Hort Innovation

Final Report

Macadamia benchmarking 2019-2021

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Public summary

The MC18002 project has delivered objective farm and industry performance information to support decision-making and improve farm productivity and profitability within the Australian macadamia industry. Productivity varies significantly between farms, offering significant scope for improvement through widespread adoption of best practice. Over the last decade the top quartile of mature participating farms achieved 70% higher productivity than others in the sample and the standard deviation in saleable kernel production per hectare averaged 50% of the mean. Average productivity also varied by up to 21% between consecutive seasons over the last decade (average 12%), partially due to environmental factors such as extreme weather events. The most productive farms in the sample generally maintained their higher-than-average productivity and positive gross margins regardless of seasonal conditions.

Yield, quality, planting and cost data were collected and analysed annually over four seasons. Personalised farm benchmark reports were produced annually for all participating businesses, ranking their seasonal farm performance relative to others with similar characteristics such as location, farm size, tree age and use of irrigation. Broader industry findings were published via annual industry benchmark reports. Annual meetings of benchmarking participants were facilitated in all major growing regions to review and compare seasonal results and trends. Compelling examples of high productivity and innovation were documented via six case studies and other key findings were presented at industry workshops and meetings and published in industry media.

A total of 264 farms, representing approximately 55% of national production, participated in the final year of the project. In a 2022 participant survey more than 95% of respondents indicated their business had directly benefitted from their involvement in the project. Most indicated they used their confidential farm benchmark report to better understand how their farm compared with others (88%) and to monitor and track their performance (83%). More than two-thirds of respondents used their report to support continuous improvement, and half indicated it had supported management decisions. More than 91% of respondents found benchmarking case studies either very useful or useful as a learning tool, particularly those studies focused on high-producing farms. Almost 73% of respondents found Benchmark Group meetings either very useful or useful, with most indicating the meetings provided opportunity to network with other growers and to discuss and compare management practices.

Benchmark data has informed other macadamia RD&E projects through provision of custom reports, economic forecasts and seasonal trend data. Examples include breeding and regional variety trials (MC19000 and MC17006), Integrated Pest Management (MC16005), Industry Innovation and Adoption (MC20000), Industry Communication (MC21002) and Crop Forecasting (MC18003). Findings have also been utilised by investors, processors, consultants and accountants. Key benchmark data has informed processes and decision-making in financial institutions and other authorities such as the Australian Taxation Office and Plant Health Australia. Trend data has provided objective metrics for strategic planning and RD&E investment.

Seasonal industry benchmark reports are available for download from the Queensland Government Publications Portal. Case studies are available via the Hort Innovation web site and the Queensland Agriculture Youtube channel. Articles detailing key project findings are available via the AMS News Bulletin.

Keywords

macadamia; benchmarking; productivity; yield; quality; costs; statistics; performance; metrics; industry.

Introduction

Increasing productivity and grower returns has been a key strategic goal for the macadamia industry (*Outcome 1, SIP 2017-21, Outcome 2, SIP 2022-26*). Data from this and previous benchmarking work has shown that productivity varies significantly between farms. The long-term average nut-in-shell (NIS) yield for the benchmark sample was 2.8 t/ha with a standard deviation of 1.29 t/ha (46%). The long-term average saleable kernel (SK) yield was 0.89 t/ha with a standard deviation of 0.45 t/ha (40%). Seasonal productivity can vary due to factors such as weather, pest & disease pressure, and significant farm management activities such as canopy management and orchard rejuvenation.

Over the last decade the top quartile of mature participating farms achieved 70% higher productivity than others in the sample and the standard deviation in saleable kernel production per hectare averaged 50% of the mean. Average productivity also varied by up to 21% between consecutive seasons over the last decade (average 12%), partially due to environmental factors such as extreme weather events. The most productive farms in the sample generally maintained their higher-than-average productivity and positive gross margins regardless of seasonal conditions. There is significant scope for lifting productivity across industry through widespread adoption of best practice.

This project has focused on comparing seasonal productivity of a sample of farms as well as tracking long-term individual farm performance to support decision-making. Growers participating in benchmarking have indicated they see benefit in understanding how their farm performance compares with other similar farms, and that such understanding is an important driver of positive practice change. To this end, the project provided participants with confidential, objective rankings of their individual farm performance against similar farms in the sample according to size, tree age, location and use of irrigation. Rankings for yield, kernel recovery and costs provided an understanding of relative farm performance within comparable sub-samples as well as across the whole benchmark pool.

Improved understanding of the conditions and factors influencing seasonal and regional productivity and quality provided important context for practice change. These included seasonal conditions and pressures such as pests, diseases and weather as well as attributes such as tree or soil health. Relating limiting factors to measured yield and quality also afforded insight into their relative economic significance at both a farm and industry level.

Publication of case studies demonstrating high-performing farms and innovation offered compelling examples of leading practices and achievable productivity goals. Inclusion of long-term farm performance data provides critical credibility to these farm business scenarios, which further builds confidence for decision-making and practice change.

Bringing growers together via regional Benchmark Group meetings to discuss and compare seasonal outcomes has provided opportunity for detailed information sharing and peer-to-peer learning. Those who attended Benchmark Group meetings indicated they were valuable opportunities for discussing practices, sharing knowledge and learning from owners and managers of high-performing farms. Many of these events also provided valuable opportunities for networking and information sharing between growers, consultants and other industry RD&E service providers.

Methodology

Data collection and validation

The project collected data annually from participating growers, including plantings, production, quality and costs. Data collection forms (Appendix B) included consigned production, kernel recovery and factory rejects, tree counts and spacings and seasonal limitations to production such as weather, pests, and diseases. An optional section included operating costs, split into a standard set of expense categories, as well as expenditure priorities and unpaid labour. Online surveys were also used for annual collection of some data, particularly to allow existing participants whose circumstances had not changed to specify which processors they had supplied during the current season.

Data collection forms and online surveys were distributed to growers by email at the end of the harvest season around October. Participants who did not respond to this initial call for data were telephoned by team members to expedite data collection and to assist with interpreting questions and seasonal outcomes. Team members also visited some participants in person to assist with data collection, particularly of complex data such as production costs.

Approximately 80% of participants provided consent for their seasonal yield and quality data to be sourced directly from their processor(s). This data was sourced from processors in batches to minimise disruption to their business processes. Data collection ceased at a pre-determined date following the end of each production season to ensure findings could be reported at the earliest opportunity to aid decision making.

Collected data was digitised and validated using a range of threshold tests to identify outliers or errors and to ensure consistency between farms and seasons. Any data falling outside of accepted thresholds was verified with the relevant growers prior to commencement of the annual reporting cycle.

Reporting

Confidential farm reports were produced for each participating farm business in each year of the project (Appendix B). These reports compared and ranked individual farm performance based on yield, quality and optionally production costs, where provided. Each farm was ranked against averages of other farms of similar size, location, weighted average tree age, planting density, management structure or irrigation usage. Individual farm performance trends were also tracked and reported for all available seasons dating back to 2009.

Industry reports were produced and published each season to summarise seasonal findings and long-term trends. Variation in seasonal productivity and quality was reported according to farm size, tree age, region and planting density. Variability within the sample was further reported via distributions and percentiles. Detailed regional analyses were also reported, including weather and soil moisture data in relevant seasons.

The format and content of the industry report was continuously refined according to feedback from participants and industry stakeholders. Professionally produced and printed hard copies were distributed to all participating growers each season. An electronic version in PDF format was also uploaded annually to the Queensland Government Publications Portal and promoted to the wider industry via the industry communications program.

Benchmark Groups

Benchmark Group meetings provided forums for discussing benchmark findings and sharing information and experience. Six groups were established across the major macadamia production areas (Appendix A, Figure 1), including Central Queensland (CQ), Southeast Queensland (SEQ), Northern Rivers of NSW (NRNSW) and the Mid Coast of NSW (MNNSW). One additional group was piloted in 2021 to include growers with young farms in coastal NSW. Participation in meetings was offered to all benchmarking participants. Key consultants, processor representatives and RD&E service providers were also invited to participate, subject to consent from participating growers.

Meetings were facilitated annually, generally early each year prior to commencement of harvest, but also tailored wherever possible to suit the availability of growers in each region. Meetings commonly focussed on reviewing seasonal results and observations, with additional content tailored according to the priorities identified by each group to maximise local relevance. The strong sense of ownership promoted by this approach resulted in high retention of members during the life of the project (>90%). Most meetings included presentations and interaction with other RD&E service providers to facilitate discussion and information exchange relating to major industry-funded projects. Benchmark groups were also used to introduce and trial new initiatives developed as part of other projects, such as the IPM scorecard, which was trialled during 2022 meetings.

Case studies

Six case studies were produced to communicate compelling examples of innovation, highly productive farms or significant research outcomes (Appendix A, Table 8). Video based case studies were produced and published via the Queensland Agriculture YouTube channel. Their availability was promoted to industry via the industry communications channels. Case study fact sheets were also produced and were published in industry media and the Hort Innovation website.

Communication

In addition to presentations at Benchmark Group meetings, findings were presented at industry events including MacGroup and consultant meetings, and processor field days. Two articles and two case studies were also published in the Australian Macadamia Society News Bulletin. Four case study videos were published via the Queensland Agriculture YouTube channel. Farm rankings based on productivity and quality were generated annually for small and large farms to identify regional finalists for the Australian Macadamia Society's Awards of Excellence.

Results and discussion

Participation

A total of 801 personalised confidential farm benchmark reports were produced during the project. 305 farms participated in the macadamia benchmarking program in its final year, representing approximately 13,252 planted hectares and 10,274 bearing hectares. 264 of those farms had some trees aged five or more years and were therefore considered bearing for the purpose of the benchmark study. Those farms represented 10,053 bearing hectares and produced 30,303 tonnes of NIS in 2021, which was approximately 55% of national production (*AMS, 02 December 2021*). Production cost data was sourced from 89 participating farms (87 bearing), representing 29% of the total benchmark sample, or 21% of national production for the 2021 season. Tables 4 and 5 in Appendix A show seasonal participation rates and sample coverage for yield and quality and operating costs respectively.

The targeted industry coverage rate of more than 50% has been maintained throughout the project, despite significant changes to farm ownership during the last few years. While the number of participating farms fell by 0.8% during the project term, the total planted hectares for the sample increased by 2.8% during the same period. Regional representation within the sample has been relatively constant throughout the project. Table 6 in Appendix A shows a breakdown of bearing farms and their planted hectares by region for each year of the project. Most sample growth was evident in the CQ region, with participating farms in that region increasing by 12% and plantings by 7% during the project term.

A total of 243 farms (average 81 per season) participated in 16 regional Benchmark Group meetings held during the project term. Most businesses attending Benchmark Group meetings participated in all years of the project, although NSW meetings were cancelled during 2020 due to public health and travel restrictions associated with COVID-19. Table 7 in Appendix A provides details of Benchmark Group meetings that were facilitated during the project. Participation rates increased in the CQ region throughout the project but remained relatively constant in other regions. A trial meeting was held for new growers and farms in the NRNSW coastal flats area, which may ultimately lead to additional participation in that region.

Yield and quality trends

The latest industry benchmark report (Appendix B) provides a comprehensive summary of seasonal and long-term trends for the benchmark sample. Over the last 5 seasons, 31% of farms averaged 2-3 t/ha, followed by 3-4 t/ha (28%) as shown in Figure 2 in Appendix A. The rolling five-year average productivity per hectare from 2009–2021 showed a net increase of approximately 0.47 t/ha (19%) for NIS and 0.2 t/ha (25%) for saleable kernel (Appendix A, Figure 3). The most significant productivity gains from 2009-2021 were evident in the CQ region, with increases of 30% for NIS and 40% for saleable kernel. Many young farms in this region have reached bearing age during this period. Participating farms in the CQ region have achieved the highest weighted average productivity within the benchmark sample in six of the last seven seasons. Long-term yield data suggests that productivity per hectare generally tapers at 10 to 14 years and plateaus around 20 years, although there are significant differences between farms and regions. The CQ region has achieved higher yield in younger trees than in other regions, although there is some evidence of yield plateauing earlier at 10-14 years, while yield generally continues increasing with age for farms in SEQ (Appendix A, Figure 4).

Variability between farms in any given season has remained high, with a long-term average seasonal standard deviation of 46% for NIS and 40% for saleable kernel. The lowest long-term variability is evident in the CQ region (SD 26-42%) while the highest is in SEQ (SD 41-60%) and MNNSW (SD 39-94%). Various factors have influenced this variability including canopy management, orchard rejuvenation, severe weather events and prolonged periods of climatic extremes such as hot and dry weather, particularly in recent seasons. The impact of these events on the sample average is balanced in some cases by increased investment in soil and tree health, with many anecdotal examples of farms improving resilience through this work. Hot or dry weather was the most reported factor limiting productivity throughout the project, although generally favourable weather in 2020 meant that pests were a more significant limitation in that season.

Between 2009 and 2021 average saleable kernel recovery increased by 1.8% (premium 1.2% and commercial 0.6%) while reject kernel recovery decreased by 0.3% (Appendix A, Figure 5). Analysis of factory rejects showed that insect damage was the most significant cause of factory rejects for most farms in the sample in most seasons and particularly for farms with less than 10 hectares of trees. Insect damage followed a rising trend over many years but more recently has shown some signs of plateauing and perhaps declining (Appendix A, Figure 6). This coincides with increased production from

farms in the CQ region, which tend to have lower average levels of insect damage compared with other regions. Most growers who provided seasonal limitation feedback indicated that Fruitspotting bug (*Amblypelta spp*.) was primarily responsible for their insect damage losses.

When factory rejects are weighted by production, 'brown centres' emerges as the most significant cause of loss. Rejects due to brown centres are most prevalent on farms larger than 100 hectares, particularly in the CQ region. The highest levels of brown centres were recorded more than twelve years ago. Average levels then declined over several years but more recently have generally increased again, particularly in Queensland. This trend again coincides with increasing production in the CQ region.

Immaturity has been a significant problem in some seasons, particularly in very dry periods such as 2013/14 and 2019/20. The most significant immaturity losses were evident in Queensland, particularly non-irrigated farms in the SEQ region. These losses mostly coincided with prolonged periods of hot and dry weather during critical periods of nut development.

Cost and profitability trends

Production cost data has been collected and reported since 2013. Estimates of unpaid labour were added from 2017 and imputed at a standard rate of $30 per hour in accordance with the Horticulture Award.

The most common expenditure range over the last five seasons was less than $6,000/ha (72 farm-years or 18% of the sample), followed by $6,000-$8,000/ha and $10,000-$12,000/ha (17% each). There is however wide variation in expenditure between farms and regions (Appendix A, Figure 7).

Average operating costs per planted hectare have increased almost every year since they were included in the benchmark sample in 2013 (Appendix A, Figure 8). Cash costs have risen by almost 70% over that period. Feedback from growers suggests that while input costs have generally risen, in some cases favourable margins in recent years have also encouraged additional on-farm improvement and rejuvenation expenditure. Average costs per tonne NIS also generally rose over the same period, however these are more variable due to seasonal fluctuations in productivity. There is a significant positive correlation between expenditure and productivity, and particularly expenditure on nutrition and crop protection ($P<0.01$), suggesting that farms with higher average expenditure generally also achieve higher NIS and saleable kernel productivity.

Farm profitability is significantly influenced by both yield and NIS price. Recent fluctuations in NIS price and seasonal productivity, combined with increased costs, have collectively impacted average farm gross margins, which have fluctuated by up to $5,000/ha between seasons over the last five years (Appendix A, Figure 9). This equates to gross margin ratios (i.e., gross profit margins) of between 46% and 59% over the last five seasons.

Outputs

Table 1. Output summary

Output	Description	Detail
Confidential farm benchmark reports	**2019:** 264 reports to growers Reach: 10,463ha, 26,595 tonnes NIS **2020:** 273 reports to growers Reach: 10,851ha, 29,464 tonnes NIS **2021:** 264 reports to growers Reach: 13,251ha, 30,303 tonnes / NIS	A total of 801 confidential, bespoke 12–16-page farm benchmark reports were e-mailed to participating businesses, which collectively represented more than 55% of annual production. Results of a 2022 participant survey (Appendix B) indicated that 98.5% of survey respondents found the content and timeliness of their farm benchmark report to be useful or very useful. Most respondents used their farm benchmark report to better understand how their farm compared with others (88%) and to monitor and track the performance of their farm (83%). A sample farm report for the 2021 season is available in Appendix B.
Macadamia industry benchmark reports	**2019:** Industry report 2009-2018 **2020:** Industry report 2009-2019 **2021:** Industry report 2009-2020 **2022:** Industry report 2009-2021 **Reach:** Collectively accessed >1,400 times via the Queensland Government Publications Portal and accessed 3,418 times via the AMS web site since 2018.	Both electronic and hard copy reports were delivered to all participating businesses. Electronic versions were also published via the Queensland Government publications portal and links provided to industry stakeholders via the communications program. More than 87% of survey respondents indicated the content of industry reports was either very useful (80%) or useful (7%). Links to the industry benchmark report 2009-2021 and participant survey results are available in Appendix B.
Productivity and innovation case studies	**2019:** 2 case studies (video-based) **2020:** 2 case studies (video-based) **2021:** 2 case studies (fact sheets) **Reach:** Video case studies collectively received almost 40,000 views. Fact sheet case studies published via the AMS News bulletin were distributed to an audience of over 900 members.	Video case studies were published via the Queensland Agriculture YouTube channel and promoted via the industry communications program. Case study fact sheets were published via the AMS news Bulletin and Hort Innovation. More than 91% of survey respondents indicated the case studies were either very useful or useful, particularly those focusing on high producing farms. Case study links are available in Appendix A, Table 8.
Regional Benchmark Group meetings	**2019:** 3 Benchmark Group meetings Reach: 48 farms, 2,152Ha, 5,523 T NIS **2020:** 7 Benchmark Group meetings Reach: 112 farms, 4,154Ha, 7,969 T NIS **2021:** 6 Benchmark Group meetings Reach: 83 farms, 5,845Ha, 11,115 T NIS	All benchmarking participants were invited to attend annual Benchmark Group meetings. Almost 73% of respondents found Benchmark Group meetings either very useful or useful. Survey feedback was generally very positive, with most indicating the meetings provided opportunity to network with other growers and to discuss and compare management practices. A detailed summary of Benchmark Group activities is provided in Appendix A, Table 7. More detail on Benchmark Group participant feedback is available in the 2022 participant survey in Appendix B.
Ad-hoc reports for stakeholders	**2019:** 7 ad-hoc reports **2020:** 14 ad-hoc reports **2021:** 5 ad-hoc reports **2022**: 8 ad-hoc reports **Reach:** From single businesses through to wide audiences (e.g., via AMS). It was not	Ad-hoc reports were produced on request by industry stakeholders. All bona-fide requests for ad-hoc reports were satisfied during the project term. Narratives have been recorded to track the nature of each request, the report produced and feedback from clients (where provided). Most of these remain confidential at the request of clients. Further details

	possible to track the reach of individual reports in these instances.	about ad-hoc reports are available in Appendix A, Table 9.
Presentations and articles	**2019:** 1 article, 1 presentation **2020:** 6 presentations **2021:** 1 article, 2 presentations **Reach:** AMS News bulletin articles reached an estimated audience of over 900 members. Presentations at MacGroup meetings reached an estimated audience of 438 attendees.	Presentations were delivered at regional MacGroup meetings and consultant meetings on invitation. Further details about presentations delivered and articles developed are available in Appendix A, Table 10.

Outcomes

Table 2. Outcome summary

Outcome	Alignment to fund outcome, strategy and KPI	Description	Evidence
Improved awareness of farm performance relative to others, supporting positive practice change and improved productivity	Increased productivity and grower returns through an average yield increase to five tonnes NIS per hectare by 2021 (SIP 2017-2021)	Productivity remains seasonally variable and the >5t/ha KPI is yet to be realised, with just 6% of the sample achieving this in 2021. There is evidence of long-term improvement as the five-year moving average productivity from 2009–2021 shows a net increase of approximately 0.47 t/ha (19%) for NIS and 0.2 t/ha (25%) for saleable kernel. Some individual farms have improved productivity significantly over the long-term.	Evidence of practice change and improvement was tracked via seasonal metrics and formal evaluation (Appendix B). More than 95% of survey respondents indicated the project had a positive impact on their business. Most respondents used their confidential farm benchmark report to better understand how their farm compared with others (88%) and to monitor and track the performance of their farm (83%).
Improved quality through reduction in unsound kernel recovery	Unsound kernel received by processors reduced from 3% to 2.5%	Reject kernel recovery has generally decreased over the long-term. The 5-year weighted average for 2017-2021 was 2.66%, down from 2.76% prior to 2017.	Results were tracked via seasonal factory reject data. Evidence of practice change was observed through client feedback and regional Benchmark Group meeting discussions.

Monitoring and evaluation

Table 3. Key Evaluation Questions

Key Evaluation Question	Project performance	Continuous improvement opportunities
To what extent has the project improved knowledge and awareness of farm productivity, quality and costs of production?	• Over 88% of respondents in the 2022 participant survey (Appendix B), indicated their report helped them better understand how their farm compares with others. • Industry reports have received over 1,400 views between 2019 and 2022. Approximately 80% of survey respondents found the content of the industry report to be very useful and a further 7% found it useful. • Eleven narratives were documented during the project, detailing how ad-hoc analyses and reports supported decision-making for growers, investors, researchers, processors and fund managers. • 91% of survey respondents indicated case studies were either very useful or useful as a learning tool. • Industry articles and presentations have promoted broad industry awareness of productivity and profitability.	• There may be an opportunity to produce farm reports earlier each season by enforcing data collection deadlines. The need for early reporting needs to be balanced against goals to maintain or increase sample size. • Survey participants indicated that more case studies of high performing farms would be beneficial. • Improving awareness of climate change and its implications on productivity and sustainability has become increasingly relevant during recent challenging seasons.
To what extent have the project outputs (farm reports, industry reports, benchmark groups and case studies) met the needs of industry levy payers?	• >95% of respondents indicated their business had directly benefitted from their involvement in the project. • Farm reports were the most highly ranked project output, with almost all (98.5%) respondents indicating their report was either very useful or useful. • Case studies ranked second among project outputs, with more than 91% of respondents indicating they were either very useful or useful. Video-based case studies were collectively viewed more than 40,000 times, the most popular of which was *"What makes a top-performing farm"*. Fact sheets published in the AMS News Bulletin were distributed to over 900 members. • Annual industry reports ranked third among project outputs, with more than 87% of respondents indicating the content was either very useful (80%) or useful (7%). • Almost 73% of respondents found Benchmark Group meetings either useful or very useful. Although Benchmark Groups ranked fourth among project outputs, it should be noted that only 30% of participants attend these meetings. Those who do attend the meetings generally rate them as important learning opportunities.	Suggestions received via the 2022 participant survey included: • Analysing yield by variety • Spatialise data to include climate, soil type, etc. • More detailed costs, including costs of establishment • More face-to-face meetings • More insight into top performing farms

What percentage of the Australian macadamia industry participate in the project?	Detailed participation rates in the project can be found in Appendix A. **Production** **2018**: 272 farms (59% of production) **2019**: 264 farms (57% of production) **2020**: 273 farms (59% of production) **2021**: 264 farms (55% of production) **Production Cost (optional)** **2018**: 87 farms (22% of production) **2019**: 94 farms (23% of production) **2020**: 87 farms (22% of production) **2021**: 87 farms (21% of production)	• As the industry grows and expands there is opportunity to capture establishment data in new regions. • Participation rates should be maintained wherever possible to represent at least 50% of production. Coverage should be determined according to plantings and production rather than farm counts. • Collaboration with industry Awards of Excellence should continue to encourage participation.
Were the format of project outputs such as farm reports, industry reports, Benchmark Group meetings and case studies appropriate for the target audience?	• The appropriateness of project outputs was evaluated via a 2022 participant survey. Results are highlighted above and shown in detail in Appendix B. • 75% of respondents to a 2020 participant survey indicated that the information contained in their benchmark reports was appropriate for their needs.	Suggested improvements to the format of project outcomes from the 2020 evaluation survey include: • More data on effects of change, canopy management, nutrition etc. • Interactive reporting and filtering.
What efforts did the project make to improve efficiency and timeliness of deliverables (reports, meetings, case studies)?	The timeliness of project outputs was evaluated via the 2022 participant survey: • Farm reports: 94% very useful or useful • Case studies: 88% very useful or useful • Industry reports: 81% very useful or useful • Benchmark Group meetings: 68% very useful or useful Improvements to efficiency and timeliness of outputs during the project included advertised cut-off dates for data collection, simplified grower data collection via online surveys and batch requests to processors for data to reduce impact on their workload.	Suggested improvements to the timeliness of project outcomes from the 2020 evaluation survey included: • online benchmark groups • less industry reporting in favour of more timely farm reports • earlier Benchmark Group meetings in some regions.

Recommendations

Data collection and reporting

In a 2022 evaluation more than two-thirds of participant survey respondents indicated their farm report supported continuous improvement, and half indicated it directly supported management decisions (see Participant Survey Report, Appendix B). Some growers indicated they share their reports with others each year such as growers, banks and investors. Ongoing annual collection of data and production of farm benchmark reports is recommended to support these activities, and to avoid gaps in seasonal farm performance trends. Temporal continuity within the sample is also important to track and inform the extent and impact of seasonal agronomic and environmental factors that influence productivity and profitability, such as biennial bearing, severe weather events and challenging climatic conditions.

Benchmark clients have indicated the importance of timeliness in delivery of farm benchmark reports each season. Maintaining seasonal sample size targets and proportionate regional representation can cause delays. Balancing these goals with the timely delivery of farm reports requires compromise, particularly in late production seasons or regions. While some consideration of seasonal conditions is important, a limit on the data collection period is recommended to avoid extended delivery delays. Farms unable to provide data within the prescribed timeframe could still participate, either through later reporting in the current season or inclusion of historical data in the following season.

Some survey participants have also indicated interest in tracking the performance of specific varieties via the benchmarking project. While most farms currently do not have capacity to harvest by variety, new technologies such as load cells could potentially make this feasible. The recent and ongoing establishment of large, single-variety plantings may also make this more achievable in the future. Ongoing communication with benchmark participants is recommended to track industry capacity for harvesting and reporting yield by variety.

Many management changes impacting productivity have been applied as a result of previous research, extension and best practice work, such as single-pass harvesting, effective canopy management, minimising root exposure and refinements to on-farm sorting and storage. Benchmarking can continue to track the impact of such practice change, but that change may increasingly require a more detailed understanding of tree physiology and relationships with light, soil and climate. Opportunity exists to spatially analyse seasonal production and quality data in conjunction with agronomic, ecological and climatic factors such as soil type, climate and local weather events to improve understanding of the impact of these factors on productivity and quality.

Sustainability

Some participants have expressed interest in expanding the focus of the benchmarking study to include sustainability. As the industry continues to expand, it is important that farm owners and the wider industry can demonstrate sustainable operating practices with minimal impact on communities, ecosystems, and the environment in general. Trialling the addition of key sustainability metrics within the benchmark data set is recommended, particularly those relating to resource use efficiency such as water, nutrients and energy inputs per unit of production. Metrics such as these could potentially support decision-making for growers, investors and supply chain stakeholders to maximise resource use efficiency and minimise emissions and impact. Prioritisation of specific metrics and their implementation timeframes should be determined in consultation with industry stakeholders.

Benchmark Groups

Approximately 31% of participants attend regional Benchmark Group meetings, representing 57% of bearing plantings within the sample. Meeting attendees and survey participants most commonly report that they find these events valuable for discussing seasonal findings, sharing information and experience and networking with other growers and in some cases consultants, researchers and processors. Feedback from the 2022 survey suggests there is value in continuing to facilitate these regional meetings each season. There may be opportunities for adding further value to these meetings, either through inclusion of new information such as sustainability metrics or through specialised topics such as activity-based or orchard establishment costs.

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Intellectual property

No project IP or commercialisation to report. Intellectual property was developed in the form of data, reports, scientific papers and extension materials. Raw data remains confidential and securely stored by DAF. Data summaries have been published in strict accordance with the Project Privacy Policy. All other forms of IP generated were designed for industry dissemination rather than commercialisation.

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Appendix A — Summary of results

Scope and coverage

Yield and quality data by season						
Year	**Total participating farms**	**Bearing farms**	**Planted hectares**	**Bearing hectares**	**Non-bearing hectares**	**Production (tonnes of NIS)**
2009	192	178	8059	5810	2249	16030
2010	195	184	8238	6398	1840	15478
2011	207	192	8691	6949	1743	14159
2012	252	243	9464	8435	1029	20337
2013	265	262	10044	9454	590	19181
2014	268	267	10122	9804	317	23539
2015	271	271	10403	10096	307	27846
2016	273	271	10053	9785	268	29556
2017	278	274	10293	9809	484	26098
2018	281	275	10828	9923	905	31570
2019	279	265	11096	9818	1278	26609
2020	290	273	11787	10096	1691	29550
2021	305	264	13252	10274	2978	30303
Total farm years (2009-2021)	**3356**	**3219**				

Table 4: Summary of yield and quality data by season

Production cost data by season						
Year	**Total participating farms**	**Bearing farms**	**Planted hectares**	**Bearing hectares**	**Non-bearing hectares**	**Production (tonnes of NIS)**
2013	47	47	2357	2151	206	4719
2014	47	47	2314	2226	88	6173
2015	40	40	2059	1988	71	5358
2016	54	53	2296	2290	6	7414
2017	74	71	3241	3233	9	8922
2018	89	87	3854	3551	302	11661
2019	97	94	4322	3949	373	10775
2020	89	87	4110	3743	366	11243
2021	89	87	4166	3813	353	11786
Total farm years (2013-2021)	**626**	**613**				

Table 5: Summary of production cost data by season

Benchmark regions broken down by bearing farms and planted hectares										
Year	**CQ**		**SEQ**		**NRNSW**		**MNNSW**		**TOTAL**	
	Farms	**Ha**	**Farms**	**Ha**	**Farms**	**Ha**	**Farms**	**Ha**	**Farms**	**Ha**
2019	50	5428	52	1433	136	3204	28	431	**266**	**10496**
2020	53	5616	50	1514	144	3370	27	423	**274**	**10924**
2021	56	5810	52	1495	131	3048	25	443	**264**	**10795**

Table 6: Breakdown of number of bearing farms and planted hectares in the benchmark sample by region (2019-2021)

Regional Benchmark Group meetings					
Region	**Year**	**Farms**	**Hectares**	**NIS tonnes**	**Date of meeting**
Glass House Mountains	2020	13	307	829	31/01/2020
Gympie	2020	13	335	1,064	4/02/2020
Bundaberg	2020	22	1,510	3,630	27/02/2020
No NSW meetings (COVID)	2020	-	-	-	-
Total	**2020**	**48**	**2152**	**5523**	
Glass House Mountains	2021	10	142	386	2/02/2021
Gympie	2021	10	315	750	4/02/2021
Bundaberg	2021	24	1,213	4,309	12/03/2021
NSW Northern Rivers Group A	2021	19	572	1,112	11/03/2021
NSW Northern Rivers Group B	2021	13	252	809	12/03/2021
NSW Northern Rivers Coastal Flats	2021	21	1,376	N/A	16/03/2021
NSW Mid North Coast	2021	15	284	603	17/03/2021
Total	**2021**	**112**	**4154**	**7969**	
Glass House Mountains	2022	5	62	253	21/04/2022
Gympie	2022	7	186	728	22/04/2022
Bundaberg	2022	36	4,736	7,714	12/05/2022
NSW Northern Rivers Group A	2022	7	198	542	19/05/2022
NSW Northern Rivers Group B	2022	12	319	1067	20/05/2022
NSW Mid North Coast	2022	16	344	811	25/05/2022
Total	**2022**	**83**	**5845**	**11115**	

Table 7: Regional Benchmark Group meetings 2020-2022

Case studies

Case studies		
Case study	**Views**	**Description**
What makes a top-performing farm 21/10/19	36,422	High yield variability within the macadamia industry highlights opportunities to improve productivity. The benchmarking team takes a closer look at top performing farms to see what they have in common that helps them achieve sustained high productivity and quality.
Maintaining productivity during challenging seasons 12/10/19	2,165	Macadamia productivity can be affected by lack of rainfall, particularly during crucial nut development periods. Michael Cooper has been able to produce above average productivity even in dry seasons and shares how he has been able to achieve this on his orchards in the Glasshouse Mountains region.
Lifting productivity through rejuvenation 08/10/2020	863	In recent years many macadamia growers have undertaken, or at least considered, orchard rejuvenation to improve tree health and increase productivity. One of the biggest challenges can be knowing where to start and determining which improvements will result in the biggest gains. Trevor Martin shares his story on orchard rejuvenation.
Production costs: A summary of the 2013 to 2019 seasons 08/10/2020	351	Cost data has been collected annually since 2013 as part of the macadamia industry's national benchmarking project. Over the last seven years an average of more than 60 farms each season have contributed valuable data on total operating costs, as well as a breakdown of their major expenses. The data reveals interesting trends for all growers and those looking to expand or develop new farms.
Rejuvenation breathes new life into an old orchard 09/2021	N/A	Steve Ferndale details how he has rejuvenated and built resilience into his orchard, including his approach to canopy management, drainage, nutrition and orchard floor management. Distributed to 959 AMS members.
Maintaining productivity at 'Twisted M' farm 09/2021	N/A	Bruce Maguire discusses his approach to managing his farm in Kin Kin, Queensland. Bruce provides insight into seasonal challenges and how he has maintained high long-term productivity. Distributed to 986 AMS members.

Table 8: Case studies produced 2019-2021

Ad-hoc reports and other communication

Ad-hoc reports produced		
Year	**Reports**	**Topics**
2019	7	Expense categories, production by sub-region, long-term productivity and productivity ranges, expenditure trends for top performing farms
2020	14	Seasonal vs long term costs, Costs by farm size, yield x tree age, seasonal gross margins, top performing farms (5%, 10%, 25%), planted area by tree age estimates, segmentation of top performing farms by region, tree age and farm size
2021	5	Farm employment FTEs and costs, top performing farms, average costs by region and farm size
2022	8	Top performing farms, yield by tree age, yield and costs for large farms, trees and hectares by age and region, production costs, copy of farm history (with appropriate consent)

Table 9: Case studies produced 2019-2021

Other communication activities		
Year	**Type**	**Description**
2019	Article	*Benchmarking identifies the industry's top performing orchards* AMS News Bulletin Vol 47, Number 4, 2019.
2019	Presentation	Summary of benchmark findings Annual Consultants meeting, Brisbane 4th June 2019.
2020	Presentation	*The impact of environmental conditions on productivity* Regional MacGroup meetings February/March 2020 • Glass House Mountains 25/02/2020 • Gympie 26/02/2020 • Bundaberg 28/02/2020 • Northern River 11-12/03/2020 • Mid North Coast NSW 13/03/2020
2021	Article	*Benchmarking 2020 season wrap-up* AMS News Bulletin Vol 49, Number 2, 2021.
2021	Presentation	Benchmarking update Annual Consultants meeting, Yamba 11th November 2021.
2021	Presentation	Industry benchmarking trivia Annual Consultants meeting, Hervey Bay 19th November 2021.

Table 10: Regional Benchmark Group meetings 2020-2022

Project linkages

Project linkages		
Project name	**Project code**	**Linkage**
Macadamia integrated pest management program for the Australian macadamia industry	MC16005	Annual reports detailing factory insect damage rejects and limiting pests. Financial modelling of IPM scenarios.
Macadamia integrated disease management	MC16018	Reporting on seasonal limitations.
Macadamia regional variety trials series 4	MC17006	Benchmark data used to model industry productivity in comparison to selections being tested in regional trials. Benchmark data used in selection model for commercialisation of new varieties.
Macadamia crop forecasting 2020-2022	MC18003	Provision of yield x age data for validation of forecast model. Collection of flowering and observational data to help inform annual forecast.
National macadamia breeding and evaluation program	MC19000	Benchmark yield and quality information used to guide breeding targets and inform bio-economic model.
Macadamia growing guide	MC19001	Regional yield, quality and cost information built into growing guide
Australian macadamia industry innovation and adoption program	MC20000	Provision of data for the AMS yearbook, News Bulletin and Awards of Excellence.

Table 11: Linkages with other projects

Production regions

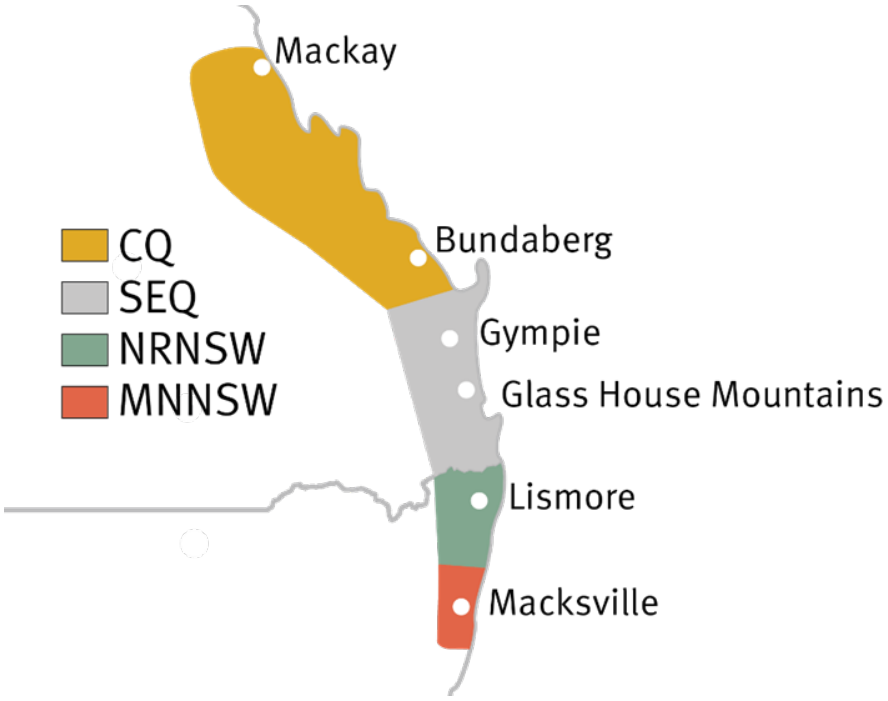
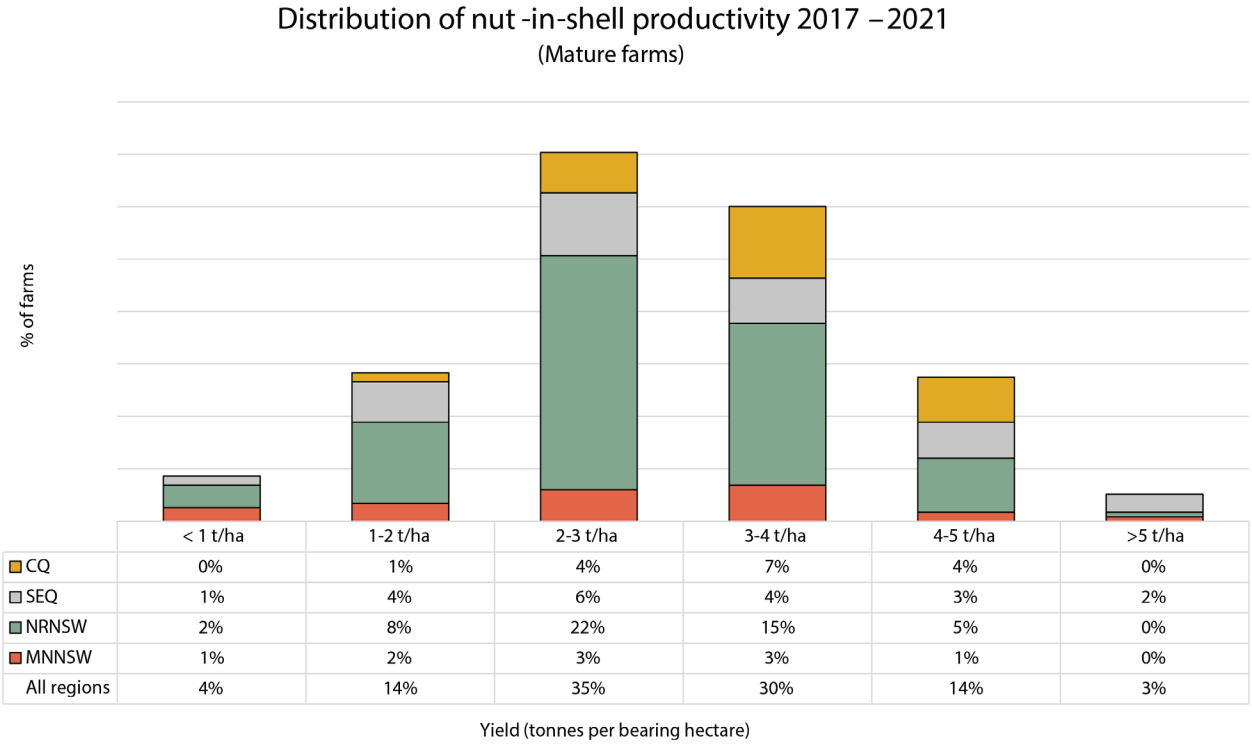


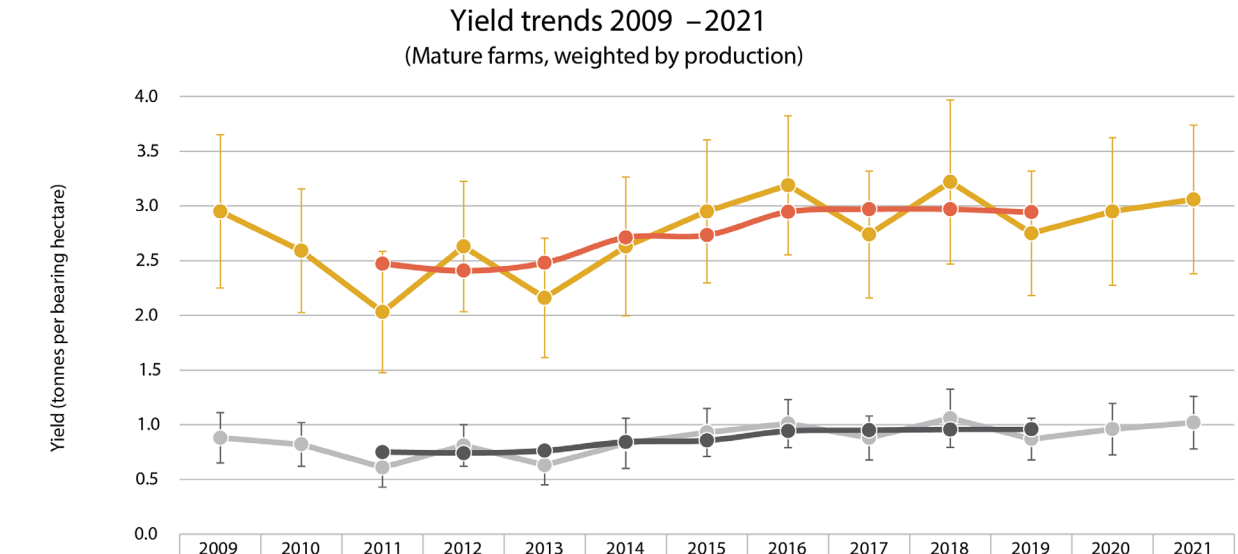
Figure 1: Major production regions and locations covered by the benchmark sample

Yield and quality



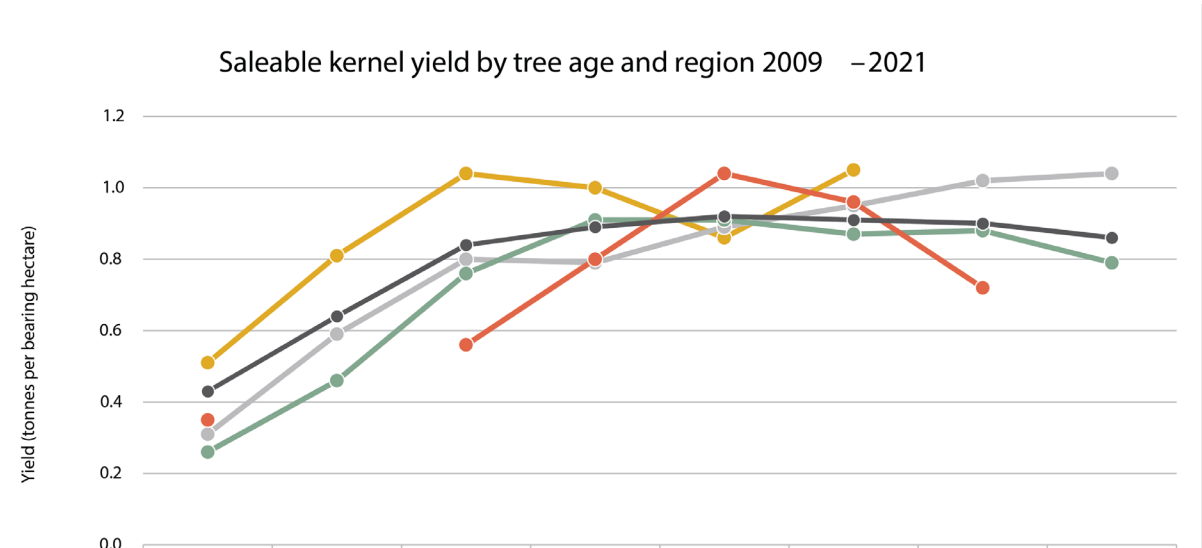
	< 1 t/ha	1-2 t/ha	2-3 t/ha	3-4 t/ha	4-5 t/ha	>5 t/ha
CQ	0%	1%	4%	7%	4%	0%
SEQ	1%	4%	6%	4%	3%	2%
NRNSW	2%	8%	22%	15%	5%	0%
MNNSW	1%	2%	3%	3%	1%	0%
All regions	4%	14%	35%	30%	14%	3%

Figure 2: Farms by NIS productivity category and region 2017-2021



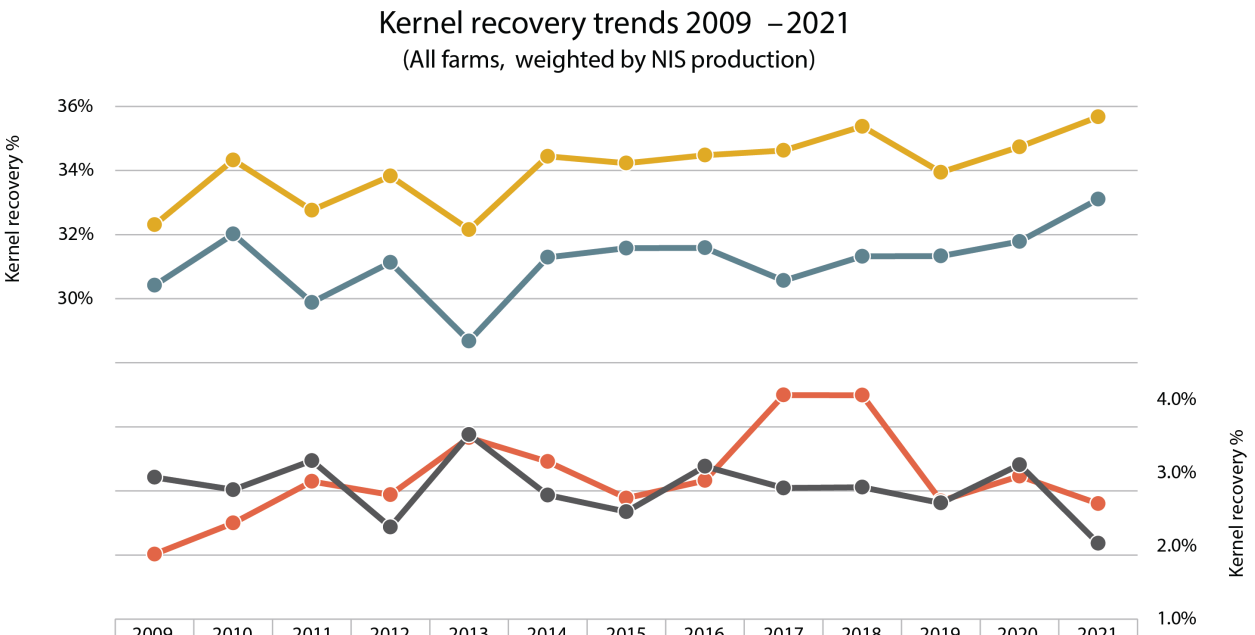
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
NIS yield	2.95	2.59	2.03	2.63	2.16	2.63	2.95	3.19	2.74	3.22	2.75	2.95	3.06
NIS Std.dev.	1.40	1.13	1.11	1.19	1.09	1.27	1.31	1.27	1.16	1.50	1.14	1.35	1.36
SK yield	0.88	0.82	0.61	0.81	0.63	0.83	0.93	1.01	0.88	1.06	0.87	0.96	1.02
SK Std.dev.	0.46	0.40	0.36	0.38	0.36	0.46	0.44	0.44	0.40	0.53	0.38	0.47	0.48
NIS 5-year avg			2.47	2.41	2.48	2.71	2.73	2.95	2.97	2.97	2.94		
SK 5-year avg			0.75	0.74	0.76	0.84	0.86	0.94	0.95	0.96	0.96		

Figure 3: Weighted average NIS and saleable kernel yield trends for mature farms 2009–2021



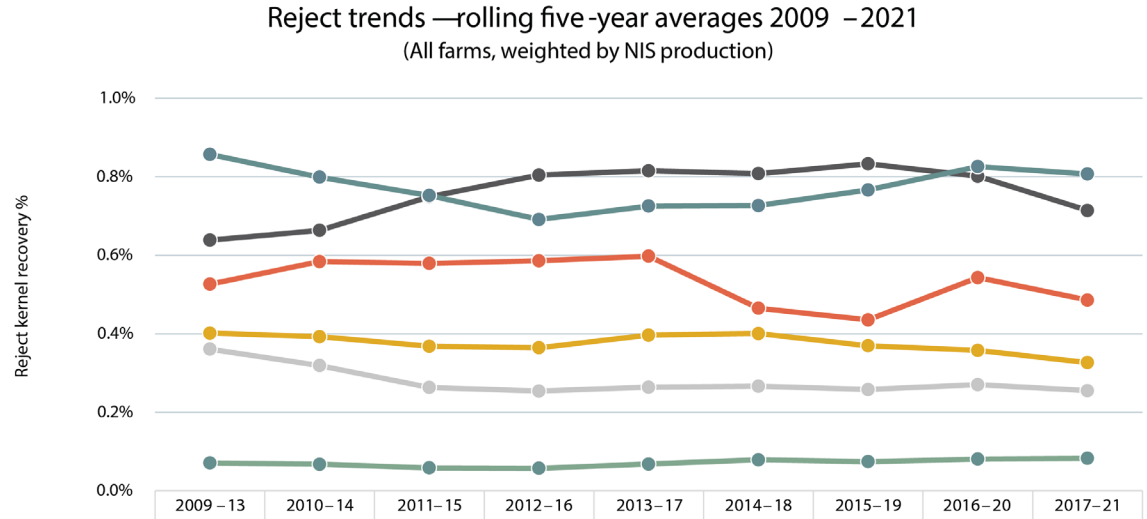
	5 to 7 years	8 to 9 years	10 to 14 years	15 to 19 years	20 to 24 years	25 to 29 years	30 to 34 years	35+ years
CQ	0.51	0.81	1.04	1.00	0.86	1.05	-	-
SEQ	0.31	0.59	0.8	0.79	0.89	0.95	1.02	1.04
NRNSW	0.26	0.46	0.76	0.91	0.91	0.87	0.88	0.79
MNNSW	0.35	-	0.56	0.8	1.04	0.96	0.72	-
All regions	0.43	0.64	0.84	0.89	0.92	0.91	0.90	0.86

Figure 4: Saleable kernel productivity by tree age and region 2009–2021



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
SKR%	32.3	34.3	32.8	33.8	32.2	34.4	34.2	34.5	34.6	35.4	33.9	34.7	35.7
PKR%	30.4	32.0	29.9	31.1	28.7	31.3	31.6	31.6	30.6	31.3	31.3	31.8	33.1
CKR%	1.9	2.3	2.9	2.7	3.5	3.2	2.7	2.9	4.1	4.1	2.6	3.0	2.6
RKR%	2.9	2.8	3.2	2.3	3.5	2.7	2.5	3.1	2.8	2.8	2.6	3.1	2.0

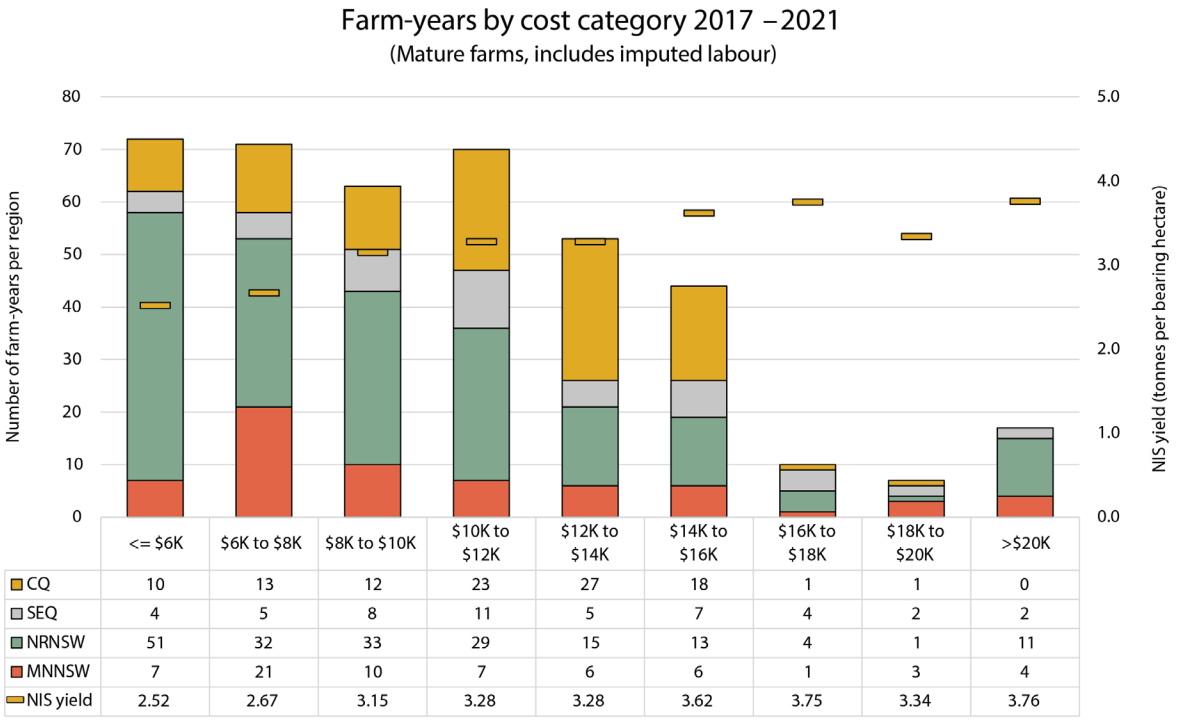
Figure 5: Saleable, premium, commercial and reject kernel recovery trends 2009–2021



	2009 – 13	2010 – 14	2011 – 15	2012 – 16	2013 – 17	2014 – 18	2015 – 19	2016 – 20	2017 – 21
Insect	0.64	0.66	0.75	0.80	0.82	0.81	0.83	0.80	0.71
Mould	0.40	0.39	0.37	0.36	0.40	0.40	0.37	0.36	0.33
Discoloured	0.36	0.32	0.26	0.25	0.26	0.27	0.26	0.27	0.26
Brown centres	0.86	0.80	0.75	0.69	0.73	0.73	0.77	0.83	0.81
Immaturity	0.53	0.58	0.58	0.59	0.60	0.47	0.44	0.54	0.49
Germination	0.07	0.07	0.06	0.06	0.07	0.08	0.07	0.08	0.08

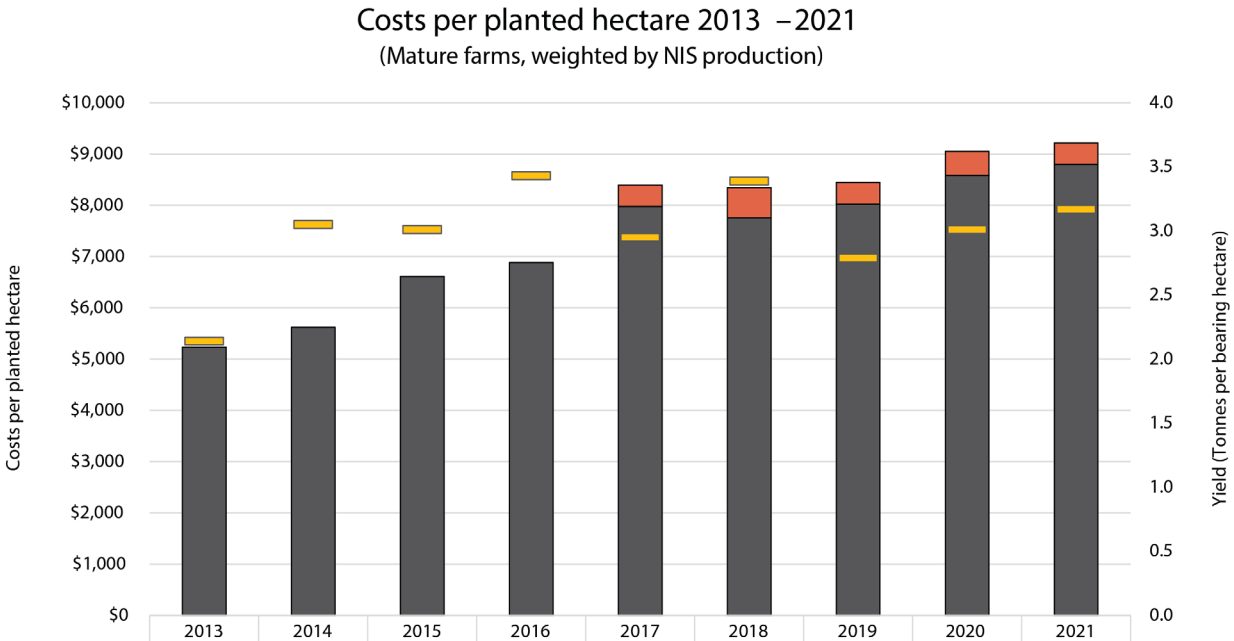
Figure 6: Rolling 5-year average factory reject trends 2009–2021

Costs and profitability



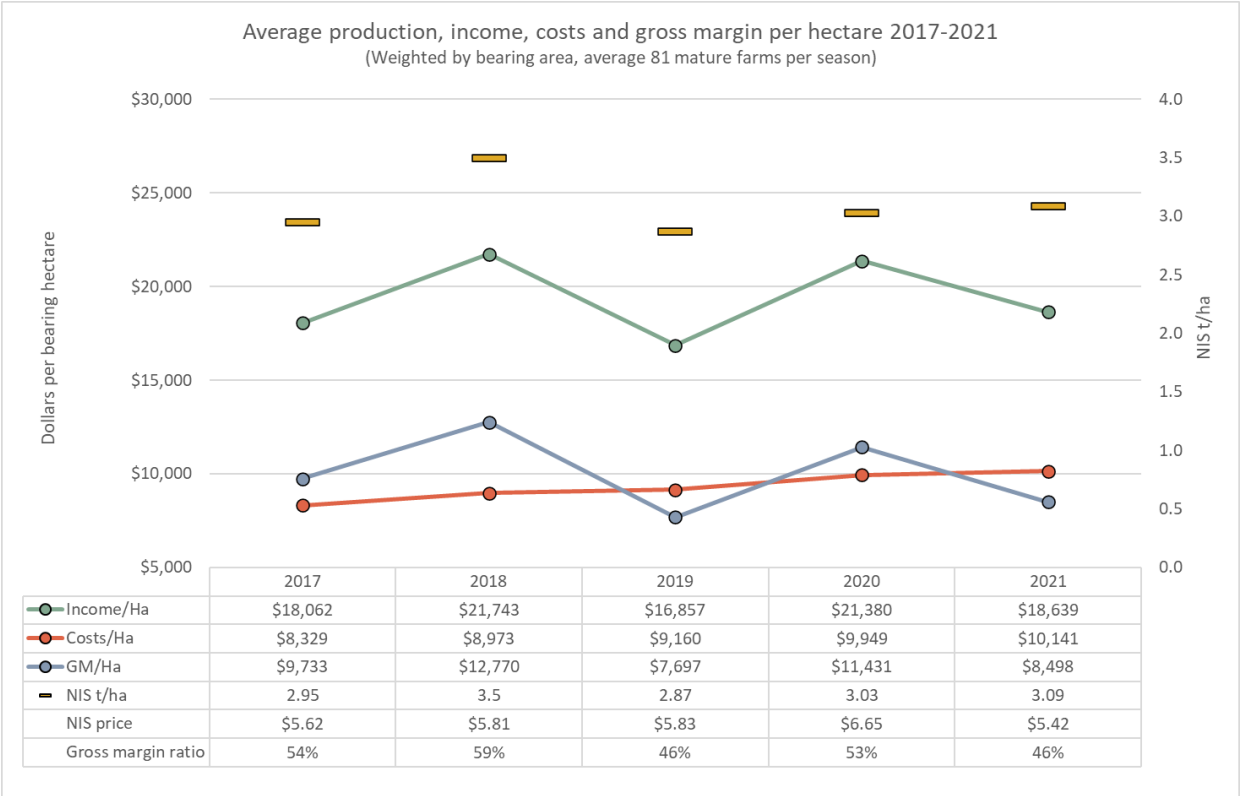
	<= $6K	$6K to $8K	$8K to $10K	$10K to $12K	$12K to $14K	$14K to $16K	$16K to $18K	$18K to $20K	>$20K
CQ	10	13	12	23	27	18	1	1	0
SEQ	4	5	8	11	5	7	4	2	2
NRNSW	51	32	33	29	15	13	4	1	11
MNNSW	7	21	10	7	6	6	1	3	4
NIS yield	2.52	2.67	3.15	3.28	3.28	3.62	3.75	3.34	3.76

Figure 7: Number of farm-years by operating cost per hectare category between 2017 and 2021



	2013	2014	2015	2016	2017	2018	2019	2020	2021
Imputed labour	-	-	-	-	$415	$589	$421	$470	$414
Cash costs	$5,232	$5,619	$6,611	$6,881	$7,976	$7,752	$8,023	$8,583	$8,802
Total costs					$8,303	$8,341	$8,443	$9,052	$9,217
NIS yield	2.14	3.05	3.01	3.43	2.95	3.39	2.79	3.01	3.17

Figure 8: Weighted average operating costs per hectare 2013–2021



	2017	2018	2019	2020	2021
Income/Ha	$18,062	$21,743	$16,857	$21,380	$18,639
Costs/Ha	$8,329	$8,973	$9,160	$9,949	$10,141
GM/Ha	$9,733	$12,770	$7,697	$11,431	$8,498
NIS t/ha	2.95	3.5	2.87	3.03	3.09
NIS price	$5.62	$5.81	$5.83	$6.65	$5.42
Gross margin ratio	54%	59%	46%	53%	46%

Figure 9: Average production, income, costs and gross margin per hectare 2017–2021

Appendix B — External report links

Benchmark reports

Industry benchmark report 2009-2018
Industry benchmark report 2009-2019
Industry benchmark report 2009-2020
Industry benchmark report 2009-2021

Sample farm report (2021 season)

Data collection

Data collection form (2021 season)

Evaluation

Benchmark participant survey report (2020)

Benchmark participant survey report (2022)

AMS Awards of Excellence

AMS Awards of Excellence