iodine</td><td>5</td><td>30</td><td>Nil</td><td>Increased efficacy at approx. 20°C</td></tr>
<tr><td colspan="5">Non Chemical Disinfestation</td></tr>
<tr><td colspan="2">Name</td><td colspan="3">Treatment regime</td></tr>
<tr><td colspan="2">Ultrafiltration</td><td colspan="3"><0.1µm</td></tr>
<tr><td colspan="2">UV irradiation</td><td colspan="3">>60% UV transmittance at 254µm</td></tr>
<tr><td colspan="2">Slow Flow Filtration (SFF) (**)</td><td colspan="3">≤100L/hr/m² flow rate</td></tr>
</table></td><td>SAMAC SECTION 7. Irrigation Water Code of Practice Protocol

The nursery water source should be tested to ensure that it is free of pathogens. This should be done once a year if borehole water (borehole deeper than 30m) is used, and every six months for any other source.
• Water analysis must be done by registered laboratories, and a copy of this certification will be required upon inspection.
• If river water is used, it must be free of impurities and treated to remove any fungi, bacteria, nematodes and other organisms.
• Filtration and subsequent sterilisation is crucial if a contaminated water source is used.
• Water can be sterilised by means of chlorination, flocculation, ozonation or ultraviolet irradiation.
• Hose nozzles should not touch the ground. NOT RELEVANT FOR THIS SECTION – addressed as hygiene.</td><td>Risk is addressed in NIASA.

NIASA makes provision for pathogen prevention through modern best practice management of water, and disinfestation of water, where appropriate.

Water is also addressed in NIASA Nursery Production Checklist and Growing Media Supplier Checklist (See APPENDIX 5 and 11):
• Section 1: Water and irrigation - (Source).
• Section 1: Water and irrigation - (Disinfestation).

a. Based on the recommendation, for a Macadamia "Tree stock specification" Appendix, the recommended approach could provide the following advice while highlighting key points:

Water
Water is managed in accordance with requirements provided in NIASA section 1.1.1 Water.

Key requirements for a Macadamia "Tree stock specification" appendix
• Water that is obtained from town suppliers, bores free of surface run-off or clean roof catchments does not require disinfestation.
• Other sources of irrigation water (creeks, dams, rivers etc.) must be disinfested using an approved NIASA disinfestation procedure.
• Subsequent storage of disinfested/clean water requires facilities and procedures to be established and implemented that do not allow for contamination by untreated water, soil, plant debris, dust and animal movement.
• The pH and EC (Electrical Conductivity) of all water sources must be checked and recorded at least once per month as even town water supplies can have variations in quality.
• Water from surface supplies, springs, effluents, or water testing positive for the presence of root-rot organisms must be disinfested using a NIASA approved method.</td></tr>
</table>

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
Adequate records of water disinfestation treatments must be maintained. The minimal requirement for testing and recording chlorination, chlorine dioxide or chloro-bromination treatments is once per month. These records must include; pH of water before treatment, free chlorine concentration at start of contact time, contact time, free chlorine concentration at end of contact time (residual). See APPENDIX 4 SAMPLE RECORDING SHEETS for a sample recording sheet. The Nursery Production FMS Auditor can require a greater degree of testing. The Nursery Production FMS Auditor will recommend recording requirements for other disinfestation treatments. The subsequent storage of treated water requires facilities and procedures that do not allow for contamination by untreated water, soil, plant debris, dust and animal movement.		• *Please also note APPENDIX 5 NIASA PRODUCTION NURSERY CHECKLIST SECTION 1: Water and irrigation.*
1.1.2 Growing media/propagating media **Disinfestation of growing media.** Growing media or growing media components, which present a risk of contamination (non- approved materials), must be treated by an approved method. More detailed information is provided in Appendix 3. Adequate records of all disinfestation treatments, including date, amount treated, method used and results must be kept. **NIASA growing media suppliers.** Growing media components other than those generally accepted as being pathogen-free (for example perlite and vermiculite), or consistently testing free of specified pathogens, or which are routinely disinfested by any of the approved methods already described (approved materials), must be from an approved source. An approved source is a NIASA accredited growing media supplier of pathogen-tested materials (Appendix 1). If not from an accredited source it must be pathogen tested. **Growing Media Quality.** Each batch of growing media to be tested for EC and pH using suitable equipment. Adequate records of all growing media must be maintained, including pH and EC (electrical conductivity). See Appendix A.4 for a sample recording sheet **Mixing of growing media.** Growing media mixing areas (if growing media is not to be subsequently treated or disinfested) must be situated on surfaces and in areas, which both shed and exclude runoff water and exclude contamination by tracked soil and other possibly contaminated materials. Mixing surfaces and equipment must be suited to easy cleaning.	**SAMAC SECTION 5 - Planting Media Code of Practice Protocol** Planting media may consist of • Steam sterilised river sand or other soil sources • Bark/compost • Vermiculite/Perlite • Any combination of the above. • All of the above-mentioned material must be obtained from a traceable source. • Analysis must either be supplied by the source or be done per incoming batch for disease presence • Planting media must have a pH (H_2O) of 5.5-6.5 (NIASA ref aus standard AS3743 5.3-6.5) • These tests should be performed monthly, and these results must be available during inspection • Drainage should be suitable for plant propagation.	**Risk is addressed in NIASA.** NIASA makes provision for pathogen prevention through modern best practice management of growing media including storage and disinfestation of growing media using a number of techniques and where appropriate. NIASA also provides comprehensive guidelines for growing media quality. **e. However**, in NIASA, growing media disinfestation is only directed at mixes which include [non-approved] materials that present a risk of contamination. Non-approved materials are addressed in NIASA Appendix 3. These requirements are also listed in NIASA Nursery Production Checklist (See APPENDIX 5): • Section 2: Growing media (Propagation growing media source), (Propagation growing media quality), (Propagation growing media mixing), (Propagation growing media storage and handling) • Section 2: Growing media (Production growing media source), (Production growing media quality), (Production growing media mixing), (Production growing media storage and handling). Further, these requirements are also listed in NIASA Growing Media Supplier Checklist (See APPENDIX 11):

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
Storage of growing media. Growing media needs to be stored in facilities that effectively prevent infestation or reinfestation by root rot organisms. As such, all growing media and growing media components which are already treated, or do not need treatment, are to be stored on surfaces and in areas which both shed and exclude runoff water and exclude contamination by soil and other possibly contaminated materials. Alternatively, growing media can be stored in clean bins, trailers and trolleys. Different types of growing media should be stored separately to avoid possible cross contamination. More specific information is provided in Appendix 3. All storage surfaces must be suited to easy cleaning between batches. Where the possibility of disease risk occurs, the site must be assayed for the presence of soil borne plant pathogens. Storage areas for approved and/or treated growing media must be effectively separated from areas used to store possibly contaminated growing media. **Transport of growing media.** Treated growing media and growing media determined as being free of specified pathogens must not be contaminated during handling and transport. Equipment used to transport growing media must be washed and disinfested between loads, if the vehicle is also exposed to unapproved growing media or growing media components. **Reuse of growing media.** Growing media may be reused, but only on the following conditions: b. Growing media to be reused must be disinfested in an approved manner (Appendix 3); c. Prior to disinfestation, growing media to be reused must be stored on a site well separated from storage sites of new or treated growing media ingredients; d. Treated recycled growing media will be pathogen-tested by the Nursery Production FMS Auditor on a six monthly basis.	• SAMAC officers will take biannual samples of planting media to be analysed for the presence of pathogenic *Phytophthora* and *Pythium* species. The results will be presented to the nurseries after analysis, and the presence of these pathogens would be dealt with in accordance with the identified pathogen code of practice protocol • Sterilisation of planting media is advisable **SAMAC SECTION 6 - PLANTING MEDIA DRAINAGE CODE OF PRACTICE PROTOCOL** • The planting media must be well drained, yet also have a good water holding capacity. REF NIASA **A.1.4 Quality control procedures** • The planting media must have high air-filled porosity. **YES** (NIASA ref aus standard AS3743 >=13)	• Section 3: Completed growing media (Finished product processes) - Disinfestation procedures, Records of disinfestation and testing e.g. composting, boiling, etc f. **Based on the recommendation, for a Macadamia "Tree stock specification" Appendix, the recommended approach could provide the following advice while highlighting key points:** ***Growing media/propagating media*** • *Growing media is managed in accordance with requirements provided in NIASA section 1.1.2 Growing media/propagating media'.* ***Key requirements for a* Macadamia "Tree stock specification" *appendix*** • *Growing media/propagating media that is sourced from a NIASA accredited growing media supplier does not require additional pathogen testing and treatment prior to use.* • *Growing media/propagating media that is sourced from a non-NIASA accredited growing media supplier requires treatment, or pathogen testing and where pathogens are detected – treatment, prior to use.* • *Growing media/propagating media prepared on-site which includes components that pose a risk of contamination, for example river sand, must be disinfested using an approved NIASA disinfestation procedure.* • *Each batch of growing media must be tested for EC (Electrical Conductivity) and pH using suitable equipment. Adequate records of all growing media must be maintained, including pH and EC.* • *Growing media/propagating media must be stored in a manner to prevent contamination prior to use.* • *Please also note APPENDIX 5 NIASA PRODUCTION NURSERY CHECKLIST SECTION 2: Growing media.*
1.1.3 Motherstock plants Motherstock plants must be monitored for pests, diseases and weeds and treated as appropriate with plant protection chemicals to decrease the possibility of pests, diseases and weeds entering propagation facilities. Drainage must be adequate to promote plant health and	**SAMAC SECTION 8 - Mother Material Code of Practice Protocol** **MOTHER BLOCK ORIGIN AND VERIFICATION**	**NIASA does not address specific best practice requirements for motherstock materials for macadamia.** g. **Must be addressed in the Macadamia "Tree stock standard" Appendix**.

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
prevent the contamination of propagules. A suitable system for identifying plants by variety needs to be in place. **Seeds** must either be collected from the plants or if collected from the ground, treated in a manner approved by the Nursery Production FMS Auditor. This could include the use of a suitable heat disinfestation procedure or chemical treatment, depending on the nature of the material. **Cuttings** must be obtained, where possible, from parts of the plant not contaminated by soil splash. Mulching is recommended to minimise contamination of the lower part of the plant with soil. Cuttings should be routinely disinfested. **Divisions** must come from motherstock free of pests, weeds and diseases. Where motherstock is in-ground, good drainage is essential.	• Mother block origin forms must be completed for each cultivar propagated by the nursery and available during SAMAC nursery inspections. **PLANT IMPROVEMENT SCHEME** • The function of a plant improvement scheme is to improve the productivity and quality of the macadamia industry by ensuring that the macadamia producers receive the best quality trees available. The program will deal with the selection, production and distribution of healthy, top quality trees. • Seed, cuttings and scions are only to be taken from the healthy trees. • Trees that do not perform according to the cultivar average for three years running are to be removed. **MOTHER BLOCK LABELLING** • The mother material from which the nursery gets its propagation material must be of a known origin. • Each mother block/ line (tree if mixed rows) must be clearly marked, indicating cultivar, date planted, and origin. • Each tree within the mother block must be supplied with an easily accessible, readable marking indicating line and tree number **SEED, CUTTING AND SCION VERIFICATION** • Propagation material used in the nursery must be traceable to the	h. **For a Macadamia "Tree stock standard" Appendix,** considering the options provided, the following advice could be included while highlighting/reinforcing key points – ***Key requirements – Source blocks*** • *The production nursery must make and maintain a record of source blocks (a source block record) from which parent material is collected for propagation of nursery trees.* • *Information must be recorded that identifies ownership, and geospatially identifies the location of the source block including an aerial/satellite image/map identifying the location of the source block or blocks on the source property.* • *Tree variety must be identified, and records held that confirm variety obtained from an independent and recognised source maintained.* • *Method used to identify individual trees within the source block for material collection purposes must also be documented within the record where all parent trees are not of the same variety.* • *Please also note the APPENDIX 15 MACADAMIA NURSERY STOCK SPECIFICATIONS CHECKLIST.* ***Key requirements – Propagation material collection records*** • *The production nursery must maintain a record of propagation material collected for propagation of nursery trees (a propagation material collection record).* • *The production nursery must maintain a record for the propagation material that identifies the name or code of the source block, the variety, the date of the collection, the name of the collector, the type of the material collected, the amount, and a unique batch code.* • *The production nursery must also identify the tree, or trees, the batch of material was collected from where all parent trees in the source block are not of the same variety.* • *Other comments may also be recorded.*

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	mother block and preferably a specific tree. • SAMAC Standardised Macadamia Cultivar Colour Codes must preferably be used in the nursery, but labelling with cultivar name/HAES number is also acceptable. • The horizontal colour should be indicated above the vertical colour. • On dispatch of trees, SAMAC Standardised Macadamia Cultivar Colour Codes must be used to identify trees. **MOTHER MATERIAL HEALTH** • SAMAC officials will investigate the mother material for visual health. • Other characteristics such as nut size and quality, branch angles, root development and disease and pest resistance can be recorded. **SAMAC SECTION 9 - Seed and Seedling Selection Code of Practice Protocol** • Seed must be selected from a mother block that is traceable. • Seed must be picked from trees to ensure true to type. • Seed is a potential source of *Phytophthora cinnamomi* • Seed should be treated with a sterilant - 10ppm free available chlorine (DPD-1) for 10 minutes will be sufficient • Seeds should first be planted in a bed, and may not be planted directly into bags. Seedling roots are to be pruned	***Key requirements – Parent tree variety identification*** • *Variety of parent trees may be confirmed through records provided by an independent and recognised source, including genetic testing results.* • *Where a variety may be clearly identified by one or more morphological traits, the variety is identified by a person experienced in variety identification through observation and recording of those morphological traits.* • *Please also note the APPENDIX 15 MACADAMIA NURSERY STOCK SPECIFICATIONS CHECKLIST.* ***Key requirements – Seed nut.*** • *Seed nut is collected from an identified source block.* • *Mature seed nut is collected from healthy parent trees of known variety while still attached to the tree, or may be collected off the ground if freshly fallen and all trees within the source block are of the same variety.* • *A propagation material collection record is completed after collection, and seed nut are assigned a unique batch code.* • *After de-husking, seed nut is washed to remove soil and other surface contaminants.* • *Seed nut is stored in appropriate conditions and appropriately labelled.* • *When soaking seed nut to break dormancy, all seed nut that does not sink is rejected for use.* • *Please also note the APPENDIX 15 MACADAMIA NURSERY STOCK SPECIFICATIONS CHECKLIST.* ***Key requirements – Budwood*** • *Prior to collection of budwood from an identified source block, material for collection from healthy trees of known variety is identified and prepared to allow carbohydrate build up in the material to assist in graft take.* • *A propagation material collection record is completed after collection and budwood is assigned a unique batch code.* • *Budwood is stored in appropriate conditions and appropriately labelled.* • *Please also note the APPENDIX 15 MACADAMIA NURSERY STOCK SPECIFICATIONS CHECKLIST.*

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	before replant. This is to prevent benchroots being formed. • Seedlings must have well developed root systems as well as healthy foliage. • Seedlings that do not comply must be removed from the batch during the transplantation process. • The selection process should continue after transplantation to ensure weak/ diseased/ substandard trees do not enter the grafting process.	***Key requirements – Sowing seed nut*** • *Seed nuts must be sown in a quality free draining propagating media of sufficient depth to allow unimpeded development of the seedling's root system.* • *Sown seed/seedling batches must be clearly labelled to identify variety and allow tracing back to the propagation material collection record.* • *Poor performing seedlings must be removed and disposed of.* ***Key requirements – Transplanting seedlings*** • *When seedlings are removed for transplanting into larger containers, only seedlings with a well-developed root system are selected.* • *Roots must be trimmed and only replanted into containers of sufficient size and depth to allow appropriate root system development.* • *Seedlings must be planted at the centre of the container and care must be taken to not bend the tap root.* • *Seedlings should be provided with adequate wind/sun protection.* • *Seedlings must be clearly labelled to identify variety and allow tracing back to the propagation material collection record.*
1.1.4 Working surfaces	N/A	Contributes to risk mitigation for introduction and spread of pathogens and other contaminants from working surfaces. **i. See Comment for 1.1.5 Tools.**
1.1.5 Tools All tools need to be treated between batches of growing media or after use, by first cleaning off surface residue and then scrubbing or pressure cleaning using an acceptable disinfectant.	**SAMAC SECTION 15 - General Nursery Code of Practices Protocol** Site cleanliness Nursery Sites should be kept free of weeds Plant material and inorganic litter should be removed Equipment and tools • Tools should be kept in nursery confinement	**Decontamination and hygiene to be grouped into one section.** j. **For a Macadamia "Tree stock standard" Appendix,** considering the options provided, the following advice could be included while highlighting/reinforcing key points – ***Hand hygiene*** • *High hygiene levels must be maintained in risk areas such as propagation, potting or staging operations.* ***Footwear***

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
	• Sterilization should be done daily	• *Footwear disinfestation and hygiene is undertaken in accordance with the requirements provided in NIASA Section 1.1.6 Footwear.* ***Tools, knives and other instruments*** • *Tool disinfestation and hygiene is undertaken in accordance with the requirements provided in NIASA Section 1.1.5 Tools.* ***Equipment*** • *All equipment, including trolleys, barrows and trays that come into contact with vegetative propagation material or inputs such as growing media, should be routinely cleaned with a brush or pressure washer then treated with a suitable disinfectant or detergent.* ***Plant Containers (pots, bags and trays)*** • *Containers are managed in accordance with the requirements provided in NIASA Section 1.1.15 Containers.* ***Working surfaces*** • *Working surface disinfestation and hygiene is undertaken in accordance with the requirements provided in NIASA Section 1.1.4 Working surfaces.* ***Key requirements – Disinfestation and hygiene*** • *High hygiene levels must be maintained in risk areas such as propagation, potting or staging operations.* • *Production/staging areas should be protected from contamination by ensuring staff entering an area have clean hands and footwear is clean and decontaminated where required.* • *Tools, knives, other instruments, equipment and working surfaces must be cleaned and disinfected regularly.* • *New clean containers need not be disinfected however used containers must be disinfested using heat, or reasonably cleaned of waste material and then disinfested with a fresh 4000 ppm (or 0.4%) hypochlorite solution for at least 20 minutes.*

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
		• *Clean and disinfected containers must be stored above floor level to prevent soil, plant debris and drainage water contamination.* • *Please also note APPENDIX 5 NIASA PRODUCTION NURSERY CHECKLIST SECTION 3: Propagation.*
1.1.6 Footwear Where contamination of footwear may have occurred; either they should be cleaned and disinfested, or changed at different workstations. Methods of disinfestation should be in compliance with health regulations in each state. Regularly replenished and cleaned footbaths may be essential in some situations (for instance at entries to in-ground sites).		**Risk is addressed in NIASA but could be strengthened in NIASA Appendix.** Requirements are also included in the NIASA Nursery Production Checklist (See APPENDIX 5): • Section 3: Propagation (Plant propagation area), (Acclimatisation Facilities – Hardening off) – Footbaths. • Section 3: Propagation (Plant propagation area) – Footbaths. k. **See comment above in 1.1.5 Tools.**
1.1.7 Vehicles	N/A	N/A
1.1.8 Access Pests and diseases can be easily spread on hands, clothing, footwear and equipment. Access to in-ground stock areas and propagation facilities must be restricted to all but essential traffic. Propagation areas must not be thoroughfares for staff or materials involved in materials and plant handling operations unrelated to propagation. Propagation propagules areas should also be separated from sources of contamination.	**SAMAC SECTION 3 - Site Code of Practice Protocol** SITE SELECTION • Select a site where rain and irrigation water will drain out of and away from the nursery • Dust should be minimised around the nursery perimeter. NURSERY PERIMETER • The nursery perimeter should be fenced to prevent human and animal traffic • The growth medium storage area and fumigation area should be fenced off separately from the planting area. • Water run-off from outside the nursery perimeters should be channelled away from and out of the nursery. NURSERY LAY-OUT • The nursery should preferably be divided into "red" and "green" zones. In the red zone, growth medium is	**Risk is addressed in NIASA. No additional content required.** Access to propagation areas limited to essential traffic. **l. See comment above in 1.1.5 Tools.** Also addressed in the NIASA Nursery Production Checklist (See APPENDIX 5): • Section 3: Propagation (Propagules Preparation area), (Plant Propagation area), (Acclimatisation Facilities) – Access restrictions. • Section 9: Plant imports – Receiving area/quarantine facility for inspection purposes clearly identified.

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	prepared and disinfected with using steam or a fumigant. Plant bags or pots are filled in this area, and these are transferred to the green area. The direction of "traffic" flow is always from the red area to the green area and not vice versa. The green area is where the plants are grown. Workers and tools are not allowed to move between the zones. This is essential to prevent spread of diseases. • The area designated for medium preparation should have a concrete floor and storage bins for growth media. • Dust from access roads to the nursery should be minimised. • Pathways must be sloped slightly to facilitate drainage and must be constructed so that there is no standing water • Site should be designed so that water flows out of the beds and drains onto pathways and away from the nursery • No standing water allowed. **ADMISSION TO THE NURSERY** • Gates to the nursery perimeter should be kept to the minimum. • Each gate requires a copper footbath with a roof over the footbath area • Footbaths should always contain sufficient copper. • Copper sulphate is preferable but copper oxychloride may also be used. • Limit admittance and movement of people within the nursery.	

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	• Trolleys and wheelbarrows that are used in the planting area should remain there and only be used there. • Facilities with soap/disinfectant and disposable towels should be provided at a convenient location where workers and personnel can wash their hands. • Workers should be provided with shoes that may only be worn in the nursery. • Under-roof copper footbaths should also be erected between the different zones of the nursery. • Tools used in the nursery must be retained in the areas in which they will be used, e.g. the fumigation or planting areas – no movement of tools permitted • Unaccompanied visitors should not be allowed in the nursery	
1.1.9 Removal of plant and growing media wastes Discarded plants and spilt growing media are to be accumulated in specially allocated containers and removed on a frequent basis. Plants with difficult to control pests (e.g. Western Flower Thrips and Silver Leaf Whitefly) and diseases (especially viruses) should be removed promptly from the production area. Delays cause an accelerated spread of pests and disease.	**SAMAC SECTION 15 - General Nursery Code of Practices Protocol** Site cleanliness Nursery Sites should be kept free of weeds • Plant material and inorganic litter should be removed Equipment and tools Tools should be kept in nursery confinement Sterilization should be done daily	**Risk is addressed in NIASA. No additional content required.** Waste material management is addressed in the NIASA Nursery Production Checklist (See APPENDIX 5): • Section 2: Growing Media (Plant growing media mixing) – Disposal of used or contaminated growing media in an appropriate manner. • Section 3: Propagation (Plant propagation area) – Refuse disposed of in an appropriate manner. • Section 10: Plant growing and storage containers – Waste materials disposed on in an appropriate manner.
1.1.10 Floors and pathways **Propagating facilities.** Although sealed surfaces are preferable, gravel is permitted on paths and under benches where the ground is well drained and the coarse gravel aggregate is 10–25mm in diameter and at least 75mm deep. However, disease organisms such as Botrytis spp. can become a problem in older facilities where gravel is used. Floors should be washed and treated or drenched with disinfectant solutions on a frequent basis. Plant debris must not be placed on the floor. Dead and diseased plants and propagules should be placed directly into	**SAMAC SECTION 3 - Site Code of Practice Protocol** **NURSERY LAY-OUT** • Dust from access roads to the nursery should be minimised. • Pathways must be sloped slightly to facilitate drainage and must be	**Risk is addressed in NIASA in this and other sections. No additional content required.**

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specially allocated containers (refer Section 1.1.9). Footbaths can greatly reduce the risk of disease entry into these areas. **Production facilities.** Pathways adjacent to containerised plant production facilities should be sealed using bitumen or concrete or by the use of coarse gravel (10–25mm diameter) on a consolidated graded surface at a depth of at least 75mm. Pooling is unacceptable on pathways, roadways and surfaces used for plant production. Roadways adjacent to production facilities must be properly drained and consolidated, and preferably sealed. Dust from roads should not enter production or propagating areas.	constructed so that there is no standing water • Site should be designed so that water flows out of the beds and drains onto pathways and away from the nursery • No standing water allowed.	
1.1.11 Quarantine areas Plants or propagules entering the nursery should be from NIASA Accredited suppliers. Those from non- NIASA sources need to be placed in a specially designated quarantine area and carefully monitored for pests and diseases. The intent is to prevent the movement of pests and diseases into production areas. An appropriate pesticide application regime should also be maintained.	N/A	**Risk is addressed in NIASA. No additional content required.** NIASA provides for risk mitigation steps to be taken for plants generally, and plants from non-NIASA accredited businesses specifically. Also Listed in NIASA Nursery Production Checklist (See APPENDIX 5): • Section 9: Plant imports.
1.1.12 Potting facilities Containers, plants to be potted/staged, the growing media and the newly potted plants must not come into contact with possibly contaminated materials or surfaces during potting operations. Spilt growing media should be cleaned up and discarded regularly.	N/A	Contributes to risk mitigation for spread of pathogens and other contaminants.
1.1.13 Plant handling Plants and/or their containers must not come into contact with possibly contaminated surfaces, plants or materials, during handling operations on the production nursery.	N/A	Contributes to risk mitigation for spread of pathogens and other contaminants.
1.1.14 Washing facilities The importance of removing disease inoculum from hands, clothes and feet is under rated. *Pythium spp., Fusarium spp., Rhizoctonia spp., Chalara spp., Phytophthora spp*. and *Cylindrocladium spp*. can all be transmitted to benched plants by the use of soiled hands. Good access to hand washing facilities and their routine use is essential in a disease prevention programme. While a hand washing biocide (recommended by State Health Departments) may be necessary in some situations, soap and water used with a brush is usually suitable.	N/A	Contributes to risk mitigation for spread of pathogens and other contaminants.
1.1.15 Containers	**SAMAC SECTION 10 - Nursery Bags Code of Practice Protocol**	**Container depth not specified within NIASA.**

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
New containers need not be disinfected if stored free of soil, plant debris and drainage water contamination. Clean and disinfected disinfested containers must be stored above floor level. Used containers must be reasonably cleaned of waste material and then dipped in fresh 4000 ppm (or 0.4%) hypochlorite solution for at least 20 minutes, longer contact periods are necessary for some diseases. Alternatively, they can be treated with aerated steam or other methods approved by the Nursery Production FMS Auditor (see Appendix 3). Records of the disinfestation of containers must be kept. Disinfectant chemicals are dangerous and the nursery must be equipped to use and dispose of the spent solutions safely. They must be handled and stored as per government regulations regarding hazardous chemicals.	• Bags may not be used more than once, unless sterilised • The growth medium height should be 250 mm minimum, and trees should be planted into a bag with a 4litre minimum capacity for rooted cuttings or 5litre minimum capacity for seedlings. Relevant research is currently undertaken to determine the justification hereof. • On dispatch, nursery bags must be neat and in an acceptable condition.	m. <u>It is recommended that</u> NIASA procedures for containers are adopted for Macadamia Nursery Stock Specifications – in appropriate sections advice provided as follows. • *Containers must provide for adequate drainage and the size of the container used must consider the vigour of the plant and the time that the plant will be occupying the container in order to minimise the risk of development of root disease and allow appropriate root development and prevent excessive root binding (see NIASA section 2.6 Root binding).*
1.1.16 Beds and benching **Coarse gravel or crushed rock** covered surfaces have been shown, by broad scale nursery testing, to be effective in disease prevention where the surfaces are consolidated, well drained and the gravel aggregate, screenings of 10mm to 25mm diameter, is a minimum of 75mm deep and preferably deeper. Weed mat over gravel aggregate may be useful in keeping the material free of crop debris and growing media spill, and reducing root escape. **Concrete, polythene or bitumen** is permitted where; they are covering properly consolidated surfaces, exceptionally good drainage occurs, and all other hygiene practices are excellent. Beds with these surfaces must not pool water and must be separated as much as possible from adjacent production sites in terms of water runoff. **Benches.** Where benches are used, the height requirement is dependent on the type of surface underneath. Benches spanning or adjacent to either properly sealed or aggregate surfaced floors and paths and grown in polyhouses/glasshouses with low Mean Application Rates (MAR), <u>need not be higher than 30cm</u>. However, <u>where splash and other methods of contamination are likely to occur, a suitable bench height is 75cm or higher</u>. The bench surface should preferably be free draining (for example galvanised mesh) and easily disinfested. Hanging baskets and double benches are allowed in growing areas providing all other hygiene practices adhere to the Guidelines.	**SAMAC SECTION 4 - Raised Platform Code of Practice Protocol** • The minimum requirement set out by SAMAC is that plants must stand on a raised platform at least 30cm thick consisting of an inert material with no water holding capacity. • SAMAC however advise that nursery platforms should be raised higher than 30cm (above the splash-line of rain and irrigation water), as higher beds are less conductive for soil borne diseases to occur in nursery plants • If crushed stone is used (in the absence of cement), it should be kept clean and contain no plant material or growing media	**Complies however SAMAC allows only for benching. NIASA allows for a range of options.** NIASA makes provision for pathogen prevention by allowing a number of options to prevent contamination by soil including use of coarse gravel or crushed rock sealed surfaces and benching. n. <u>It is recommended</u> that additional options for beds and benching provided for in NIASA are adopted for macadamia production (NIASA risk mitigation procedures include a suite of up to date best practice hygiene options that control the risk of soil borne pathogens contaminating propagated plants. Supporting these options are requirements for control of run-off through propagation and hardening off areas). Also Listed in NIASA Nursery Production Checklist (See APPENDIX 5): • Section 3: Propagation (Plant propagation area) – Bench type & Bench height. • Section 3: Propagation (Acclimatisation facilities- hardening off) – Bench type & Bench height. • Section 4: Protected production areas & Section 5: Exposed production areas – Bench height. o. **For a Macadamia "Tree stock standard" Appendix,** considering the options provided, the following advice could be included while highlighting/reinforcing key points –

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
		Key requirements – Beds and benching • *Ground level propagating beds. Beds must be totally isolated from soil (e.g. with the use of black plastic) and must be free draining.* • *Production beds for containerised stock. The surface of the bed and the pathways adjacent to it must prevent contact of the plant, the plant roots or the container, with soil or water contaminated by soil (or growing media) or water draining from other containers or from any other possibly contaminated sources (e.g. road base). Pooling of water is not permitted.* • *Coarse gravel or crushed rock covered surfaces must be well drained and the gravel aggregate (screenings of 10mm to 25mm diameter) must be a minimum of 75mm deep and preferably deeper.* • *Concrete, polythene or bitumen is permitted where they are covering properly consolidated surfaces and exceptionally good drainage occurs, and all other hygiene practices are satisfactory. Beds with these surfaces must not pool water and must be separated as much as possible from adjacent production sites in terms of water runoff.* • *Benches spanning or adjacent to either properly sealed or aggregate surfaced floors and paths need not be higher than 30cm. However, where splash and other methods of contamination are likely to occur, a suitable bench height is 75cm or higher.* • *Please also note APPENDIX 5 NIASA PRODUCTION NURSERY CHECKLIST SECTION 3: Propagation.*
1.1.17 In-ground production	N/A	
1.2 Disease Pest and Weed Control	**Partially related section.**	Contributes to quality of plants produced.
1.2.1 Weed control Growing media. Growing media and growing media components supplied to the nursery must be free of weeds and weed propagules. Growing media storage and mixing areas must be free of weeds and weed propagules. Propagation areas and production areas must be free of weeds. Weeds must be suppressed on the general nursery site, even when outside of the immediate production area.	**SAMAC SECTION 15 - General Nursery Code of Practices Protocol** Site cleanliness • Nursery Sites should be kept free of weeds Plant material and inorganic litter should be removed Equipment and tools	**Risk is addressed in NIASA. No additional content required.**

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
	Tools should be kept in nursery confinement Sterilization should be done daily	
1.2.2 Insects and other pests, Integrated Pest Management (IPM)	N/A	Contributes to quality of plants produced.
1.2.3 The prevention and control of pathogens, other than those causing root and crown rots Pathogens should be prevented from entering the site where possible and if not, managed to levels that allow the sale of a high-quality product. Pathogen tested mother stock should be used wherever possible. Freedom from and testing for quarantinable pests and diseases may be mandatory in the future.	N/A	Does not contribute in a specific way over and above that provided elsewhere.
1.2.4 Crop protection programs in general	N/A	Contributes to quality of plants produced.
2 CROP MANAGEMENT PRACTICES	**Partially related Chapter.**	Contributes to quality of plants produced.
2.1 Water, irrigation and humidity	N/A	Contributes to quality of plants produced.
2.2 Wind control The physiological and physical damage sustained by plants should be, where necessary, minimised by the use of suitably constructed windbreaks. Windbreaks and other methods of dust control must be employed where applicable.	N/A	**Complies.**
2.3 Light	N/A	Contributes to quality of plants produced.
2.4 Temperature	N/A	Contributes to quality of plants produced.
2.5 Plant nutrition and fertilising	N/A	Contributes to quality of plants produced.
2.6 Structures and production areas	N/A	Contributes to quality of plants produced.
2.7 Root binding	N/A	Contributes to quality of plants produced.
3 GENERAL SITE MANAGEMENT	**Partially related Chapter.**	**Contributes to production nursery standing.**
3.1 Professional image and appearance	N/A	Contributes to production nursery standing.
3.2 Staff facilities and safety measures	N/A	Contributes to production nursery standing.
3.3 Training and continuous improvement	N/A	Contributes to production nursery standing.
3.4 Environmental performance	N/A	Contributes to production nursery standing.
3.5 Product quality and meeting customer expectations Product quality is a contentious issue as there are few objective quality measures for nursery products and quality can be interpreted in a large variety of ways. However, one of the aims of NIASA is to "improve customer confidence at all levels of the distribution chain", which includes buyers of finished product. For growing media producers, the buyers are primarily production or wholesale nurseries and there are some measurable quality parameters, e.g. pH and EC.	**SAMAC SECTION 13 - Plant Quality Code of Practice Protocol** • A minimum of 85% must be obtained for this section to qualify for nursery accreditation	**p. NIASA does not address specific best practice requirements for plant quality for macadamia.** q. **Must be addressed in the Macadamia "Tree stock standard" Appendix**. ***For a Macadamia "Tree stock standard" Appendix,*** *considering the options provided, the following advice could be included to address plant quality and dispatch –*

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
NIASA accredited production nurseries on the other hand sell to a wide range of buyers operating many and varied businesses. Large forestry operations buy millions of just one type of tree from specialist nurseries by contract and orchardists buy thousands of fruit trees from other specialists also by contract. Chain store and retail buying groups buy hundreds if not thousands of different plant lines every week of the year, mostly under arranged terms of supply. A lot of other stock is sold from 'spec vans' to small independent buyers with their own ideas of quality and value for money. In the checklist businesses are asked for 'product specifications' or 'market specifications', which are stated quality expectations, e.g. not more than 150mm high. For businesses supplying to a written contract these specifications should form part of the contract and the Nursery Production FMS Auditor can then check the systems you have in place to meet those specifications. For much of the industry it's nowhere near that simple. The key element is that a consistent product is supplied which meets the customer's expectations. The Nursery Production FMS Auditor can do a quick visual assessment of your products consistency but the aim should be for you to evaluate customer satisfaction. Formal and informal feedback on the quality of finished product supplied by NIASA accredited businesses can be considered by accreditation committees when those businesses come up for re-accreditation.	• Leaves must be dark green, well formed, with no deficiencies or chlorosis • There must be a minimum of 2 hardened flushes before sale • There must be no insect damage on the new flush • No visible pests in the nursery • No damage to stems • Plants must have a straight stem with no kinks • Trees must be trained to a central leader up to 500mm • Plants must have a well-developed root system • Taproots must not be bent - i.e. must not have a gooseneck/ benchroot • Roots must not be pot bound • Graft union must be strong, healthy and not higher than 40cm. IT is advised that a whip graft be used. • No callus tissue should be visible at graft union • Unless otherwise requested by buyer, trees must be taller than 90cm in height from the top of the planting medium (With the exception of Beaumont cuttings - 70cm) • The batches must be kept uniform • Grafting tape must be removed before sale/ dispatch • Cuttings should not be in the nursery for more than 18 months • Seedlings should not be longer than 24 months in the nursery	*Requirements for meeting customer expectations are managed in accordance with requirements provided in NIASA Section 3.5 Product quality and meeting customer expectations.* *Trees must meet the following quality requirements, prior to consignment, to meet Macadamia Nursery Stock Specifications:* • *Trees are labelled in accordance with this Appendix.* • *Trees are true-to-type without any obvious sign of pest, disease, mechanical, nutritional or chemical disorder.* • *Leaves are glossy, dark green, and without any sign of deformity or malnutrition.* • *Trees have a strong central leader.* • *Stems are straight (<15 degrees vertical deviation) without significant bends or kinks.* • *Internodes are greater than 40mm in length.* • *Graft unions are smooth and healthy without any indication of incompatibility.* • *Trees are free of shoots and suckers below the graft.* • *Trees are uniform and of the size specified by the customer for field planting, and carry a minimum of two hardened flushes.* • *Trees are planted into containers that are of adequate volume and depth to provide sufficient space to accommodate a healthy and vigorous root system.* • *Trees are self-supporting.* • *Containers are free of weeds.* • *Trees should be continually monitored throughout the production process, however trees must be inspected towards the end of the propagation process and no later than 72 hours prior to despatch and comply with the quality specifications.* • *In accordance with requirements provided in NIASA Section A.12.2 Dispatch, a visual assessment of trees must be conducted prior to loading and consignment.* • *Trees that do not meet these requirements must be rejected for consignment, and action must be taken to determine the source of the problem and correct the problem.*

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
	SAMAC SECTION 17 - Tree Dispatch Code of Practice Protocol • A separate record book, recording the details of each delivery of nursery trees from each nursery (in the case of satellite nurseries) must be kept. • The following details must be recorded: • Trees must meet the standards set out in the SAMAC plant quality Code of Practice protocol; • Be of an even height; • Be dark green in colour; • Be photo recorded; • Be linked to an invoice or reference number • A dispatch sheet (supplied by SAMAC) must be signed by the grower receiving the trees.	
4 WATER MANAGEMENT	Unrelated Chapter.	Contributes to production efficiency.
4.1 Efficient irrigation	N/A	Contributes to production efficiency.
4.1.1 Top irrigation	N/A	Contributes to production efficiency.
4.1.2 Bottom irrigation	N/A	Contributes to production efficiency.
4.1.3 Irrigation controllers	N/A	Contributes to production efficiency.
4.1.4 Irrigation scheduling	N/A	Contributes to production efficiency.
4.1.5 System Design and Operation	N/A	Contributes to production efficiency.
4.1.6 Misting Systems	N/A	Contributes to production efficiency.
4.1.7 Filtration Systems	N/A	Contributes to production efficiency.
4.1.8 Pumps and other irrigation equipment	N/A	Contributes to production efficiency.
4.1.9 Fertigation	N/A	Contributes to production efficiency.
4.2 Wastewater reuse	N/A	Contributes to production efficiency.
4.3 Sediments and litter	N/A	Contributes to site management.
4.4 Nutrients in wastewater	N/A	Contributes to site management.
4.5 Contamination of wastewater with plant protection products	N/A	Contributes to site management.
4.5.1 Reducing levels of plant protection products in wastewater	N/A	Contributes to site management.
4.5.2 Application equipment and chemical handling and storage	N/A	Contributes to site safety and production efficiency.

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
REQUIREMENTS NOT ADDRESSED DIRECTLY IN THE NIASA GUIDELINES – GAPS – OR ADDITIONAL CONTENT		
Administrative matters are addressed within the NIASA Terms & Conditions, and the NIASA Application for Accreditation form.	**SECTION 1 - Basic Qualifying Criteria Code of Practice Protocol** es must comply with the following basic criteria to qualify as a registered nursery: SAAFQIS • Must be registered • Certificate must be up to date SAMAC • Must be associated with a SAMAC member farm or join SAMAC as a non-grower member and pay audit fees as determined by the SAMAC board • Nursery must be open for inspection by SAMAC officer at all times • A overall minimum of 65% must be obtained by a nursery to obtain Nursery accreditation • A minimum of 85% must be obtained for the plant quality section in the star rating • Sales volume must be supplied to SAMAC twice a year (Jan – Jun, Jul - Dec) Must comply with the following Code of Practice Protocols: • Raised platform Code of Practice Protocol • Planting medium Code of Practice Protocol • Irrigation water Code of Practice Protocol • Mother material Code of Practice Protocol	**NOTES** Audits conducted annually. Some requirements of NIASA (including all requirements in the Macadamia appendix must be assessed as satisfactory at audit). NIASA does not use a scoring system. All records required under the Guideline must be made available on request. NIASA does not require records of sales volumes.

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
	• Display of regulations Code of Practice Protocol • Root system development Code of Practice Protocol If satellite nurseries are established, a separate audit should be carried out with only the relevant protocols applying to the satellite nursery and all other protocols applying to the mother nursery **SAMAC SECTION 2 - Nursery Accreditation Code of Practice Protocol** • SAMAC will be responsible for biannual audits of all registered nurseries. • Random inspection visits may be also be conducted during the year • Nursery accreditation will be awarded according to the Nursery Accreditation System. • The list of accredited nurseries will be updated annually and any changes will be published in relevant media. • Nurseries will obtain accreditation if an overall of at least 80% is obtained for the audit, as well as a minimum of 85% for the plant quality section. • A certificate will be issued after each audit and the updated version must be on display • Individual nurseries may use the SAMAC accreditation for marketing purposes • SAMAC will publish a list of accredited nurseries “In a Nutshell” and other relevant media • The accreditation system consists of the following sections:	

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
	Site Planting Media Water Source Mother Material Planting Area/ Techniques General Nursery Practices Plant Quality Administration **SAMAC SECTION 12 - Display and Administration Code of Practice Protocol** The following certificates and documentation should be up to date, on display and visible at all times • SAMAC nursery accreditation system certificate • SAAFQIS certificate • SAMAC colour code The following documentation should be available on request • SAMAC Nursery Protocol • Water analysis • Media analysis • Media pH analysis • Mother Material Origin form • Sales volumes • Records of planting and grafting dates, as well as dispatch information, including buyer details. These records should be available upon inspection Sales volumes must be supplied to SAMAC prior to inspection the in January and July of each year.	
	SAMAS SECTION 16 - Payment of Plant Breeders Rights Royalty Fees Code of Practice Protocol • All SAMAC registered nurseries will pay plant breeders' rights royalty fees in	**NOTES-** NGIA does not administer or audit compliance to Plant Breeders Rights obligations.

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
	accordance with international plant breeders' rights law. • For the A-series cultivars, nurseries will work through and with the company Citrogold. Citrogold manages the distribution of labels and the collection of royalties for and on behalf of the Bell Cultivar Development Group worldwide. • All SAMAC nurseries propagating plant breeders rights registered cultivars, are required to keep correct and accurate records of the propagation, sales, distribution and own use of all such plants, cuttings and graftwood used to multiply such cultivars. The records must show: • The number of cuttings taken in an attempt to root them; • The number of trees planted into nursery pots; • The number of trees that reached a saleable size; • The number of trees sold; • The number of trees successfully grafted and sold; • To whom any trees were sold, recording the date of sale; • Compliance with the SAMAC Nursery Tree Dispatch Code of Practice Protocol.	
Plant health / Inspection and Monitoring Not sufficiently addressed in NIASA.	**SAMAC SECTION 14 - Identified Pathogen Code of Practice Protocol** • This protocol must be followed after positive identification of macadamia pathogens, with specific relevance to Phytophthora and Pythium species	**r. Monitoring for plant health and quality on above ground and below ground plants parts is a key priority in identifying significant problems early. Inspection and monitoring for biosecurity risks is specified in detail within BioSecure HACCP, an additional certification program that may be adopted by businesses.**

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
	• Nursery manager/owner in conjunction with SAMAC representative must take the following steps: • Identify possible source • If possible to isolate infected batches, these batches should be removed from the nursery area and marked clearly for treatment • Initiate a integrated control treatment program to eliminate the infection from the source to the infected plant • Do random isolations of healthy trees to determine whether contamination did not take place • Monthly testing must continue for three months where after the nursery will be visited by a SAMAC representative who will take samples for evaluation • If positive isolations are made, steps will be followed by SAMAC to remove the nursery from the registered and published nursery list until such time that the problem has been resolved	s. **Must be addressed in the Macadamia "Tree stock standard" Appendix**. t. **For a Macadamia "Tree stock standard" Appendix,** considering the options provided, the following advice could be included while highlighting/reinforcing key points – ***Key requirements – Inspection and monitoring.*** • *Propagated trees must be regularly inspected for the presence of stem, graft, foliar pests and diseases and root health and quality.* • *Above ground plant parts must be inspected at least quarterly. At least 35 trees within each batch within each production area must be closely examined for pests, diseases and disorders.* • *Below ground plant parts must be examined for root quality and disease symptoms at least quarterly commencing 6 months after individual tree establishment and up to three months before anticipated despatch date.* • *Below ground plant parts are examined on sentinel trees established throughout the crop at a rate determined based on estimated annual nursery production and on any other tree displaying symptoms consistent with root disease.* • *Sentinel trees are marked with a unique sentinel tree number that is to be linked to the crop monitoring record* ***Key requirements – Maintaining records of inspection*** • *Records must be made and maintained of tree inspection and monitoring and outcomes including any samples collected and testing results.* ***Key requirements - Pathogen testing.*** • *Where symptoms of infection are identified, steps must be taken based on the plant part inspected including requirements for sample collection and submission.* • *Should a positive test for a serious pathogen be received, follow up inspection and resampling is to be conducted to confirm infection, and determine the extent of contamination and determine the likelihood of elimination. Until such time as the extent of contamination is identified, propagated trees produced*

NIASA GUIDELINE	RELATED SAMAC TECHNICAL CRITERIA	COMMENT IN RELATION TO NIASA AND SOLUTIONS BASED ON LIT REVIEW
		at the production site must not be certified as meeting the requirements of the Macadamia Nursery Stock Specification. Trees must be identified as "NOT TO SPECIFICATION".
Grafting Not sufficiently addressed in NIASA.	• "It is recommended that a whip graft be used"	**u. Grafting requirements are not adequately addressed in NIASA.** v. **Must be addressed in the Macadamia "Tree stock standard" Appendix**. w. **For a Macadamia "Tree stock standard" Appendix,** considering the options provided, the following advice could be included while highlighting/reinforcing key points – ***Key requirements – Grafting.*** • *Rootstock and scion diameter must be matched to allow maximum cambium contact.* • *Graft surfaces must not be allowed to dry out.* • *Once surfaces are mated, they must be tightly wrapped and tied with grafting taper or parafilm or equivalent.* • *The remainder of the scion must be sealed to prevent desiccation.*
Culling/selection/thinning. Not adequately addressed in NIASA.	**SAMAC SECTION 11 - Weak Plant Separation Code of Practice Protocol** • Weak / Deficient / Diseased plants must be separated from healthy plants • These selected plants must be clearly marked and kept in a plant hospital, separate from the healthy trees, for not more than one month. • These plants must be treated according to their symptoms • Plants kept under quarantine that do not respond to treatment within one month must be destroyed • These plants may not be sold	x. **Must be addressed in the Macadamia "Tree stock standard" Appendix**. **y. For a Macadamia "Tree stock standard" Appendix, to be referenced in procedures requiring or allowing root inspection.**

Appendix 2. NIASA Guidelines APPENDIX 15 - Macadamia Nursery Stock Specifications & Audit checklist

This project has been funded by Hort Innovation using the macadamia and nursery levy and funds from the Australian Government (Project MC17001).

APPENDIX 15 MACADAMIA NURSERY STOCK SPECIFICATIONS

A.15.1 Introduction

Nursery production of high-quality macadamia trees is recognised within Australia and abroad as playing an important role in supporting the macadamia nut production industry.

Purchasers of macadamia nursery stock require assurance that stock purchased meets an industry standard, is true to type, and that appropriate steps have been taken to reduce the chance of introduction of serious pathogens into the production environment.

In order for a production nursery to be eligible to be accredited as meeting Macadamia Nursery Stock Specifications, the production nursery ***must*** be:

- NIASA accredited; **AND**
- be found at audit to have implemented mandatory procedures (indicated through use of the term ***must***) within this Appendix to a **Satisfactory standard** (see Section A.15.9 Auditing for compliance and continual improvement and the MACADAMIA NURSERY STOCK SPECIFICATIONS CHECKLIST).

A.15.2 General production nursery requirements

The production nursery ***must*** take steps to mitigate the risk of human assisted entry and spread of plant pathogens into and within the production area. High risk entry pathways include water, growing media, and contamination of production areas through movement of people and equipment.

A.15.2.1 Water

Irrigation water ***must*** be managed in accordance with the requirements provided in NIASA Section 1.1.1 Water.

Key requirements – Water

- Water that is obtained from town suppliers, bores free of surface run-off or clean roof catchments does not require disinfestation.
- Other sources of irrigation water (creeks, dams, rivers etc.) ***must*** be disinfested using an approved NIASA disinfestation procedure.
- Subsequent storage of disinfested/clean water requires facilities and procedures ***must*** be established and implemented that do not allow for contamination by untreated water, soil, plant debris, dust and animal movement.
- The pH and EC (Electrical Conductivity) of all water sources ***must*** be checked and recorded at least once per month as even town water supplies can have variations in quality.
- Water from surface supplies, springs, effluents, or water testing positive for the presence of root-rot organisms ***must*** be disinfested using a NIASA approved method.
- Please note APPENDIX 5 NIASA PRODUCTION NURSERY CHECKLIST SECTION 1: Water and irrigation for a complete list of all audited criteria.

A.15.2.2 Growing media / propagating media

Growing media ***must*** be managed in accordance with the requirements provided in NIASA Section1.1.2 Growing media/propagating media.

Further information

- Production of macadamia trees occurs over a longer duration than most other nut/fruit trees - on average 12 to 24 months. As a result, it is important to ensure that high quality potting media is used to avoid breakdown of the media over this extended time period. The long time period also has the potential to cause problems in other areas such as nutrition and irrigation management.
- A good quality long lasting media designed for macadamias is essential if root health, and therefore tree health, is to be maintained. Of particular importance is air-filled porosity as this will decline over time as the media degrades.

Key requirements – Growing media / propagating media

- Growing media/propagating media that is sourced from a NIASA accredited growing media supplier does not require additional pathogen testing and treatment prior to use.
- Growing media/propagating media that is sourced from a non-NIASA accredited growing media supplier ***must*** undergo treatment or pathogen testing, and where pathogens are detected – treatment, prior to use.
- Growing media/propagating media prepared on-site which includes components that pose a risk of contamination, for example river sand, ***must*** be disinfested using an approved NIASA disinfestation procedure.
- Each batch of growing media ***must*** be tested for EC (Electrical Conductivity) and pH using suitable equipment. Adequate records of all growing media ***must*** be maintained, including pH and EC.
- Growing media/propagating media ***must*** be stored in a manner to prevent contamination prior to use.
- Please also note APPENDIX 5 NIASA PRODUCTION NURSERY CHECKLIST SECTION 2: Growing media for a complete list of all audited criteria.

A.15.2.3 Beds and benching

Beds and benching ***must*** be managed in accordance with the requirements provided in NIASA Section 1.1.16 Beds and benching.

Key requirements – Beds and benching

- **Ground level propagating beds**. Beds ***must*** be totally isolated from soil (e.g. with the use of black plastic) and ***must*** be free draining. Beds ***must*** not be subject to flooding during periods of heavy rain.
- **Production beds for containerised stock**. The surface of the bed and the pathways adjacent to it ***must*** prevent contact of the plant, the plant roots or the container, with soil or water contaminated by soil (or growing media) or water draining from other containers or from any other possibly contaminated sources (e.g. road base). Pooling of water is not permitted.

Coarse gravel or crushed rock covered surfaces ***must*** be well drained and the gravel aggregate (screenings of 10mm to 25mm diameter) ***must*** be a minimum of 75mm deep and preferably deeper.

Concrete, polythene or bitumen is permitted where they are covering properly consolidated surfaces and exceptionally good drainage occurs, and all other hygiene practices are satisfactory. Beds with these surfaces ***must*** not pool water and ***must*** be separated as much as possible from adjacent production sites in terms of water runoff.

- Benches spanning or adjacent to either properly sealed or aggregate surfaced floors and paths need not be higher than 30cm. However, where splash and other methods of contamination are likely to occur, a suitable bench height is 75cm or higher.
- Please also note APPENDIX 5 NIASA PRODUCTION NURSERY CHECKLIST SECTION 3: Propagation for a complete list of all audited criteria.

Image 1 – Poor drainage creates a serious risk to plant health and quality.

A.15.2.4 Disinfestation and hygiene

To minimise the risk of movement of plant pathogens into and within the production area, disinfestation and hygiene procedures are paramount in any production nursery.

Hygiene means taking steps to prevent things from becoming contaminated where possible. Hygiene steps include avoiding contact of items with potentially infested surfaces, for example keeping hose nozzles and hand tools off the nursery floor.

Disinfestation, or sanitation, means removing contamination from potentially infested items. Chemical disinfectants or detergents and heat treatments are still the most reliable methods for the control of most plant pathogens. When preparing disinfectant or detergent solutions:

- Follow all label requirements and safety precautions when handling chemicals.
- Only use freshly prepared disinfectant solutions.
- When using *chlorine* based chemicals, diluted chlorine solutions are particularly unstable and ***must*** be made up fresh daily. Use water for dilution with a pH of between 5.5 and 7.5. Undiluted chlorine ***must*** be stored out of direct sunlight preferably in a locked a cool room below 28°C. Chlorine should NOT be stored in areas with fertiliser or other farm chemicals.

Quaternary ammonium compounds (QUATs) are incompatible with most cleaners and detergents and have a low tolerance to hard water (increasing with calcium carbonate ($CaC0_3$) above 120mg/L). As a biocide the added benefit of using a QUAT is the ability to leave a residual anti-microbial film on surfaces. At concentrations greater than 1-10ppm they are regarded as highly toxic to some aquatic life forms. QUATs should NOT be stored in areas with fertiliser or other farm chemicals

Copper sulphate ($CuSO_4$) can be extremely toxic in water of low alkalinity and is ineffective at high pH. Use water for dilution with a pH of between 6.5 and 7.5. Its persistent nature makes it a good biocide however it can also be absorbed by soil and organic material. In working concentrations, it can also be lethal to some aquatic life forms.

The business ***must*** also:

- use chemicals responsibly as per the approved product label or permit conditions;
- dispose of spent disinfectant solutions responsibly as per the product label;
- if handling and storing bulk chemicals (e.g. chlorine) complete a risk assessment and develop an 'Emergency Response Plan' document.

NOTE: Some QUATS are highly toxic to plants and care **MUST** be taken to select an appropriate product when treating near crops.

Further information

- Hygiene & Sanitation of Working Surfaces in the Nursery (#2000/03)
- Hygiene in the Nursery – Disinfecting Production Surfaces; cement, gravel, capillary mats and sand beds (#2000/05)

A.15.2.4.1 Hand hygiene

High hygiene levels ***must*** be maintained in risk areas such as propagation, potting or staging operations.

The business ***must*** ensure that hands are washed thoroughly between operations using an approved hand disinfectant such as Sunlight soap, Savlon or Dettol antiseptic soap, or disposable gloves are used and changed between operations.

A.15.2.4.2 Footwear

Footwear disinfestation and hygiene ***must*** be undertaken in accordance with the requirements provided in NIASA Section 1.1.6 Footwear.

Further Information

- Care ***must*** be taken to address the risk of entry of potentially infested materials such as soil or plant material present on footwear being transferred onto the facility and then into production areas.
- On entry to the facility, footwear ***must*** be clean and ***must*** not carry excessive visible soil and/or plant material that could transfer pests and pathogens into the production areas. Excessively contaminated footwear ***must*** be scrubbed clean with a brush then treated with a suitable disinfectant or detergent solution prior to entry into the production area.
- The business may also install foot baths at all entrance points of production areas OR direct staff to change footwear and use only designated footwear in the production area.

- Alternatively, although not recommended, boot covers may be provided to contractors and visitors however these ***must*** be monitored, discarded and replaced should they show signs of damage.

A.15.2.4.3 Tools, knives and other instruments

Tool disinfestation and hygiene ***must*** be undertaken in accordance with the requirements provided in NIASA Section 1.1.5 Tools.

Cutting tools should be treated at a minimum between batches of propagated plants, and as frequently as between trees when collecting material from parent trees. Cutting tools are disinfected by first cleaning off any surface residue then treated using a suitable disinfectant.

A.15.2.4.4 Equipment

All equipment, including trolleys, barrows and trays that come into contact with vegetative propagation material or inputs such as growing media, should be routinely cleaned with a brush or pressure washer then treated with a suitable disinfectant or detergent.

A.15.2.4.5 Plant Containers (pots, bags and trays)

Containers ***must*** be managed in accordance with the requirements provided in NIASA Section 1.1.15 Containers.

Further Information

- For used containers, disinfestation using a hypochlorite solution may be used but is not recommended as a means of decontamination to achieve the Macadamia Nursery Stock Specifications.
- The preferred method for used container disinfestation is through the use of a heat treatment procedure. Steam is the best and most common heat source for disinfection. A temperature of 60ºC for 30 minutes is most desirable, because as well as killing pathogens it may leave many beneficial micro-organisms.

Used containers, or new containers not stored in a way to prevent contamination, pose a significant risk of transfer of pathogens and if used, ***must*** be disinfested. When heat treatment is not used, used containers ***must*** be reasonably cleaned of waste material, including plant and media residue, prior to disinfection.

A.15.2.4.6 Working surfaces

Working surface disinfestation and hygiene ***must*** be undertaken in accordance with the requirements provided in NIASA Section 1.1.4 Working surfaces.

Key requirements – Disinfestation and hygiene

- High hygiene levels ***must*** be maintained in risk areas such as propagation, potting or staging operations.
- Production/staging areas ***must*** be protected from contamination by ensuring staff entering an area have clean hands and footwear is clean and decontaminated where required.
- Tools, knives, other instruments, equipment and working surfaces ***must*** be cleaned and disinfected regularly.
- New clean containers need not be disinfected however used containers ***must*** be disinfested using heat, or reasonably cleaned of waste material and then disinfested with a fresh 4000 ppm (or 0.4%) hypochlorite solution for at least 20 minutes.

- Clean and disinfected containers ***must*** be stored above floor level to prevent soil, plant debris and drainage water contamination.
- Please also note APPENDIX 5 NIASA PRODUCTION NURSERY CHECKLIST SECTION 3: Propagation for a complete list of all audited criteria.

A.15.3 Source materials to be used for propagation

Care ***must*** be taken in the sourcing, collection and storage of propagation material prior to use.

Key risks include:

- Lack of material traceability.
- Misidentification of parent tree variety.
- Loss of viability.
- Infection by plant pests, diseases or weeds.

A.15.3.1 Source blocks

A 'block' is defined as a tree, or a group of trees, on a property that is planted and managed as one unit and is separated from other trees that may be present on the property by natural or artificial boundaries, for example by access tracks, roadways or fences.

The production nursery ***must*** maintain a *source block record* for each block on a source property from which material is collected that includes:

- A unique name or code for the source block.
- The source property address, and the entity (e.g. person or business) that exercises care, control or management of the block.
- Geospatial information including the Lot on Plan of the land parcel the block is situated in **OR** a GPS coordinate located at the centre of the block.
- An aerial/satellite image identifying the location of the source block or blocks on the source property.
- The type/s of trees present to variety level and records held that confirm variety, if any, obtained from a recognised or experienced source in varietal identification (see Section A.15.3.3 Parent tree variety identification).
- If the block includes mixed varieties, the number of rows present in the block.
- Information on how individual trees within the source block will be identified for material collection purposes where all parent trees in the source block are not of the same variety.

Where the production nursery receives material from a source block from a *source material supplier* (a third party), the production nursery ***must*** require the information for the source block to be provided by the *source material supplier* in order to complete the record.

An example of a *source block record* is provided in SCHEDULE 2: EXAMPLE RECORD SHEETS.

Further information

- Free Online map search tools, for example https://maps.google.com/, are sufficient for obtaining aerial imagery of source blocks and obtaining appropriate GPS readings for source block location details.

Key requirements – Source blocks

- The production nursery ***must*** make and maintain a record of source blocks (a *source block record*) from which parent material is collected for propagation of nursery trees.
- Information ***must*** be recorded that identifies ownership, and geospatially identifies the location of the source block including an aerial/satellite image/map identifying the location of the source block or blocks on the source property.
- Variety ***must*** be identified, and records held that confirm variety obtained from an experienced or recognised source maintained.
- Method used to identify individual trees within the source block for material collection purposes ***must*** also be documented within the record where all parent trees are not of the same variety.
- Please also note the APPENDIX 15 MACADAMIA NURSERY STOCK SPECIFICATIONS CHECKLIST.

A.15.3.2 Propagation material collection records

A *propagation material collection record* ***must*** be maintained by the production nursery for propagation material used that includes:

- Identification of the source block (name or code) the material was collected from that links back to the *source block record* (see Section A.15.3.1 Source blocks).
- The date of collection and the name of the collector/s.
- The type of material collected (for example, seed nut, budwood or scion material) and the amount of the material collected.
- Identification of the material type to the variety level.
- Identification of the tree, or trees (for example row number), the material was collected from within the source block for each batch of material collected where all parent trees in the source block are not of the same variety.
- A unique batch code.
- Any other comments or observations.

Where the production nursery receives material collected from a source block from a *source material supplier*, the production nursery ***must*** require the information to be provided by the *source material supplier* in order to complete the record.

The *propagation material collection record* ***must*** provide sufficient information to allow traceback to a batch of material collected from a source block should problems be detected in propagated trees.

An example of a *propagation material record* is provided in SCHEDULE 2: EXAMPLE RECORD SHEETS.

Further information

- A source block record and propagation material collection record for a source block may be combined as one record.

Key requirements – Propagation material collection records

- The production nursery ***must*** maintain a record of propagation material collected for propagation of nursery trees (a propagation material collection record).
- The production nursery ***must*** maintain a record for the propagation material that identifies the name or code of the source block, the variety, the date of the collection, the name of the collector, the type of the material collected, the amount, and a unique batch code.
- The production nursery ***must*** also identify the tree, or trees, the batch of material was collected from where all parent trees in the source block are not of the same variety.
- Other comments may also be recorded.
- Please also note the APPENDIX 15 MACADAMIA NURSERY STOCK SPECIFICATIONS CHECKLIST.

A.15.3.3 Parent tree variety identification

Parent trees ***must*** be identified to variety prior to collection of propagation materials to confirm details recorded in the *source block record*.

Parent tree variety may be identified by one or more methods:

1. Records are available to confirm variety from a recognised source.

Further Information

- Examples include variety confirmation in writing from established macadamia variety improvement programs that hold PBR for the trees, or through genetic testing results.

2. Where a variety **may be clearly identified by one or more morphological traits**, parent trees are inspected by a person experienced in variety identification, AND observations are made on one or more relevant features including tree shape, tree size and density, leaf length, leaf width and tip shape, leaf spines, husk shape and distinctive shell features, AND observations made are consistent with morphological norms for the variety.

Further information

- A number of reference materials are available to support correct variety identification. An example is the 'Macadamia Variety Identifier' produced by the Queensland Government in association with the New South Wales Government and the Australian Macadamia Society and available online at - http://era.daf.qld.gov.au/id/eprint/1964/14/mac-varieties.pdf.

Where the production nursery receives material from a source block from a *source material supplier*, the production nursery ***must*** require the information for varietal confirmation to be provided by the *source material supplier.*

Key requirements – Parent tree variety identification

- Variety of parent trees may be confirmed through records provided by a recognised source, including genetic testing results.

- Where a variety may be clearly identified by one or more morphological traits, the variety is identified by a person experienced in variety identification through observation and recording of those morphological traits.
- Please also note the APPENDIX 15 MACADAMIA NURSERY STOCK SPECIFICATIONS CHECKLIST.

A.15.4 Material collection and handling

A.15.4.1 Seed nut

A.15.4.1.1 Collecting seed nut

Seed nut ***must*** only be collected from an identified source block (see Section A.15.3.1 Source blocks). Fruit for seed extraction should be collected from healthy parent trees of a known variety (see Section A.15.3.3 Parent tree variety identification).

Seed nut should be mature and preferably be collected directly off the tree, however freshly fallen seed nut may be collected off the ground where all parent trees in the source block are of the same variety.

Where seed nut is collected from the ground preference should be given to selecting those nuts still in green husks. Seed nut that has been on the ground for any length of time, particularly if it has been wet, can be subject to fungal and bacterial infection. This infection once inside the shell may be difficult to treat and may not be immediately apparent when the nut is collected.

Immature or damaged seed nuts should be rejected. Seed nuts that display disease symptoms, or signs of pest infestation, should be rejected.

After collection, the *propagation material collection record* ***must*** be completed and each batch of seed nut ***must*** be labelled with variety, block name or code, date and assigned a unique batch code (see Section A.15.3.2 Propagation material collection records), that will follow the material through the propagation process.

Further information

- A unique batch code could be developed to meet other labelling requirements, and be as simple as 'variety-block code-collection date'. For example, 'H2-001-131118'.

A.15.4.1.2 Washing seed nut

After de-husking, seed nut may be washed/disinfested in water treated with an appropriate decontaminant to remove soil and other surface contaminants and air dried to remove excess water.

Immature or damaged seed nut should be rejected. Seed nuts that display disease symptoms, or signs of pest infestation, should be rejected. Immaturity may be tested by putting the freshly harvested de-husked nuts into the treated water for a period of time, then removing those nuts which float.

A.15.4.1.3 Storing seed nut

Seed viability reduces over time. Seed nut ***must*** be de-husked prior to storage.

Typically, seed can retain viability for about 12 months at 4°C, but at room temperature viability starts decreasing rapidly after about 3 to 4 months. Seed nut stored at <10% humidity may prolong storage life and viability. Open woven bags (for example onion bags) are recommended for storage.

Key requirements – Seed nut.

- Seed nut ***must*** be collected from an identified source block.
- Mature seed nut ***must*** be collected from healthy parent trees of known variety while still attached to the tree, or may be collected off the ground if freshly fallen and all trees within the source block are of the same variety.
- A propagation material collection record ***must*** be completed after collection, and seed nut are assigned a unique batch code.
- After de-husking, seed nut may be washed/disinfested in water treated with an appropriate decontaminant to remove soil and other surface contaminants.
- Seed nut is stored in appropriate conditions and appropriately labelled.
- Please also note the APPENDIX 15 MACADAMIA NURSERY STOCK SPECIFICATIONS CHECKLIST.

A.15.4.2 Budwood

A.15.4.2.1 Pre-collection preparation

Material ***must*** only be collected from an identified source block (see Section A.15.3.1 Source blocks).

Parent trees selected for material collection ***must*** be inspected and found free of disease symptoms or disorders, and signs of significant pest infestation.

The most common form of grafting uses cinctured wood as this increases the chances of graft success particularly with some varieties and at certain times of the year. Cincturing/girdling, (ring barking) prevents the downward flow of carbohydrates from portion of the branch above the cincture and these are then stored in the wood and provide a source of nutrition for the graft.

However, some material may be grafted successfully without cincturing. The benefit of cincturing can vary with the variety selected and other factors.

When cincturing, at least 6 weeks in advance of material collection (often longer in winter to allow sufficient callous formation), parent trees of a known variety (see Section A.15.3.3 Parent tree variety identification) should be selected and budwood selections identified. This will allow time for carbohydrates to build up in the selected material (after girdling), which assists in graft take.

When suitable budwood is identified, in consultation with the grower, girdle the branch as far back as possible to allow several pieces of scion from the branch to be produced.

Use pliers or another suitable tool to remove 2 to 3cm of bark around the branch at this point.

Remove the bark to a depth that allows you to see the white woody tissue of the branch.

The cincture is left open, and not covered, after completion.

Identify the prepared branch - flagging tape is ideal for this purpose. Additional information may also be included on the marker to assist with future collection processes.

Image 2 – Correctly performed cincture – ready to cut

Image 3 – Wood that has been left too long on tree and has calloused over

Tools used to prepare material ***must*** be regularly disinfested (see Section A.15.2.4.3 Tools, knives and other instruments). Disinfect tools between trees, by wiping with a disposable cloth dampened with 30% methylated spirits to 70% water solution to prevent spread of disease.

Further information

- It is recommended that only material that is present at a height greater than 100cm from the ground surface is selected. This will reduce the risk of infection from Phytophthora from contamination by rain splash from the soil surface.
- Budwood selections should be straight hardened wood.
- It is preferable to select upright wood with as few side branches/twigs as possible. This will maximise the amount of potentially viable buds on the grafting material.
- Girdled branches should be kept free of fruit and flowers to an extent that is reasonably practicable.

A.15.4.2.2 Collecting budwood

Material ***must*** only be collected from an identified source block (see Section A.15.3.1 Source blocks).

When collecting material:

- Young material should be collected from healthy trees that have been visually inspected and found free of pest and disease symptoms.

Further information

- Felted coccid (Eriococcus ironsidei) can be particularly hard to detect on budwood sticks as it hides in the cracks in the bark. Great care should therefore be taken in inspecting wood if felted

coccid is thought to be present. Once in a nursery environment, it can rapidly multiply and markedly impact on tree health, growth and saleability. It is also difficult to control in a nursery environment as there are few registered chemicals for its control. Infested nursery trees are one of the main methods by which this pest spreads.

- Material should not be taken from water stressed trees, or wet trees - wet material increases the possibility of wound infection by pathogens.
- Material with internal browning or abscised buds should not be collected.

Secateurs, or other tools used to collect material ***must*** be sharp (to ensure a clean cut) and regularly disinfested (see Section A.15.2.4.3 Tools, knives and other instruments). Disinfect secateurs between trees, by wiping with a disposable cloth dampened with 30% methylated spirits to 70% water solution to prevent spread of disease.

If applicable, cut the material below the girdle and remove all leaves using a cutting tool.

Place the material in a small cooler box containing an icepack, or wrap in a clean damp cloth or damp newspaper and place in a plastic bag to prevent water loss.

The *propagation material collection record* ***must*** be completed and each batch of material ***must*** be labelled with variety, block name or code, date and assigned a unique batch code and be assigned a unique batch code (see Section A.15.3.2 Propagation material collection records), that will follow the material through the propagation process.

Further information

- It is recommended, where practical, that collection of material occurs early in the morning of the same day as grafting, or late afternoon of the day before grafting when the material will not be desiccated by heat and wind as it is being cut.
- A unique batch code could be developed to meet other labelling requirements, and be as simple as 'variety-block code-collection date'. For example, 'G-001-1311218'.

A.15.4.2.3 Storing scion material and budwood

All leaves ***must*** be removed prior to storage taking care not to damage the scion. Material should be used as soon as possible after collection, however, for short term storage of material:

- Budwood can be kept wrapped in a damp cloth in the vegetable section of the fridge for at least a week.
- Risk of pathogen infection and poor plant vigour increases with storage time.

Further information

- Because of respiration producing heat and moisture, it is recommended that no more than 50 scions should be stored in the same bag.

Key requirements – Budwood

- Prior to collection of budwood of a known variety from an identified source block, parent trees selected for material collection ***must*** be inspected and found free of disease symptoms or disorders, and signs of significant pest infestation.
- A propagation material collection record ***must*** be completed after collection and budwood is assigned a unique batch code.

- Budwood is stored in appropriate conditions and appropriately labelled.
- Please also note the APPENDIX 15 MACADAMIA NURSERY STOCK SPECIFICATIONS CHECKLIST.

A.15.4.3 Notes on Cuttings

Cuttings are not widely grown in Australia, due their reputation for having poor root systems making them prone to wind damage. However, in South Africa, a major macadamia producer, cuttings are used extensively. There are two possible reasons for this difference, the South Africans use different varieties to Australia such as Beaumont (695) which grows more readily from cuttings, and the nurseries have developed more expertise in this area and are therefore able to produce cuttings with good root systems.

In Australia, the Hidden valley selections, the A varieties, are generally easier to grow from cuttings than the Hawaiian varieties and there a number of orchards that have been planted with cutting grown A varieties.

Cuttings production is a specialist propagation technique and should not be attempted without considerable trial and research. If this technique is to be used, the same labelling, hygiene and culling standards would need to be applied if a quality tree is to be produced.

A.15.5 Propagation

A.15.5.1 Sowing seed

After de-husking, washing (see Section A.15.4.1.2 Washing seed) and any pre-treatment of seed nuts, the dried seed nuts ***must*** be planted in a quality free draining propagating media (see NIASA Section 1.1.2 Growing media/propagating media) of sufficient depth to allow full expression of the seedling's root system without impediment.

Seeds may be sown in sand beds, heat beds, or directly into containers.

Fresh seed collected directly off the tree, carefully de-husked, and planted within 48 hours generally assists in maximising germination percentage. However, if semi-dried or dried seed nut is going to be planted then soaking the seed nut in water overnight may improve both the germination percentage and the speed of germination. Seed nut that has been stored for any length of time should be thoroughly inspected and any diseased or cracked nut removed prior to planting.

A.15.5.1.1 'Sand' beds

Sand bed construction

The following criteria should be considered in sand bed construction:

- A sand bed should be at least 150mm deep, and often deeper, to ensure the development of a good root system.
- The bottom of the bed should allow for free drainage but should be off the ground or isolated from the ground using polythene sheeting so that the sand bed cannot be contaminated with disease infested water (also see Section A.15.2.3 Beds and benching).
- The sides of the bed should be constructed from non-porous material to prevent diseases contaminating the bed between batches.

- The bed should be filled with disease free coarse sand, or similar material such as crushed granite sourced from an accredited supplier (also see Section A.15.2.2 Growing media / propagating media).
- The beds also need to be designed so that the sand can easily be removed for disposal between batches of seed nut/seedlings, and the emptied bed sterilised (also see Section A.15.2.4.6 Working surfaces).
- The seed bed may be covered with both polythene sheeting to retain heat in winter, and shade cloth in autumn and spring once the seeds have germinated.

Further information

- One method of applying polythene sheeting is to construct half circles of high-density polythene pipe above the bed over which the polythene sheeting and shade cloth can be stretched. The sides of the sheeting/shade cloth need to easily rolled up to facilitate seedbed management and to regulate heat. If the bed is above the ground, then having covers that go down to ground level may be a good idea. Side covers will prevent cold air in winter passing under the bed decreasing the sand temperature and thus prolonging germination time.

Image 4 – Example hooped seedbed.

Image 5 – Example polythene sheeting

The irrigation system used in the sand bed should be designed to ensure even water distribution.

Further information

- When irrigating, even coverage is essential as the nuts need to kept damp but not wet. Dry spots can lead to slow germination and death of the apical bud leading to the production of multi-stemmed trees which may need to be discarded. Similarly, areas that are too wet can lead to nuts rotting, disease, and again the loss of the apical bud and the production of multi-stemmed trees.
- The pipes bringing the water should also be buried/protected as much as possible so that the water contacting the emerging seedlings is not too hot as this can cause damage. Similarly, if the irrigation line runs along the apex of hoops over the bed, then the length of the pipe needs to kept as short as possible so as to minimise the amount of hot water that builds up in the pipe. Some systems are designed with a flushing valve at the end of the line which lets the water out when the system switches off and the pressure drops. This is very effective at removing the potential for hot water damage but the flushing valves require a high level of maintenance.

Planting the sand bed

It is important when growing macadamia trees to produce a tree without bends of kinks and this starts with careful orientation and placement of seed nut in the sand bed. The macadamia nut has suture line, a crease or groove, that runs half way around the nut from the micropyle (the white dot at one end of the nut) to the other end. It is along this suture line that the nut will open when it starts to germinate and roots and shoots will both emerge from this point.

Further information

- A common practice when placing the nut in the sand bed is to ensure that the suture line is placed horizontally (not with the seed nut planted with the suture line at the top or bottom of the seed). When the root (radical) emerges, it will then go straight down and the shoot straight up. If the suture line is facing up the root will follow the curve of the shell around leading to a bend in the root and if the suture line faces straight down the shoot will emerge and follow the curve of the nut around leading to a bend in the shoot. (see Image 6).

Image 6 – Effect of poor seed orientation. All of these seedlings are unsuitable for use.

When placing the nuts in the sand bed they should be evenly spaced to prevent a nut that rots from contaminating nuts in close proximity and allows the seedlings to be removed from the sand bed with minimal damage.

Further information

- Spacing techniques may vary, however one method of ensuring nuts are evenly spaced is to purchase a piece of 40mm x 40mm weld mesh and press this into the sand before planting. Nuts are then placed evenly in the middle of each square. A 40 x 40mm grid will give a nut density of 400 nuts per square metre of sand bed.

Image 7 – Example of use of mesh sheeting to assist in planting

Image 8 – Example of seedlings ready for removal, inspection and transplanting.

Further Information

- There is some debate as to whether nuts should be placed just below the surface of the sand or at a maximum depth of 25mm above the seed surface. Placing the nuts at a depth of 25mm reduces the chance of them drying out as readily as nuts placed just below the surface.
- Planting the nuts at depths greater than 25mm above the seed surface is not recommended as this increases the germination time which may lead to more nuts rotting. It is also more difficult to remove the seedlings from the sand bed.

Managing the sand bed

The seed nuts in the bed should be kept damp but not wet.

Seed beds ***must*** be regularly checked for the presence of pest, disease and for weed growth (see Section A.15.6.1 Inspection and monitoring).

Further information

- The frequency of irrigation required will change with season and with daily weather. Nuts may be checked regularly by digging one or two up to check on the progress of germination and the how wet the nuts are.
- Watering the seed bed late in the afternoon in late autumn or winter may reduce seed bed temperature, through evaporative cooling, and lead to slower germination. A cool wet sand bed is also likely to be more conducive to pathogen development. Similarly, when the seedlings have emerged, they should not 'go to bed' wet at night as this may encourage pathogen development.
- When the seeds have germinated, consider keeping the surface of the sand cool as the emerging shoot tip is very delicate and easily damaged. Sand can easily heat up and retain enough heat to damage the shoot tips.

A.15.5.1.2 Heat beds

Germination may be enhanced with the use of bottom heat supplied by electric heating cables, however specialist heat mats, designed for the purpose, should be used as the combination of water and electricity can be lethal.

If using a heat mat then ideally it should be placed on an insulated bed of Styrofoam (polystyrene) to reduce heat loss through the bottom of the mat. This foam pad should be carefully wrapped in plastic so as to prevent it becoming contaminated with pathogens.

The heat mat is generally best placed on a normal height table as this will allow the nuts on the table to be readily inspected for germination. This table needs to be in a room that is not subject to draughts or extremes of temperature or this may negate the effectiveness of the heat mat.

Nut placement

Nut should be evenly placed on the mat so they are not touching so as to prevent pathogen transfer between nuts. It is not as important to orientate the nuts on a heat bed as in a sand bed as they will be transferred to a pot before the radical has developed any length.

Watering the nuts

The nuts need to be kept damp so that they germinate and the heat mat may need to be watered several times a day. If an irrigation system is used then it is better to use sprinklers with fine mist jets as this will dampen the nuts without watering them. Care should be taken to ensure water does not pool in any area on the seed bed.

Heat bed maintenance

The heat bed should be checked daily to ensure they maintain the correct temperature and the room in which it is placed is not becoming excessively hot or cold.

The bed should be checked daily for the presence of nut that have started to rot. Rotting nuts often go a dark black colour and may start to exude a creamy white sometimes orange streaked pus like secretion. Any suspect nut should be removed as soon as it is detected and discarded. Disposable gloves should be worn to prevent cross contamination.

Germination

Seed nut should be removed from the heat bed as soon as the nut has cracked, and the root has started to emerge.

Seeds should be placed on a tray lined with a damp cloth and then while planting the seed nut they should be covered with a clean damp cloth to prevent desiccation. When collecting germinated seed nut, do not collect more germinated seed that can be planted within a short period of time.

Potting up

Containers need to have been prepared in advance of germinated seed nut removal and planting. Containers should be tightly filled and contain well-watered potting media. A dry media may remove moisture from the growing roots and shoot causing damage.

Generally, a small hole is made in the centre of the pot so the top of the seed nut can be placed around 25mm below the surface of media surface. The nut should be placed so the suture line is parallel with the surface of the pot. This will promote a root that grows straight down and a shoot that grows straight up. The nut should then be carefully covered with potting media.

A.15.5.1.3 Direct seeding in containers – Interim potting

Direct seedling into small pots (e.g. 'forestry pots') is another method of germinating seed.

While it has the potential reduce both labour and transplant losses, great care ***must*** be taken when using this technique to ensure the trees do not become pot bound.

Further information

- Despite the use of root training and air pruning pots, there is some evidence to show that trees that have become pot-bound in smaller interim pots do not develop a strong spreading root system. This may, after planting, result in trees that are prone to instability and lodging.

Planting seed

Seeds nuts should be treated as for sand bed planting and heat bed planting with any diseased or damaged seeds discarded.

- Use only 'root training pots' so that the roots are guided down.
- The pots should contain a growing media similar to that into which they will be eventually be transferred.
- The seeds should be planted just below the potting mix surface with the suture line parallel with the surface on the mix.

The pots should then be kept moist but not wet until the seedlings emerge.

Image 9 – Satisfactory root system on left - on right unsatisfactory root system (left in interim pot too long).

Image 10 –Tree that was planted but fell over as root system still restricted by having been left in interim pot too long

Seedling maintenance

Once germinated, it is important to ensure that trees which are at the optimum stage for transplanting are identified. Once identified, these trees need to be transplanted as soon as practically possible to avoid them becoming root bound.

As for the other techniques, poorly performing seedlings need to be discarded.

If two or three batches of seeds are planted the care needs to be taken to keep the batches separate. For example, the poorly performing seedlings from the first batch should not be confused with the

better performing seedlings from subsequent batches simply because they are the same size. Poorly performing seedlings should be disposed of.

A.15.5.1.4 Direct seeding – Final container

Seeds nuts should be treated as for sand bed planting and heat bed planting with any diseased or damaged seeds discarded.

As with other techniques there are no hard and fast rules around the depth of planting the seed, with some nurseries placing the seed just at the surface and others with the top of the seed 25mm below the potting media surface. Whatever depth is chosen, the seed should still be placed so that the suture line is parallel with the surface of the mix so as to ensure as straight a tree as possible.

Rogueing of poor performing seedling ***must*** be undertaken in the same manner recommended for the other methods of growing macadamia trees. All poorly performing seedlings need to be removed as soon as they are detected.

Unlike other methods, there are not the stages where the root system can be examined during early development and this should be considered.

A.15.5.1.5 Poor performing seedlings

Poor performing seedlings that are stunted, deformed or showing any form of abnormality ***must*** be removed for disposal.

Image 11 – Bent stem and loose in pot.

Image 12 – Poor performing seedings. Irrigation water with a (high) EC of 1200.

Image 13 – Bent stem.

A.15.5.1.6 Labelling

Sown seed/seedling batches ***must*** be clearly labelled to identify variety and origin and allow tracing back to the *propagation material collection record* (see Section A.15.3.2 Propagation material collection records

Key requirements – Sowing seed nut

- Seed nuts ***must*** be sown in a quality free draining propagating media of sufficient depth to allow unimpeded development of the seedling's root system.
- Sown seed/seedling batches ***must*** be clearly labelled to identify variety and allow tracing back to the propagation material collection record.
- Poor performing seedlings ***must*** be removed and disposed of.

A.15.5.2 Transplanting seedlings into a final container

A.15.5.2.1 Removal

When seedlings are of sufficient size for transplanting into larger containers, each seedling should be gently removed from the propagating media taking care not to break off the seed attached to the root system.

A.15.5.2.2 Inspection

After removal, the root system of each seedling ***must*** be inspected to ensure only seedlings with a healthy well-developed root system are chosen for replanting. Seedlings with root abnormalities ***must*** be disposed of (see Section A.15.6.3.1 Root quality).

Once inspected, the seedlings should be placed in a container with as much of the germination media attached to the roots as possible and then covered with a damp cloth to reduce desiccation. Don't remove more plants that can be comfortably planted in a short period of time

Prior to replanting, seedling roots may be trimmed to encourage further development of a compact fibrous root system and to avoid creating J roots when seedling is placed in containers.

Image 14 – Healthy well-developed root system. smaller interim pot.

Image 15 –. Root bound. Left in smaller interim pot too long.

Image 16 – 'J' rooting. Unsatisfactory root system.

Image 17 – Healthy root system on left, poor quality roots on seedlings on right.

A.15.5.2.3 Replanting

Without delay, seedlings should be replanted in a container of appropriate size using a good quality growing media.

Containers ***must*** provide for adequate drainage and the size of the container used ***must*** consider the vigour of the plant and the time that the plant will be occupying the container in order to minimise the risk of development of root disease and allow appropriate root development and prevent excessive root binding (see NIASA Section 2.7 Root binding).

Containers should be prepared in advance of replanting. Potting media should be firmly packed with sufficient space made in the centre to accept the root ball.

Care ***must*** be taken to ensure that each seedling is planted within the centre of the container and the root system is not bent (J rooting). The seedling is planted to the same depth as it was planted prior to removal.

Further information

- When filling bags, the bag needs to be packed as tightly as possible. As the media degrades over time the bag may ‘slump’ causing a crease to form in the lower portion of the bag. This crease often forms along the line of the drainage holes. As the mix ‘slumps’, and the crease forms, these holes may go from round to oval and may eventually completely close reducing their drainage ability. This can then create an anaerobic or waterlogged bottom of the pot causing roots to die. Purchasing a suitable macadamia growing media and tightly packing the bags at the beginning may reduce this problem.

A.15.5.2.4 Avoiding wind damage and sunburn

Seedlings ***must*** be provided with sufficient wind protection, and sufficient shade to avoid sunburn on lower leaves and death of apical bud.

Further information

- Although not mandatory, it is recommended that the nursery be surrounded by a shade cloth fence at least 1.8m high. This will help protect the seedlings from side winds which may desiccate the trees and damage delicate new growth. When the trees are older the fence may also reduce the number of trees that are blown over during periods of high wind. An incidental benefit may include a reduction the amount of weed seed that is blown into the nursery area from the nursery surrounds which may reduce the amount of weeding required.

Image 18 – Sunburn on lower leaves

A.15.5.2.5 Labelling

Transplanted seedlings ***must*** be clearly labelled to identify variety and origin and allow tracing back to the *propagation material collection record* (see Section A.15.3.2 Propagation material collection records).

Key requirements – Transplanting seedlings

- When seedlings are removed for transplanting into larger (final) containers, only seedlings with a well-developed root system ***must*** be selected.

- Seedlings ***must*** be planted at the centre of the container and care ***must*** be taken to not bend the root system.
- Seedlings should be provided with adequate wind/sun protection.
- Seedlings ***must*** be clearly labelled to identify variety and allow tracing back to the propagation material collection record.

A.15.5.3 Grafting

Success in establishing a successful graft in macadamia is not absolute. Graft success in a conventional production nursery situation has been reported on average to be in the order of 75%, however this varies with variety and the time of year. The cause or causes of graft failure are often not clear, however poor graft technique is likely to be associated with early death of the scion. Good nursery stock hygiene coupled with monitoring graft success rates and changes in technique will allow a production nursery to improve graft success over time.

The grafting method used by the business may vary, however whip and side-wedge graft are most frequently used. With all methods, the rootstock or scion ***must*** not be allowed dry out prior to attachment. While grafting in the production nursery, budwood/scion should be kept in a box lined with wet cloth or newspaper and covered with a damp cloth to prevent desiccation.

A.15.5.3.1 Conventional grafting

For conventional grafting, when material is ready for grafting (the diameter of the rootstock matches the diameter of the scion to be used) remove the top portion of the tree leaving approximately at least 250mm of the rootstock measured from the media surface. Remove leaves present at the top of the rootstock.

When performing a whip graft, a sloping surface should be made that extends at least 20mm in length at the top of the rootstock using a sharp cutting instrument or a plane. As soon as the rootstock is prepared select a scion of the same approximate diameter and cut/plane a matching sloped surface to provide the best contact with the cambium.

When performing a side-wedge graft, the scion is prepared by making a 'V' shaped wedge cut at the base of the scion then the wedge is inserted into a straight downward cut on the edge of the rootstock. Again, the wedge and the cut ***must*** match and align to provide the best contact with the cambium. Where the process causes the rootstock to split, the graft process ***must*** be started again.

The graft surfaces ***must*** then be mated and tightly wrapped and tied with grafting tape or parafilm or equivalent, then the remaining scion is also wrapped, or provided with an alternative coating, to prevent desiccation. Grafting paint is often used to cover the graft to reduce desiccation and also reduce the heat load on the new graft.

The propagated tree should then be well watered. The appearance of vegetative shoots on the scion some weeks later will indicate a successful graft.

Image 19 – Poorly matched graft

Image 20 – Badly matched graft - scion too large.

Image 21 – Gaps at side of graft

Image 22 – Better graft – even sides.

A.15.5.3.2 Micro-grafting

Micro-grafting (grafting when the trees are less than 15cm high), and mini-grafting (grafting when the trees are as thick as a large pencil and <30cm high), are specialist propagation techniques and should only be attempted by highly experienced nurseries with appropriate facilities.

Businesses contemplating micro or mini-grafting should seek specialist advice. In both these systems there is the need for a misting system to maintain humidity post-grafting. This can lead disease problems unless strict hygiene procedures are followed.

Key requirements – Grafting.

- Rootstock and scion diameter ***must*** be matched to allow maximum cambium contact.
- Graft surfaces ***must*** not be allowed to dry out.
- Once surfaces are mated, they ***must*** be tightly wrapped and tied with grafting tape or parafilm or equivalent.
- The remainder of the scion ***must*** be sealed to prevent desiccation.

A.15.5.4 Labelling of grafted trees

Propagated trees ***must*** carry a durable label that identifies:

The variety of rootstock and/or scion material used.

The material used for its propagation that links back to the *propagation material record*.

Key requirements - Labelling

- Trees ***must*** carry a durable label that identifies the rootstock/scion variety and links the material used back to the propagation material collection record.

A.15.6 Plant health monitoring

A.15.6.1 Inspection and monitoring

All trees ***must*** be regularly monitored for root, stem, graft and foliar pests and diseases, weeds, and nutritional and physiological disorders.

An early indicator of infection can be identified through monitoring of both above ground and below ground plant parts.

Inspection for symptom expression on above ground plant parts should be conducted on propagated plants as part of good nursery practice, however a representative number of plants will require monitoring for root quality and disease expression. Where suspicious symptoms are detected, samples ***must*** be sent for diagnostic testing.

A.15.6.1.1 Inspection frequency

Monitoring of propagated trees for pests, diseases, weeds and disorders ***must*** be conducted at least quarterly.

Quarterly monitoring and inspection of above ground plant parts continues throughout the production cycle, **however inspection of the below ground plant parts**:

- **commences 6 months after the initial establishment of an individual tree**, that being from the time of establishment / planting of a rootstock plant in its final container; **and**
- **concludes** 3 months prior to the anticipated despatch date.

Below ground plant part monitoring is conducted on 'sentinel' plants established within the crop and on any other tree displaying symptoms consistent with root disease and nutritional/physiological disorders.

A.15.6.1.2 Establishing sentinel trees for root health monitoring

The proportion of propagated trees to be monitored for below ground plant part quality and health is based on the estimated number of trees (rootstock or rooted cuttings) established in containers by the production nursery per year.

Sentinel trees are established in a systematic manner based on the estimated annual production of the business in accordance with Table 3 – Sentinel tree establishment rate.

For example, for a business that establishes an estimated 100,000 rootstock trees in containers per year, each new batch of trees should have at least 1 sentinel tree for every 600 trees containerised. For a business that has an estimated annual production rate of 40,000 trees per year, each new batch of trees should have at least 1 sentinel tree for every 200 trees propagated.

Table 3 – Sentinel tree establishment rate

Number of macadamia trees produced by the production nursery per year	Proportion of trees to be monitored as sentinel trees	
	Approximate % of total	Actual rate per batch of new trees
<30,000	1.5%	1 in 50 trees
>=30,000	0.50%	1 in 200 trees
>=60,000	0.25%	1 in 400 trees
>=90,000	0.17%	1 in 600 trees
>=120,000	0.125%	1 in 800 trees
>=150,000	0.10%	1 in 1000 trees

Sentinel trees should be evenly distributed through each batch and also be kept at a practical distance from walkways to allow for inspection without damaging surrounding trees.

Each sentinel tree ***must*** be given, and marked with, a unique sentinel tree number that is to be linked to the *crop monitoring record* (see Section A.15.6.4 Maintaining records of inspection).

Further information

- By applying the sentinel tree establishment rate provided in Table 1, approximately 150 trees will be established as sentinel trees for below ground plant part monitoring within the production nursery.
- It is recommended that sentinel trees are established in pots of equivalent size to other containers that will be used (for example, bags) to allow easy inspection of roots and sampling where necessary. Sentinel trees may then be transferred into other containers when root quality and health monitoring concludes, based on the production nursery's desired container type.

Key requirements – Inspection and monitoring.

- Propagated trees ***must*** be regularly inspected for the presence of stem, graft, foliar pests and diseases, weeds, nutritional and other disorders, and root health and quality.
- Above ground plant parts ***must*** be inspected at least quarterly. At least 35 trees within each batch within each production area ***must*** be closely examined for pests, diseases and disorders.

- Below ground plant parts ***must*** be examined for root quality and disease symptoms at least quarterly commencing 6 months after individual tree establishment and up to three months before anticipated despatch date.
- Below ground plant parts ***must*** be examined on sentinel trees established throughout the crop at a rate determined based on estimated annual nursery production and on any other tree displaying symptoms consistent with root disease.
- Sentinel trees ***must*** be marked with a unique sentinel tree number that is to be linked to the crop monitoring record

A.15.6.2 Inspection procedure - Above ground plant parts

Enter each separate area within the nursery and visually inspect for abnormal plant growth, pest presence, disease symptoms or weed growth.

Abnormal plant growth inspection includes inspection for distorted, brown, yellowed or damaged leaves, leaf fall, stem/trunk/graft abnormalities, stunting, dieback, abnormal tree form, temperature or water stress or damage, chemical damage, or signs of mineral deficiency.

Pest inspection includes inspection for leafminer, felted coccid, scale, thrips, mites, aphids, beetles (including beetle larvae), weevils, caterpillars, cicadas, tip borer, ants (many ant species, including fire ants, are regulated pest species), mealybugs, fungus gnats and other bugs.

Further information

- The NGIA provides pest fact sheets and a Pest ID Tool that is free to download at http://nurseryproductionfms.com.au/pests-diseases-weeds/ to assist in pest inspection and identification.

Weed inspection includes inspection of plant parts for saprophytic or parasitic weeds as well as inspection of the growing media for weeds growing independent of the tree.

Within each batch of trees within each growing area, **closely examine at least 35 trees**. Make an effort to select those trees that appear less healthy for close up inspection.

Inspect the tops and undersides of leaves, branches, stems and buds.

Use at least a 10x hand lens when examining abnormal growth. Damage from pathogens, insects, thrips, mites or scale insects suspected non-pathogenic sources should be recorded.

Symptoms caused by insect pests should be managed as required such that outbreaks are minor and limited. No trees should be knowingly sold that are infested with a pest population that is likely to become damaging and would require a customer to take corrective action (see Section A.15.8 Product quality and meeting customer expectations).

Image 23 – Scale on foliage

Monitor health of graft union by looking for excessive build-up of necrotic tissue around the graft union. Check under graft tape for the presence of felted coccid. Felted coccoid can rapidly multiply under the graft tape where it is protected from predators and chemicals. The developing graft union also acts as a source of food. Trees with such symptoms should be removed from the production area. Where a tree shows stem rot or graft necrosis (cell death causing tissue darkening or wilting) that is not suspected to be the result of poor formation of the graft, mechanical damage, graft incompatibility or the physiological condition of the rootstock, submit the tree for diagnostic testing (see Section A.15.7 Pathogen testing). Likewise, examine the stems of the same tree to assess if there are any necrotic lesions present.

Do not sell trees that have symptoms of stem or graft necrosis (see Section A.15.8 Product quality and meeting customer expectations.

Image 24 – Canker on stem

Image 25 – Stem canker

Symptoms of necrosis and chlorosis (causing yellowing) on foliage should be assessed as to the suspected cause. Those symptoms that are consistent with non-pathogenic causes (sunburn, nutrient regime, environmental conditions etc.) may need to be sent for testing.

Due diligence ***must*** be taken to limit the extent and severity of such symptoms developing in the future. Any remedial action that can be taken, e.g. alteration of light, irrigation or nutrient regime, should also be taken such that trees grow optimally.

No trees should be knowingly sold with symptoms of disease, necrosis and chlorosis on foliage that would require a customer to take corrective action (see Section A.15.8 Product quality and meeting customer expectations.

Examine trees around symptomatic tree/s to ensure that they are free of disease. Where a large number of trees (greater than 5) show symptoms speak to a diagnostic laboratory about the specific symptoms and submit trees that will best equip them to test and diagnose the problem based on their advice (see Section A.15.7 Pathogen testing). For example, a problem in propagation will require more trees to be submitted than larger, more mature nursery trees.

Should weeds be detected they ***must*** be removed and managed as required. No tree should be knowingly sold that is infested with weeds.

Image 26 – Serious weed infestation

A.15.6.3 Inspection procedure - Below ground plant parts (Sentinel trees)

Remove each sentinel tree from its container and examine the root system.

A.15.6.3.1 Root quality

Trees should have a uniform distribution system of roots. Advanced trees should retain at least 90 percent of the growing media volume around the rootball.

Examine trees around problem tree/s to ensure that they are free of root quality problems. Where further quality problems are identified, the batch ***must*** be rejected until such time that the extent of the problem has been determined and corrective taken to eliminate the problem has been taken.

Do not sell trees that display signs of root spiralling, root binding, J-roots, girdled or kinked roots.

Image 27 – Satisfactory roots (media removed)

Image 28 – Unsatisfactory roots (media removed)

Image 29 – Quality root systems. Note growing media retention when removed from the container.

A.15.6.3.2 Root health

In general, greater than 90% of visible roots should be white, healthy feeder roots. Where roots appear to be unhealthy or rotten (darkened or otherwise damaged), cut the epidermis along the root with a sharp knife to expose the centre of the root (the stele). If the root is white it is not rotten. However, if there are few actively growing, white feeder roots visible compared to the number of dark roots, it may indicate that growing conditions are not optimal.

Inspect the roots for signs of nematode infestation (root galls).

Inspect the potting mix for the presence of cane grub larvae. These larvae feed on the roots in the pot and can lead root loss. If the pots have sufficient water but still show then wilting, this may indicate root problems that are impacting on the plant's ability to uptake water**.**

Examine the roots of plants around the sentinel tree to determine if symptoms are present in more trees. If roots of trees are consistently showing signs of disfunction, submit a tree for diagnostic testing (see Section A.15.7 Pathogen testing). If it is only one tree, assess growing conditions, take remedial action and only submit a tree for testing if root health does not improve as is expected.

Examine trees around problem tree/s to ensure that they are free of root health problems. Where further health problems are identified the batch ***must*** be rejected until such time that the extent of the problem has been determined.

Where the internal root tissue appears rotten submit the tree for diagnostic testing (see Section A.15.7 Pathogen testing). Check root health of trees around the sentinel, ensuring that the blade is sterilised between trees (or use a different blade). Submit at least one tree for diagnostic testing. If more than one tree shows symptoms talk to your diagnostic laboratory for advice on how many trees to submit.

Do not sell trees with unhealthy root systems.

Where problem seeds are suspected as the cause of a disease or disorder, submit as many symptomatic seeds (and plants that may be growing from symptomatic seeds) as is practical to a diagnostic laboratory for testing (in general, 10 seeds per symptom type can be used to test for and identify a range of pathogens). See Section A.15.7 Pathogen testing.

Use disposable gloves or wash with hand sanitiser if moving on to another tree.

A.15.6.4 Maintaining records of inspection

The business ***must*** maintain a *crop monitoring record* that documents:

- the date that the activity was conducted;
- the person who conducted the activity;
- the activity type (sentinel tree inspection or above ground tree part monitoring);
- the crops monitored (for example "Propagation area 2 – Bed 3");
- the scope of the monitoring (for example "all trees" or "35 trees" or "sentinel trees 1-10"; and
- the outcomes of the inspection (for example "no suspicious symptoms detected", or a description of the symptoms detected and the tree or trees that the symptoms were identified on, and the unique sample number or sample numbers if samples are collected).

An example of a *crop monitoring record* is provided in SCHEDULE 2: EXAMPLE RECORD SHEETS.

Key requirements – Maintaining records of inspection

- Records ***must*** be made and maintained of tree inspection and monitoring and outcomes including any samples collected and testing results.

A.15.7 Pathogen testing

A.15.7.1 NIASA approved testing laboratories

Samples that are collected may be despatched to an approved NIASA testing laboratory for analysis. Contact the NIASA accreditation provider for a list of approved testing laboratories.

Samples ***must*** be accompanied by the laboratory's request for testing form. Contact the testing laboratory for a copy of the laboratory's request for testing form and instruction on how to send samples.

A.15.7.2 Maintaining records of testing

Sample details ***must*** be recorded on the approved laboratory request for testing form and sent to the approved laboratory in accordance with the advice provided by the testing laboratory.

A copy of the laboratory request for testing form and sample testing results ***must*** be maintained by the business.

The production nursery ***must*** send a copy of test results that show a positive detection of a Group 1 pathogen (see SCHEDULE 1: GROUP 1 and GROUP 2 PATHOGENS) to the NGIA accreditation provider within 24 hours of receiving the result.

Key requirements - Pathogen testing.

- Where symptoms of infection are identified, steps ***must*** be taken based on the plant part inspected including requirements for sample collection and submission.
- Should a positive test for a Group 1 pathogen be received, follow up inspection and resampling is to be conducted to confirm infection, and determine the extent of contamination and determine the likelihood of elimination. Until such time as the extent of contamination is identified, propagated trees produced at the production site ***must*** not be certified as meeting the requirements of the Macadamia Nursery Stock Specification. Trees ***must*** be identified as "NOT TO SPECIFICATION".

A.15.8 Product quality and meeting customer expectations

Requirements for meeting customer expectations are managed in accordance with requirements provided in NIASA Section 3.5 Product quality and meeting customer expectations. Trees ***must*** meet the following quality requirements, prior to consignment, to meet Macadamia Nursery Stock Specifications:

- Trees are labelled in accordance with this Appendix (see Section A.15.5.4 Labelling of grafted trees).
- Trees are true-to-type without any obvious sign of pest, disease, mechanical, nutritional or chemical disorder.
- Leaves are glossy green and uniform in colour, and without any sign of deformity.
- The above graft head of the tree should comply with the customer requirements. If a central leader is specified than a central leader should be supplied. If a multi-shoot head is specified then a multi-shoot head should be supplied.
- Stems are straight (<15 degrees vertical deviation) without significant bends or kinks.
- Graft unions are smooth and healthy without any indication of incompatibility.

- Trees are free of shoots and suckers below the graft.
- Trees are uniform and of the size specified by the customer for field planting, and carry a minimum of two hardened flushes.
- Trees are planted into containers that are of adequate volume and depth to provide sufficient space to accommodate a healthy and vigorous root system.
- Trees are self-supporting.
- Containers are free of weeds.
- Containerised trees are no more than 24 months in age.

Trees should be continually monitored throughout the production process; however, trees ***must*** be inspected towards the end of the propagation process and no later than 72 hours prior to despatch and comply with the quality specifications. In accordance with requirements provided in NIASA Section A.12.2 Dispatch, a visual assessment of trees ***must*** be conducted prior to loading and consignment.

Trees that do not meet these requirements ***must*** be rejected for consignment, and action ***must*** be taken to determine the source of the problem and correct the problem.

Image 30 – Trees ready for despatch

A.15.9 Auditing for compliance and continual improvement

Audits to assess compliance to Macadamia Nursery Stock Specifications shall be conducted annually in conjunction with annual NIASA auditing.

The auditor shall assess compliance to requirements based on examination of records, examination of general health of the crop and through crop pathology sampling where necessary. The cost of pathology analysis will be borne by the production nursery business. Examination of general health of the crop may include pathology sampling of individual trees that demonstrate symptoms of infection.

Sentinel trees will be examined for root health in the manner described within this Appendix. Where non-compliance to the Specifications is suspected, pathology samples may be taken for analysis. The cost of pathology analysis will be borne by the production nursery business.

Inspection will be undertaken on trees ready for despatch to assess whether stock meet the required standard of product quality (see Section A.15.8 Product quality and meeting customer expectations).

The inspected crop ***must*** not exceed detection of non-conformity in greater than 5% of the crop inspected and the crop ***must*** not display symptoms of infestation by Group 1 and 2 Pathogens. The auditor may remove graft tape on selected trees in order to undertake an inspection of these trees for graft union quality. After inspection the business may replace the tape should it see fit.

The business ***must*** achieve a **Satisfactory** result at audit for each of the requirements specified within this Appendix to be accredited as meeting Macadamia Nursery Stock Specifications. Results are captured within the Nursery Production Checklist (see MACADAMIA NURSERY STOCK SPECIFICATIONS CHECKLIST).

Further information

Audit assessment results for NIASA are categorised as follows:

1. Doesn't Apply (means not applicable to the business)

Is recorded where a requirement/procedure, in the opinion of the auditor, does not apply to the activities undertaken by the business, and implementation of the procedure is not required to satisfy the conditions of accreditation.

2. Complies Fully

Is recorded where the business, in the opinion of the auditor, can demonstrate that it complies fully with the procedural requirement.

3. Satisfactory

Is recorded where, in the opinion of the auditor, compliance to a procedure is generally satisfactory however a non-conformance to a requirement(s) of a procedure is identified which threatens neither the effectiveness nor the assurance provided by the accreditation. These non-conformances are generally minor, administrative or technical in nature.

4. Being Upgraded

Is recorded where, in the opinion of the auditor, a non-conformance is identified with compliance to a procedure which could threaten the assurance provided by the arrangement, but where there is no evidence of a failure to address the specific risk provided for by the procedural requirement and the business has corrective action already underway.

5. Needs Attention

Is recorded where, in the opinion of the auditor, a non-conformance is identified that could seriously threaten the effectiveness of the accreditation arrangement.

This may include a circumstance where a business fails to carry out a procedure or activity that is critical in addressing a serious risk.

Acknowledgements

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Hort Innovation Strategic levy investment | MACADAMIA FUND

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SCHEDULE 1: GROUP 1 and GROUP 2 PATHOGENS

Macadamia nursery stock pathogens are divided into two groups based on their seriousness:

- **Group 1 pathogens**- This group contains pathogens which are destructive in both the nursery and post-nursery phase. Detection of these pathogens ***must*** be reported to the accreditation provider and trees that are infected ***must*** not be sold.
- **Group 2 pathogens**- This group contains pathogens that only cause issues in the nursery and not in the field.

Trees infected with a Group 1 soil borne pathogen may not display any above ground plant part symptoms in the nursery even though there has been drastic damage to the root system over several months.

Pathogens causing stem or graft rot symptoms are very serious and often cause death of the tree, either in the production nursery or after planting. Trees should not be sold with any signs of stem or graft necrosis. Such trees should be removed from the nursery hygienically to reduce risk of infecting surrounding trees.

Similarly, a number of fungi can cause seed rot symptoms that may lead to increased risk of stem rot diseases.

For some pathogens, when present, the level of infestation can be generally low and their presence in the production nursery is frequently associated with poor cultural conditions or retaining trees in the nursery for too long. Their presence may also be indicative of a failure in nursery hygiene.

Group 1 pathogens

Common name	Scientific name (Causative agent)
Phytophthora root rot	*Phytophthora cinnamomi*
Pythium root rot	*Pythium* species
Phytophthora trunk canker	*Phytophthora cinnamomi*
Gall canker	*Tubercularia lateritia*
Stem dieback or graft rot	Fungi from the family Botryosphaeriaceae

Group 2 pathogens

Common name	Scientific name (Causative agent)
Rhizoctonia root rot	*Rhizoctonia* species

SCHEDULE 2: EXAMPLE RECORD SHEETS

The following recording sheets are examples of how the mandatory record keeping for NIASA can be achieved.

There is no requirement to use these sheets but they indicate the information that ***must*** be kept in accordance with the NIASA Macadamia Nursery Stock Specifications.

Records ***must*** be made available to the Nursery Production FMS Auditor when requested.

- Source Block Record - (Example)
- Propagation Material Collection Record – (Example)
- Crop Monitoring Record - (Example)

Macadamia Nursery Stock Specifications
Source Block Record

Example Record

Accredited Business (Name):

Source Block Address:

Source Block Reference (Name or Code):

SECTION A – Property Ownership Details	
Owner name/business name:	
Other details if applicable:	
SECTION B – Block Details	
Date block record started:	
Lot on Plan Number OR GPS coordinate at centre of block:	
Variety or varieties present:	
Number of rows present in the block if more than one variety present:	Map attached with block identified? ☐ Yes
SECTION C – Variety identification	
How is parent tree variety determined at or prior to material collection?	☐ Records are attached (genetic test results, varietal improvement program records, PBR etc.) AND/OR ☐ Examination of all or a combination of the following morphological trait/s below. ☐ Tree shape ☐ Tree size ☐ Tree density ☐ Leaf length ☐ Leaf width ☐ Tip shape ☐ Leaf spines ☐ Husk shape ☐ Shell features ☐ Other (specify) -
SECTION D – Identification of trees where there is more than one variety present in the source block	
Description of how parent trees to be harvested in a mixed block will be identified within the block (for example a tag placed on each tree, a row number and tree number in row, GPS or other method):	
SECTION E – Any other comments	

Macadamia Nursery Stock Specifications
Propagation Material Collection Record

Example Record

Accredited Business (Name):

Source Block Address: Source Block Reference (Name or Code):

Collection Details						
Date:	Collector name:	Material type:	Variety	Amount:	Batch code:	Comments:
		☐ Seed nut ☐ Budwood/scion				
		☐ Seed nut ☐ Budwood/scion				
		☐ Seed nut ☐ Budwood/scion				
		☐ Seed nut ☐ Budwood/scion				
		☐ Seed nut ☐ Budwood/scion				
		☐ Seed nut ☐ Budwood/scion				
		☐ Seed nut ☐ Budwood/scion				
		☐ Seed nut ☐ Budwood/scion				
		☐ Seed nut ☐ Budwood/scion				
		☐ Seed nut ☐ Budwood/scion				
		☐ Seed nut ☐ Budwood/scion				

Macadamia Nursery Stock Specifications
Crop Monitoring Record

Example Record

Accredited Business (Name):

Business address: Inspection Person (name):

Date:

Crop area monitored (Site Plan reference – e.g. Shadehouse 1)	Monitoring activity	Crops monitored (e.g. Bench 3)	Plants inspected (e.g. Sentinels 1-10, 35 plants etc.)	Pest/diseases/disorders detected? (record NO or describe)		Comments / actions (Include sample numbers if applicable)
				Insects/pests	Diseases/disorders/abnormalities	
	☐Sentinel/roots ☐Above ground					
	☐Sentinel/roots ☐Above ground					
	☐Sentinel/roots ☐Above ground					
	☐Sentinel/roots ☐Above ground					
	☐Sentinel/roots ☐Above ground					
	☐Sentinel/roots ☐Above ground					
	☐Sentinel/roots ☐Above ground					
	☐Sentinel/roots ☐Above ground					
	☐Sentinel/roots ☐Above ground					
	☐Sentinel/roots ☐Above ground					

MACADAMIA NURSERY STOCK SPECIFICATIONS CHECKLIST

Confidential

Nursery Industry Accreditation Scheme, Australia

Business Name: _____

Address:_____

_____Postcode:_____

Proprietor's Full Name(s):_____

Telephone:_____Facsimile:_____

Email_____

Application Number:_____

Nursery Production FMS Auditor:_____
Audit Date:_____
Review Date:_____

Note: Grey checklist items ***must*** be graded as satisfactory or greater to achieve NIASA accreditation

This project has been funded by Hort Innovation using the macadamia and nursery levy and funds from the Australian Government.

CHECKLIST: Macadamia Nursey Stock Specifications

*Applicable to businesses seeking Macadamia Nursery Stock Specifications accreditation **in addition** to meeting other NIASA production nursery accreditation requirements.*

SOURCE MATERIALS TO BE USED FOR PROPAGATION

Source block records

A *source block record* is maintained that identifies the source/s of material used for propagation

- Unique identification name or code
- Property address and owner
- Lot on Plan or GPS coordinate
- Block map
- Variety or varieties
- Variety confirmation records
- Method of identifying variety in mixed block
- Number of rows in the block (if mixed variety block)

Needs Attention	Being Upgraded	Satisfactory	Complies Fully	Doesn't Apply

Records must be sighted by the Nursery Production FMS Auditor

Comments:

Propagation material collection records

A *propagation material record* is maintained that identifies material collection details from the source block.

- Source block name or code
- Collection date
- Type of material collected
- Variety
- Source of material identified for collection from variety in mixed block
- Unique batch code

Needs Attention	Being Upgraded	Satisfactory	Complies Fully	Doesn't Apply

Records must be sighted by the Nursery Production FMS Auditor

Comments:

CHECKLIST: Macadamia Nursey Stock Specifications *Continued*

MATERIAL COLLECTION AND HANDLING

Seed nut

	Needs Attention	Being Upgraded	Satisfactory	Complies Fully	Doesn't Apply
Seed nut is stored under appropriate storage conditions					
Stored seed nut batches are labelled to identify variety, block code, collection date and a unique batch code					
Batches of seed nut can be traced back to the *propagation material collection record*					

Comments:

Budwood / scion material

	Needs Attention	Being Upgraded	Satisfactory	Complies Fully	Doesn't Apply
Budwood has been girdled					
Material is stored under appropriate storage conditions					
Stored material is labelled to identify variety, block code, collection date and a unique batch code					
Batches of material can be traced to the *propagation material collection record*					

Comments:

CHECKLIST: Macadamia Nursey Stock Specifications *Continued*

PROPAGATION

Sowing seed nut

	Needs Attention	Being Upgraded	Satisfactory	Complies Fully	Doesn't Apply
Seed nut is sown in a quality free draining propagating media					
The seed bed / container is of sufficient depth to allow unimpeded development of the seedling's root system					
Seedlings are adequately spaced					
The business has a system in place for removal and disposal of poor performing seedlings					
Seedling batches are clearly labelled to identify variety and allow tracing back to the *propagation material collection record*					

Comments:

Transplanting

	Needs Attention	Being Upgraded	Satisfactory	Complies Fully	Doesn't Apply
Seedlings are inspected and only seedlings with a well-developed root system are selected for transplanting					
The container is of sufficient depth to allow unimpeded development of the tree's root system and provides sufficient drainage					
Transplanted seedlings are planted at the centre of the container					
Care is taken to not bend the root system					
Transplanted seedlings are planted at an appropriate depth					
Trees are provided with sufficient shade - sunburn on lower leaves or death of apical bud is not evident					
Transplanted seedlings are provided with adequate wind protection – wind damage is not evident.					
Transplanted seedlings are clearly labelled to identify variety and allow tracing back to the *propagation material collection record*					

Comments:

CHECKLIST: Macadamia Nursey Stock Specifications *Continued*

Grafting

	Needs Attention	Being Upgraded	Satisfactory	Complies Fully	Doesn't Apply
Rootstock and scion diameter are matched to provide maximum cambium contact					
A system is in place to ensure that graft surfaces do not dry out					
Graft unions are tightly wrapped and tied					
The remainder of the scion is sealed to prevent desiccation					

Comments:

Labelling of propagated trees

	Needs Attention	Being Upgraded	Satisfactory	Complies Fully	Doesn't Apply
Trees are clearly labelled to identify variety of scion and rootstock and allow tracing back to the *propagation material collection record*					

Comments:

CHECKLIST: Macadamia Nursey Stock Specifications *Continued*

PLANT HEALTH – ABOVE GROUND PLANT PART MONITORING

Above ground plant part monitoring	Needs Attention	Being Upgraded	Satisfactory	Complies Fully	Doesn't Apply
Monitoring of plants for abnormal growth, pests, diseases and weeds is conducted quarterly					
At least 35 plants are inspected within each batch of plants present within each growing area					
Inspection staff can demonstrate the inspection process required for each plant inspection					
Inspection staff understand actions that *must* be taken on detection of suspicious symptoms					
Records of any testing conducted and test results are maintained					
A *crop monitoring record* is maintained that documents: • the date/s on which monitoring was conducted • the person conducting the inspections • the activity type (above ground plant part inspection) • the crops monitored (location, crop batch) • scope of the monitoring (e.g. the number of plants inspected per batch) • the outcomes of the monitoring including sample numbers if applicable					

Records must be sighted by the Nursery Production FMS Auditor

Comments:

CHECKLIST: Macadamia Nursey Stock Specifications *Continued*

PLANT HEALTH – BELOW GROUND PLANT PART MONITORING

Estimated number of trees produced per year for sentinel plant root monitoring
(Tick which box applies)

Tick	Action
	< 30,000 trees produced per year
	>=30,000 tress produced per year
	>= 60,000 trees produced per year
	>= 90,000 trees produced per year
	>= 120,000 trees produced per year
	>= 150,000 trees produced per year

Comments:

Below ground plant part monitoring (Sentinel Plants)

Needs Attention	Being Upgraded	Satisfactory	Complies Fully	Doesn't Apply

Sentinel plants are established at the specified rate

Each sentinel plant is marked with a unique sentinel plant number

Sentinel plant monitoring for root quality and health is conducted quarterly, commencing six months after the initial establishment of an individual plant until three months prior to the anticipated despatch date

Inspection staff can demonstrate the inspection process required for each inspection

Inspection staff understand actions that *must* be taken on detection of suspicious root symptoms

Records of any testing conducted and test results are maintained

A *crop monitoring record* is maintained that documents:

- the date/s on which monitoring was conducted
- the person conducting the inspections
- the activity type (sentinel plant)
- the crops monitored (location, crop batch)
- the scope of the monitoring (e.g. the unique number/s of the sentinel plants inspected in the batch)
- the outcomes of the inspection including sample numbers if applicable

Records must be sighted by the Nursery Production FMS Auditor

Comments:

CHECKLIST: Macadamia Nursey Stock Specifications *Continued*

PRODUCT QUALITY AND MEETING CUSTOMER EXPECTATIONS

Product quality at consignment	Needs Attention	Being Upgraded	Satisfactory	Complies Fully	Doesn't Apply
The business has a system in place to inspect trees for quality requirements within 72 hours of despatch					
Trees are labelled in accordance with requirements					
Trees are planted in appropriate size containers					
Trees appear true to type and uniform in appearance					
Trees are without any obvious sign of pest, disease, mechanical, nutritional or chemical disorder					
Leaves are glossy green and uniform in colour without any sign of deformity or malnutrition					
Stems are straight without significant bends or kinks					
Graft unions are smooth and healthy without any indication of incompatibility					
Trees are free of any shoots and suckers below the graft					
Trees are at the height specified by a customer for field planting					
Trees carry a minimum of two hardened flushes					
Trees are self-supporting					
Containers are free of weeds					
Staff can explain quality requirements and the process for rejection of non-conforming trees					

Comments:

CHECKLIST: Macadamia Nursey Stock Specifications *Continued*

CROP INSPECTION BY AUDITOR

	Needs Attention	Being Upgraded	Satisfactory	Complies Fully	Doesn't Apply
General crop health and quality - above ground plant parts					
General crop health and quality – below ground plant parts					

Comments:

Note- Auditor samples are recorded in Section 12 of the Production Nursery Checklist

Appendix 3. NIASA Macadamia Nursery Stock Specifications Administration and Resourcing Plan

NIASA Macadamia Nursery Stock Specifications Accreditation

Administration and Resourcing Plan

Nursery & Garden Industry Australia (NGIA)

in association with the

Australian Macadamia Society (AMS)

Version 1.0

Hort Innovation
Strategic levy investment
MACADAMIA FUND

This project has been funded by Hort Innovation using the macadamia research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au

Contents

1. Arrangements for Scheme administration

1.1 Overview

Macadamia tree stock nursery production 'standards', and programs to assess compliance to their requirements, are recognised internationally as an important foundational step in supporting the macadamia nut production industry.

Purchase and establishment of poorly produced nursery stock can cause significant productivity issues in an orchard that only materialise later in the tree life and can reduce harvest volumes and tree longevity.

Purchasers of macadamia nursery stock require assurance that stock purchased meets an industry standard, is true to type, and that appropriate steps have been taken to reduce the chance of introduction of serious pathogens into the production environment.

Macadamia Nursery Stock Specifications are included as an appendix to the Nursery & Garden Industry Australia's (NGIA) Nursery Industry Accreditation Scheme, Australia (NIASA) Guidelines.

A business may apply to NGIA for assessment against the Macadamia Nursery Stock Specifications by selecting the option on their NIASA application form and have the assessment undertaken as part of their existing NIASA audit arrangements.

In order for a production nursery to be eligible to apply to NGIA for accreditation as meeting Macadamia Nursery Stock Specifications, the production nursery **must** be:

- NIASA accredited; **AND**
- implement the requirements specified within the Macadamia Nursery Stock Specifications Appendix; **AND**
- be found at audit to have implemented the procedures within the Appendix to a **Satisfactory standard**.

In accordance with NIASA governance and administration arrangements, costs of implementation and testing are borne by the nursery production business.

1.2 Scheme administration

1.2.1 Relevant parties

The relevant suppliers are:

A. The Nursery & Garden Industry Australia (NGIA)
Unit 58 Quantum Corporate Park
5 Gladstone Road
CASTLE HILL NSW 2154

B. Australian Macadamia Society Ltd (AMS)
113 Dawson Street
LISMORE NSW 2480

1.2.2 Ownership of the Nursery Industry Accreditation Scheme, Australia (NIASA)

It is acknowledged that:

a) NGIA is the sole and exclusive owner of NIASA; being the production nursery, greenlife market and growing media production Best Management Practice Accreditation Scheme; and
b) NGIA is the sole and exclusive owner of the NIASA trademark and NIASA Intellectual Property Rights; and
c) NGIA has the sole and exclusive right to operate, manage and administer NIASA.

1.3 Input, oversight and technical support

The NGIA will administer and resource NIASA.

The requirements contained within the NIASA Macadamia Nursery Stock Specifications Appendix will be determined based on consultation between NGIA and AMS. For this purpose, decision making on production requirements is provided through NGIA and AMS as part of an Authorised Oversight Committee. Where specialist technical advice is required it has been determined that this should be provided through a supporting Technical Advisory Group.

a) The Authorised Oversight Committee will include:

- the AMS CEO;
- an AMS Board member or another person nominated by AMS;
- the NGIA CEO; and
- the National Biosecurity Manager, NGIA, or another person nominated by NGIA.

This Committee will provide the final 'sign-off' of the Macadamia Nursery Stock Specifications Appendix in consideration of advice (where sought) from the Technical Advisory Group. If the Technical Advisory Group are deadlocked on an issue the committee has the final say.

The National Biosecurity Manager NGIA will then take the approved criteria to the NGIA National Governance Committee and seek ratification and inclusion into the NIASA Guidelines in accordance with its governance and administration procedures.

b) The Technical Advisory Group will include nominated technical experts from:

- NGIA - the National Biosecurity Manager or another person nominated by NGIA; and
- AMS - the Industry Development Manager or another person nominated by AMS; and
- A macadamia nut grower nominated by AMS or another equivalent person nominated by AMS; and
- A SIAP member or other appropriately experienced industry person; and
- A macadamia plant horticulturist from the Department of Agriculture and Fisheries nominated by AMS, or another equivalent Departmental person nominated by AMS.

Unless otherwise specified, each member will bear their own costs for attendance.

1.4 Promotion of the NIASA Macadamia Nursery Stock Specifications

Both NGIA and AMS acknowledge that promotion of respective industry schemes supports the best interests of members.

Scheme promotion will be at the cost of either relevant party.

1.5 Fees and Charges for scheme administration

NGIA determines Nursery Production FMS Program and Guidelines Fees and charges. NGIA reserves the right to amend the Fees at any time after consultation with the NGIA Governance Committee.

The current schedule of fees for NIASA as it relates to the Macadamia Nursery Stock Specifications are as follows:

Program	Annual Certification Fee		Hourly Audit Rate	
	NGI Member	Non-member NGI	NGI Member	Non-member NGI
NIASA	$1,000.00	$2,500.00	$150.00	$300.00

Note: NGIA provides equivalence in membership recognition if a business is a member of a relevant PIB approved by the NGIA.

An indictive Nursery Production FMS average audit length (hr) is provided below.

Audit descriptor	Average audit time (hr)
Initial/Final NIASA Audit	4
Annual NIASA Audit	2.5
Estimated combined annual NIASA plus Macadamia Nursery Stock Specifications Audit	**4**
Audit Travel Time for each business set at	**0.5**

For an NGI member, with an annual audit conducted at the estimated average audit time, annual estimated fees and charges are $1675 per year (4.5 hours@$150 plus $1000 certification fee).

The indictive NGIA/NIASA administration and auditing cost when considered on a per tree basis is provided below. NOTE- this includes existing costs of NIASA Accreditation PLUS additional (audit time) costs for Macadamia Nursery Stock Specifications Accreditation.

Annual production (trees)	Indicative cost per tree produced (rounded to nearest cent)
30,000	Slightly less than 6 cents (NOTE – approximately 5 cents is NIASA and 1 cent addresses additional macadamia administration and auditing by NGIA)
60,000	Slightly less than 3 cents
90,000	Slightly less than 2 cents
120,000	Slightly more than 1 cent
150,000	Slightly less than 1 cent

2. Accreditation process

Application for NIASA and Macadamia Nursery Stock Specifications Accreditation shall be made by a business by completing and submitting the approved application form to NGIA. The business shall indicate application for Macadamia Nursery Stock Specifications Accreditation by ticking the appropriate checkbox and completing the form in accordance with the instruction provided.

A business must comply with the Nursery Industry Accreditation Scheme Australia (NIASA) TERMS AND CONDITIONS - ACCREDITATION UNDER THE NURSERY INDUSTRY ACCREDITATION SCHEME AUSTRALIA policy (NI-POL-001).

Rules for processing applications, and giving, rejecting, maintaining and suspending or cancelling accreditation shall be in accordance with the NGIA's **Nursery Production Farm Management System (FMS) GOVERNANCE AND ADMINISTRATION FRAMEWORK** policy (FMS-POL-001).

After a verification audit to confirm application of the scheme to scheme requirements, a successful applicant will receive a Certificate of Accreditation for NIASA including NIASA Macadamia Nursery Stock Specifications upon meeting the requirements of the Scheme. The Certificate is valid for the calendar year during which it is awarded.

3. Suppliers of goods and services

3.1 Analytical services

3.1.1 Current available suppliers of services

The relevant suppliers are:

Pathogen testing	**Genetic testing**
Grow Help Australia Department of Agriculture and Fisheries Ecosciences Precinct Loading Dock 3, Joe Baker St Dutton Park QLD 4102	**Dr Catherine Nock** Research Fellow and Biosecurity Manager, Plant Science Southern Cross Plant Science, Southern Cross University PO Box 157 LISMORE NSW 2480, AUSTRALIA

3.1.2 Fees and charges for analytical services

Fees and charges for analytical services may change from time to time and are made at the sole discretion of the service provider. Quoted fees and charges for services are as follows:

3.1.2.1 Genetic testing

Test	Cost per test
<95 samples	$77.00 (EX GST)
95 samples or more	$50.00 (EX GST)

3.1.2.2 Pathogen testing

Pathogens	
Per sample test	$121.60 (EX GST)

3.2 Auditing services

Auditing services will be managed by NGIA (also see section 0) under existing NIASA audit service arrangements.

4. Significant business costs other than for scheme administration

4.1 Sentinel plant root monitoring

An estimate of the cost of sentinel plant root health monitoring is provided below on a cost per tree produced basis. The estimate is based on a labour cost of $80 per hour with a 30 second inspection time per plant.

Annual tree production	Indicative cost per tree produced
Root health sentinel plant monitoring - 95% confidence of detecting infestation if present at 2% prevalence per round (no more than 1 in 50 plants could be infested and not detected upon completion of monitoring)	
30,000	2 cents
60,000	1 cent
90,000	1 cents
> 120,000	< 1 cent

4.2 Pathogen testing

An estimate of analytical testing costs is provided below on a cost per tree produced basis, based on proportion (%) of plants inspected each year requiring diagnosis.

Annual production (trees)	% plants requiring sample collection after inspection	Indicative cost per tree produced
30,000	0.5% (3 samples/yr)	1 cent
	1% (6 samples/yr)	2 cents
	2% (12 samples/yr)	5 cents
60,000	0.5%	< 1 cent
	1%	1 cent
	2%	2 cents
90,000	0.5%	< 1 cent
	1%	1 cent
	2%	2 cents
120,000	0.5%	< 1 cent
	1%	< 1 cent
	2%	1 cent

Annual production (trees)	% plants requiring sample collection after inspection	Indicative cost per tree produced
150,000	0.5%	< 1 cent
	1%	< 1 cent
	2%	1 cent

5. Indicative cost estimate summary

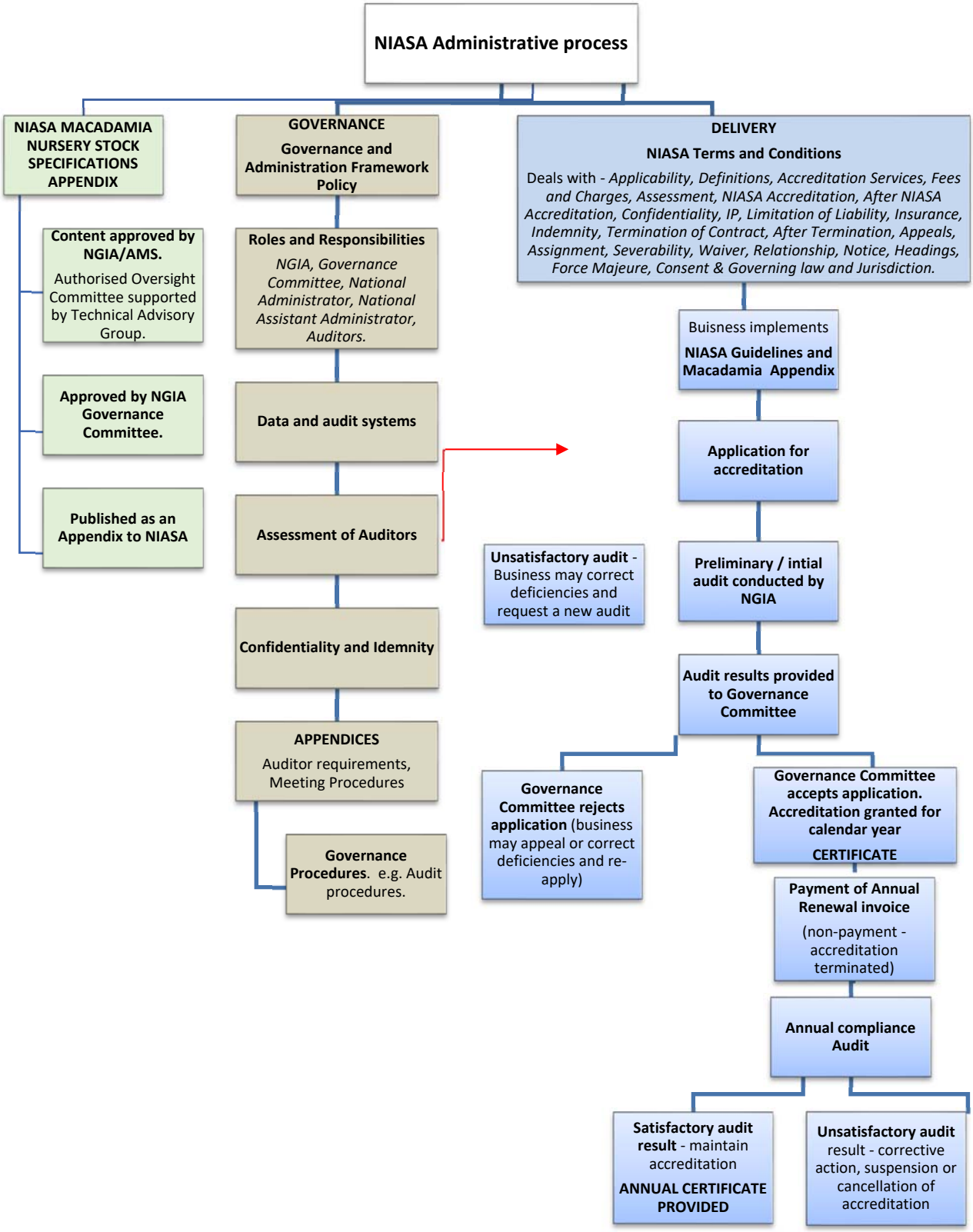
An indicative business resource cost estimate for a production nursery on a per tree produced basis is provided below. Estimates **include system administration costs (NIASA)** and costs of implementation of monitoring and testing only. Figures assume root health sampling rates of 0.5% of plants inspected. The estimate does not include the cost of testing of samples collected at audit where suspicion of infection is detected.

Annual production (trees)	Indicative cost per tree produced
30,000	9 cents* (approximately 50% admin/audit cost for NIASA accreditation which reduces as the number of trees produced increases).
60,000	5 cents
90,000	3 cents
120,000	3 cents
150,000	2 cents

6. Attachments

6.1 Attachment 1 – Scheme administration and implementation flowchart.

Attachment 1



Appendix 4. Extension and Communication

Extension activities and communications throughout the life of this project have been extensive and are reflected within the project's milestones and deliverables summarised within the projects Monitoring and Evaluation Plan included within this report. Further specific details of each activity summarised within the main body of this report are provided below.

Project workshops delivered are listed below.

- Macadamia nursery production workshop presentation.

On 3 and 4 September, a 2-day workshop focusing on macadamia nursery standards and propagation practices was hosted by the AMS at Bundaberg and Hervey Bay. Day one featured a keynote presentation by NGIA's National Biosecurity Manager John McDonald. The presentation included a general introduction to NIASA and the new Hort Innovation nursery standards project for the Australian Macadamia Industry. Approximately 30 representatives of the macadamia nursery production industry attended the presentation.

- AUSMAC2018 Industry Conference - Nurseries: Management & Standards Forum.

This forum was presented by Dr Chris Searle on 15 November 2018. The published theme for the forum was promoted as follows - *'Building on the well-regarded Nursery Industry Accreditation Scheme and following similar developments in avocados and bananas, a nursery accreditation and tree standard is being developed that will, for the first time, set standards of tree quality and nursery hygiene and provide a benchmark for nurseries producing and selling new varieties. Every tree that is sold by a macadamia nursery has the potential to affect the industry for the next 40 years; it is essential that only plants produced in the highest quality nurseries form the future of the industry'.* Over 300 people attended the plenary sessions for this day.

- AUSMAC2018 Industry Conference - *Your Levy at Work Forum.*

At this forum on 15 November 2018, key SIAP members were asked to present on the funded research project they think has the greatest potential to benefit growers and improve their bottom line. Kim Wilson (Eureka Macadamia Management), provided a presentation supporting the project. Background information was supplied to the presenter by NGIA, in the form of a PowerPoint presentation, providing an overview of NIASA and key elements of the project. Over 300 people attended the plenary sessions for this day.

- AMS nursery workshops for growers and nursery operators.

Three workshops were conducted during March 2019 were supported by communication/extension outputs to gather feedback as part of a survey on key requirements. In total, 54 growers attended across the two workshops and 10 operators at the single workshop. The AMS Nursery workshop for growers (QLD) was conducted on 19 March 2019, the AMS Nursery workshop for growers (NSW) was conducted on 20 March 2019 and the AMS Nursery workshop for nursery operators (NSW) was conducted on 21 & 22 March 2019.

The workshops covered updates on the developing standard and accreditation scheme, key criteria proposed and opportunity to provide associated feedback.

General communications outputs were delivered as the project progressed and are listed below:

- AUSTRALIAN MACADAMIA SOCIETY LTD NEWS BULLETIN | SUMMER 2018

The SUMMER 2018 edition of the Australian Macadamia Society News Bulletin, a publication provided on subscription to AMS members, was issued during November 2018. An article was presented on the project that provided an overview, its background, and objectives.

- AUSTRALIAN MACADAMIA SOCIETY NEWS - MACADAMIA NURSERY WORKSHOP A SUCCESS

On 26 September 2018, the AMS posted an electronic news item on the AMS webpage reporting on the Macadamia Nursery Workshop conducted and 3 and 4 September 2018 and re-enforcing the work being conducted as part of the Australian macadamia industry's new nursery standards project. The communication can be accessed at - https://www.australianmacadamias.org/industry/news/macadamia-nursery-workshop-a-success.

A news story on the workshop also featured in the Good Fruit and Vegetables Magazine. The article can be accessed at - https://www.goodfruitandvegetables.com.au/story/5627558/macadamia-tree-need-prompts-nursery-tour-photos/.

- NGIA NEWS & NATIONAL NURSERY NEWS– Macadamia high health nursery stock certification

The NGIA posted an article directed at industry members within its NGIA website on 22 November 2018 and through the National Nursery News, which is directed at a production nursery and allied industry audience. The article provides an overview, background, and objectives of the project and can be accessed at - https://www.ngia.com.au/Story?Action=View&Story_id=2537.

- MACADAMIA GROWER AND NURSERY PRODUCER COMMUNICATION MATERIALS AND FEEDBACK SURVEYS

Two project information sheets with attached feedback surveys were produced and distributed to support macadamia grower and nursery production workshops conducted during March 2019. These were the *Macadamia nursery stock specifications. Hort Innovation Project MC17001 – Grower survey. Quality Requirements for Accredited Trees*; and the *Macadamia nursery stock specifications. Hort Innovation Project MC17001 – Nursery survey. Quality Requirements for Accredited Trees*. A power-point presentation was also produced to facilitate discussion on Macadamia Nursery Stock Specifications key quality requirements.

- MACADAMIA NURSERY PRODUCER CIRCULAR AND DIRECT COMMUNICATION / EXTENSION WITH NURSERY PRODUCERS BY PHONE

Approximately 40 macadamia production nurseries were identified and contacted during the week commencing 22 April 2019 in order to further promote the project and arrange draft NIASA manual distribution and seek interest in on-farm site visits/consultation. Feedback on the initiative was overwhelmingly positive during phone discussions.

Post communication by telephone, further correspondence was distributed by email including a project circular - *Nursery & Garden Industry Australia (NGIA) - NIASA Macadamia Nursery Stock Specifications for macadamia production nurseries*. Circular 19/04-01.

- AUSTRALIAN MACADAMIA SOCIETY LTD NEWS BULLETIN | WINTER 2019 (1 June 2019)

An article for the WINTER 2019 edition of the Australian Macadamia Society News Bulletin, a publication provided on subscription to AMS members, has been produced. The article provides an overview of the project, its background, key production criteria and implementation framework and can be found at https://www.australianmacadamias.org/industry/resources.

On-farm site visits

Details of on-farm site visits are provided within the main body of this report.