Macadamia industry benchmark report

2009 to 2017 seasons
Project MC15005

Queensland Government

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Contents

Acknowledgements

This report has been produced as part of the "Benchmarking the macadamia industry 2015–2018" project (MC15005). This is a joint initiative of the Department of Agriculture and Fisheries, the University of Southern Queensland and the New South Wales Department of Primary Industries, with support from the Australian Macadamia Society.

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Disclaimer

Results presented in this report are based on data provided by industry participants. To ensure the confidentiality of individual farm data, this report includes group averages only. Figures presented are based on summary statistics using underlying data that is not included in this report.

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About the benchmarking project

The benchmarking project is supporting improved productivity and profitability within the Australian macadamia industry. The current project builds on previous benchmarking and best practice work conducted since 2001.

Yield, quality and planting information has been collected annually from macadamia farms throughout Australia since 2009. This information is provided either directly by growers or by processors on their behalf. Cost of production data has also been collected annually since 2013.

Each season all benchmarking participants receive a confidential, personalised report that compares their individual farm performance with the average performance of similar farms based on a range of criteria including region, locality, farm size, management structure, irrigation status and tree age. These reports highlight individual and average farm performance trends over multiple seasons.

This industry report has been produced to provide growers, processors, consultants, investors and other industry stakeholders with a summary of yield, quality and cost of production trends within the Australian macadamia industry.

Benchmark data supports a range of industry projects and initiatives. Figure 1 shows some of these major linkages and the benefits gained from availability of reliable baseline data for decision making.

Although summary information such as that published in this report is provided to a range of industry stakeholders, it is important to note that individual farm business data remains strictly confidential.

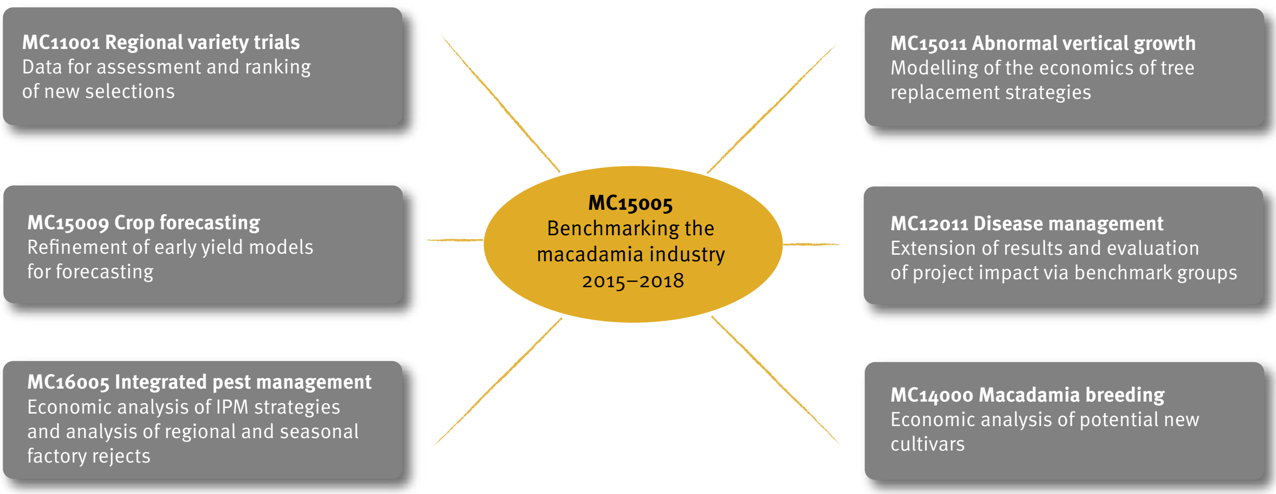


Figure 1: Benchmark project linkages

Scope and coverage

This report summarises macadamia farm yield and quality results for the 2009 to 2017 production seasons and production costs for 2013 to 2017. Many of the yield benchmarks presented are based on tonnes of nut-in-shell (NIS) or saleable kernel (SK) per bearing hectare as these are widely accepted measures of orchard productivity.

Major production regions are shown in Figure 2. These are Central Queensland (CQ), South East Queensland (SEQ), Northern Rivers of New South Wales (NRNSW) and Mid North Coast of NSW (MNNSW).

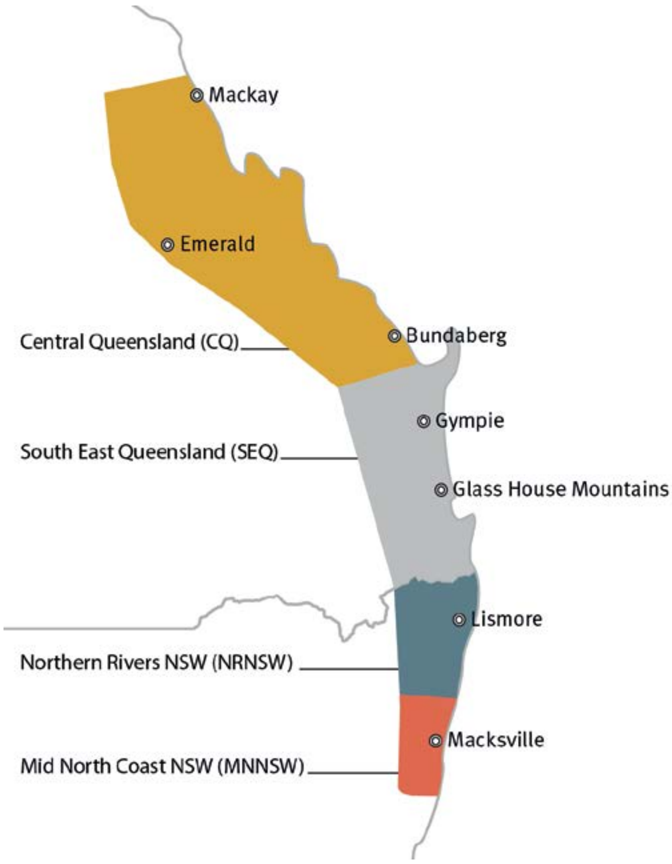


Figure 2: Production regions and localities participating in benchmarking

Table 1 shows the number of bearing farms participating in benchmarking in each major production region. It also shows average farm size and tree age for farms within each of those regions. In 2017 more than half of all participating farms were from NRNSW. Farms in the NRNSW region were, on average, older than those in other regions. CQ farms had the largest median planted hectares, making up almost a half of the sample's total planted area, and contributing over half of the sample's total NIS.

The total planted hectares can vary substantially between farms, particularly in some regions. Median rather than average planted hectares per farm is shown in the table as this is more characteristic of typical farm size in these instances.

2017 regional benchmark summary

Region	Bearing farms	% of sample by number of farms	Average tree age	Total planted hectares	% of sample by planted hectare	Median planted hectares per farm	% of sample by NIS tonnes
Central Queensland (CQ)	51	19%	14	4 959	59.1	49%	53%
South East Queensland (SEQ)	51	19%	23	1 419	12.0	14%	12%
Northern Rivers of NSW (NRNSW)	144	53%	24	3 245	16.5	32%	31%
Mid North Coast of NSW (MNNSW)	26	9%	19	417	9.0	4%	3%
All regions	272		18	10 040	18.7		

Table 1: Regional breakdown of farms in the 2017 benchmark sample

Table 2 shows the number of farms participating in benchmarking between 2009 and 2017. Yield and quality data collected from bearing farms during that time totals 2148 farm-years. The term farm-year is used to describe data for an individual farm for a given year. A total of 272 bearing farms submitted data for the 2017 season. These farms total 10,040 hectares and produced approximately 26,073 tonnes of NIS at 10% moisture content and 8419 tonnes of saleable kernel in the 2017 season. This represents approximately 56.7% of the industry's total production in 2017, based on the Australian Macadamia Society estimate of 46,000 tonnes of NIS at 10% moisture content (published December 2017).

Since 2013 some participating businesses have also submitted data relating to costs of production. Cost data collected from bearing farms between 2013 and 2017 totals 263 farm-years. A total of 71 bearing farms submitted cost data in 2017, representing more than 3279 planted hectares or approximately 19% of total production in that year.

Participating farms by season

Seasons	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–2017
Yied and quality										
Mature farms	145	155	164	202	218	224	237	246	261	1 852
Bearing farms	181	186	193	243	262	267	271	273	272	2 148
All farms	192	195	207	252	265	268	271	273	275	2 198
Seasons	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2013–2017**
Cost of production										
Mature farms	–	–	–	–	37	38	34	49	64	222
Bearing farms	–	–	–	–	48	48	41	55	71	263
All farms	–	–	–	–	48	48	41	55	74	266

Table 2: Participating farms by season

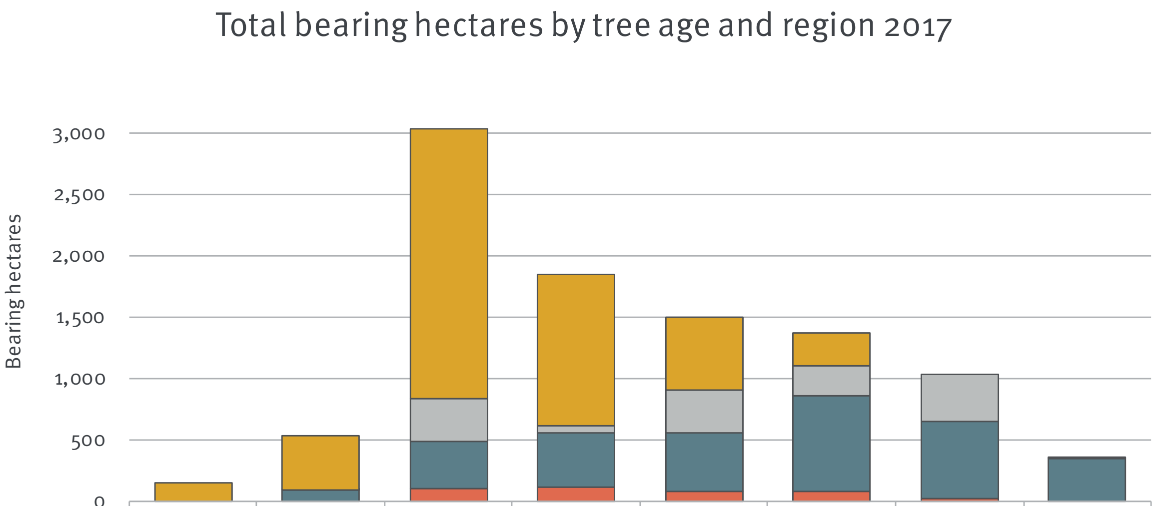
What you need to know about the data

Please consider the following points when interpreting results in this report:

- Averages presented for any given season are based on data from a minimum of ten farms. This minimum is applied to safeguard the confidentiality of individual farm data.
- Average farm performance over multiple seasons is derived only from farms that have provided data for a minimum of four seasons. This is to minimise the impact of seasonal variability on long-term averages.
- All weights presented are based on the industry-standard moisture content of 10% for nut-in-shell and 1.5% for kernel.
- Plantings less than five years of age are generally excluded from estimates of bearing hectares. This is important for consistency across the benchmark sample.
- The sum of reject kernel category values presented equates to the total reject kernel recovery percentage, rather than totalling 100%. This standard is applied across the benchmark study to ensure uniformity.
- While we try to use well recognised terms to describe kernel recovery and reject analysis categories, processors may sometimes use different terminology to describe similar reject categories.
- Unless otherwise stated, all averages presented are unweighted. This means that all farms in the sample exert an equal influence on the average regardless of their size.
- The term farm-year is used to describe data for an individual farm for a given year. Unless otherwise specified, averages that span multiple seasons are derived from all available seasons.
- Cost data collected includes all cash costs incurred in the preceding financial year (2012/13 to 2016/17). Other costs such as capital expenditure, depreciation and taxation are excluded. From 2017 onwards unpaid labour hours have also been recorded. The value of this labour has been imputed at a nominal rate of $30 per hour to derive a more complete picture of orchard expenditure, particularly on owner-operated farms.
- Unless otherwise stated all farm costs per hectare are based on total planted hectares. This may include non-bearing hectares for some farms as most businesses do not separate costs by tree age within their accounting systems.
- Heads of expenditure shown in this report are derived from a standard chart of accounts developed in conjunction with accountants and financial advisers as part of the previous levy funded project *On-farm economic analysis in the Australian macadamia industry* (MC03023). This chart of accounts is used to ensure consistent interpretation of costs across multiple farm businesses.
- Some averages may be based on subsets of the available data. Atypical or non-representative data may be excluded from some analyses to avoid adversely skewing averages. Where this has occurred it will generally be indicated in results (e.g. mature farms only).

Plantings

Figure 3 shows a breakdown of bearing hectares by region and tree age within the 2017 benchmark sample. Plantings less than five years of age are not considered bearing and are therefore excluded. Some farms, particularly in the Central Queensland (CQ) region, harvest nuts from four year old trees but these are usually small volumes. As individual tree ages vary between plantings on many farms, tree age categories shown in the chart are based on a weighted average tree age for each farm.



	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	154	439	2,196	1,231	593	265	0	0
SEQ	0	6	346	56	355	251	385	8
NRNSW	0	89	385	443	477	775	629	348
MNNSW	0	0	105	116	78	81	21	0

Figure 3: Total bearing hectares by tree age category and region (2017)

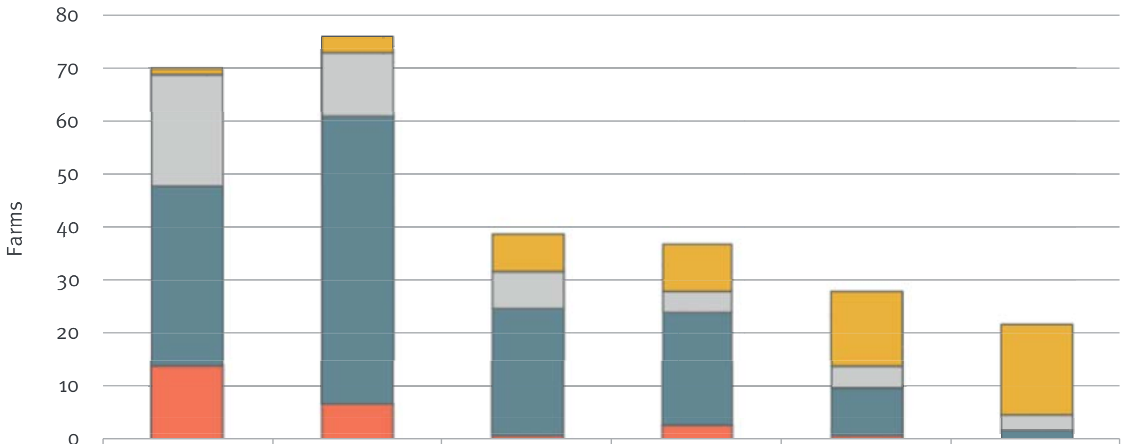
Farms with an average tree age between 10 and 14 years comprised the largest number of bearing hectares in the 2017 benchmark sample. This corresponds with trees planted between 2004 and 2008. Most of the farms in this age group are located in CQ, as are those in the 15–19 years age group.

Farms in the South East Queensland (SEQ) region are spread across multiple age groups from 8 years through to more than 35 years. Farms in the Northern Rivers NSW (NRNSW) region have the widest diversity of average ages, from 8–9 years through to more than 35 years of age. Farms in the MNNSW region are spread relatively evenly from ages 10 through to 34.

Figure 4 shows a breakdown of farms in the 2017 benchmark sample according to their size. The chart shows the number of farms within each major production region for size categories ranging from less than 10 hectares to more than 100 hectares.

Most farms had between 10 and 20 hectares (76 farms) or less than 10 hectares of bearing trees (70 farms). The majority of these farms are located in the MNNSW, NRNSW and SEQ regions. By comparison, the majority of larger farms (> 50 hectares) were located in the CQ region.

Total bearing farms by farm size and region 2017



	< 10 ha	10 to 20 ha	20 to 30 ha	30 to 50 ha	50 to 100 ha	> 100 ha
CQ	1	3	7	9	14	17
SEQ	21	12	7	4	4	3
NRNSW	34	54	24	21	9	2
MNNSW	14	7	1	3	1	0

Figure 4: Total bearing farms by farm size category and region (2017)

In 2017 the median size of farms in the benchmark sample was 18.4 bearing hectares and 18.7 total hectares. Average farm size was significantly higher at 36.2 bearing hectares and 36.9 total hectares. This difference is due to the presence of some very large farms in the sample.

Summary of the 2017 season

Figure 5 shows average yield, quality and cost measures for all 272 bearing farms in the benchmark sample in 2017. This includes some young farms that are yet to reach full maturity. Corresponding long-term averages or totals are shown in brackets. These averages span 2009 to 2017 for yield, quality and planting information and 2013 to 2017 for costs.

Productivity per hectare in 2017 was 2.55 tonnes per hectare (t/ha) nut-in-shell (NIS) and 0.84 t/ha saleable kernel (SK) which was comparable to the long-term average of 2.52 t/ha NIS and 0.8 t/ha SK. Saleable kernel recovery (SKR) was slightly higher in 2017 (34.7%) than the long-term average (33.8%).

Average total production costs were higher in 2017 ($8360/ha, $3585/t NIS) than the long-term average ($6771/ha, $3166/t NIS). It is important to note that these four cost averages exclude imputed labour costs, which were not collected prior to the 2017 season.

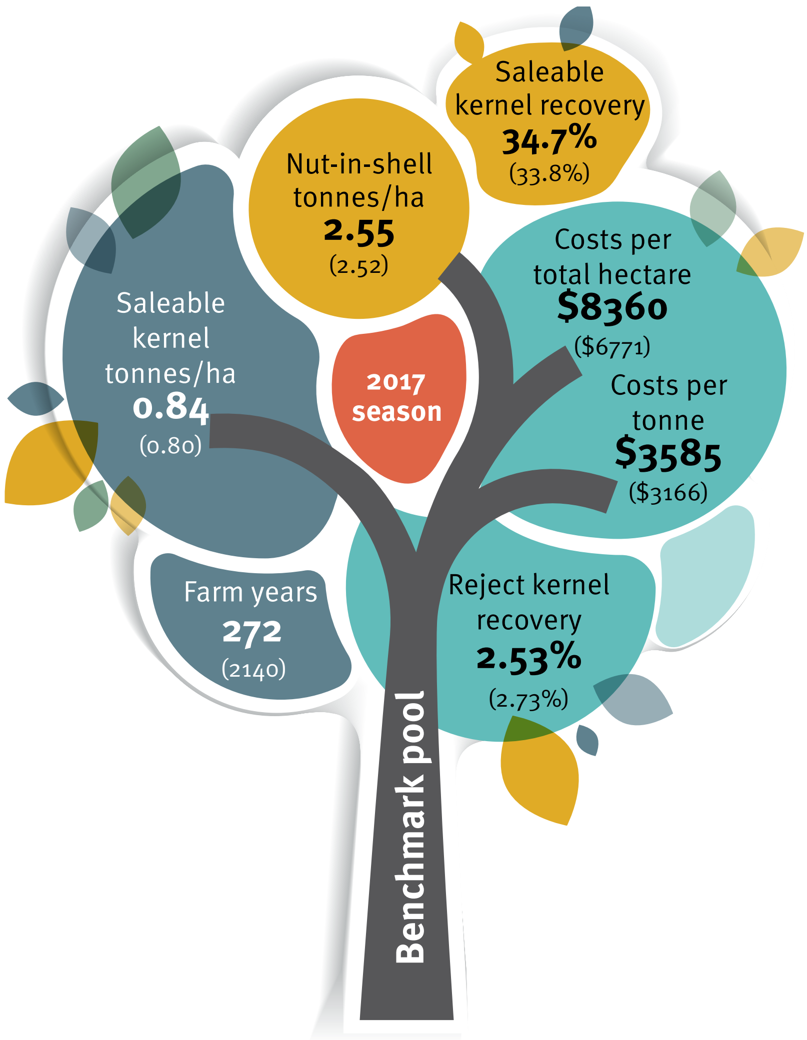


Figure 5: Summary of the 2017 benchmark sample (long-term averages/totals shown in brackets)

The benchmarking project began collecting data on unpaid labour in 2017 to provide a more consistent basis for comparing costs between managed and owner-operated farms. A standard hourly wage rate of $30 per hour is applied to unpaid labour hours to derive a notional cost. This rate was endorsed by the Project Steering Group.

Figure 6 shows a breakdown of average total production costs per planted hectare and per tonne of nut-in-shell (NIS) for the 64 mature farms (10+ years old) that provided cost data in the 2017 benchmark sample. The chart shows average costs per hectare and per tonne of NIS for both managed and owner-operated farms. Each bar comprises both cash costs (grey) and the imputed cost of unpaid labour (red).

Of the 64 mature farms in the benchmark sample that provided cost data in 2017, 41% were owner-operated and 59% were managed. Imputed labour accounted for 27% of total production costs per hectare on owner-operated farms but only 5% of total costs per hectare on managed farms.

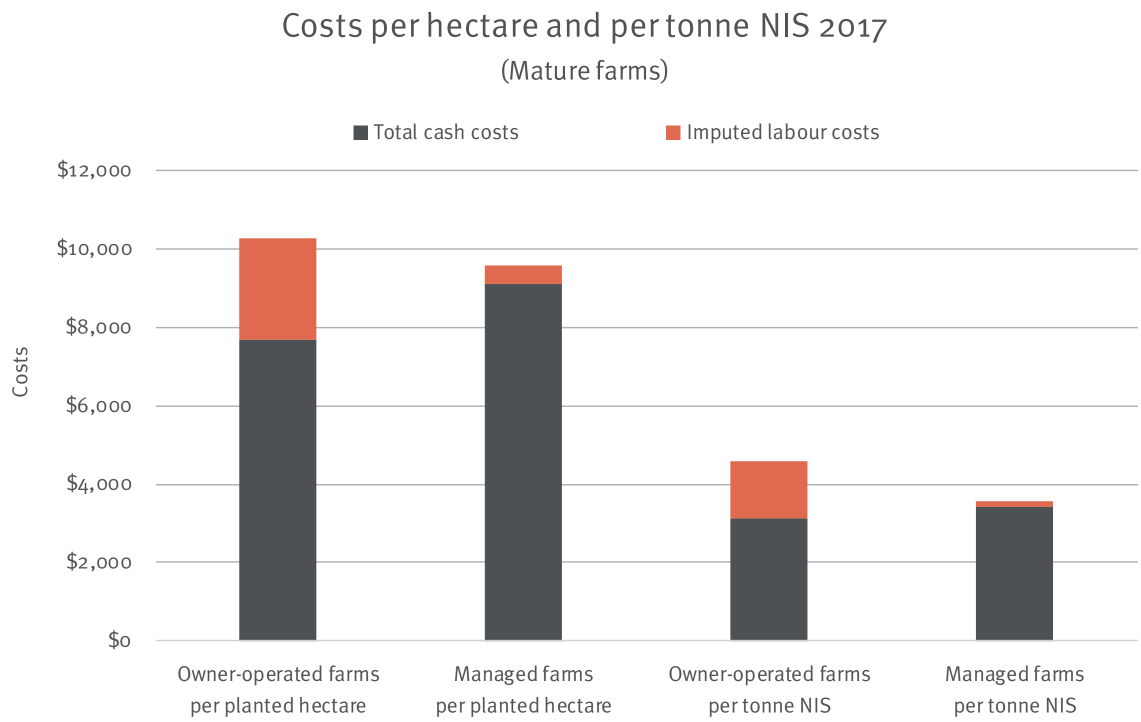


Figure 6: Costs and imputed labour per planted hectare and per tonne NIS for managed and owner-operated mature farms in 2017

Average production costs per hectare for mature farms from 2013 to 2017 was $6937/ha. This excludes imputed labour, capital and finance costs. At a NIS price of $5/kg, production of approximately 1.4 tonnes per hectare is required to cover these costs.

Figure 7 also shows imputed labour costs, this time in relation to employment costs rather than all production costs. Imputed labour accounted for 61% of employment costs per planted hectare on owner-operated farms compared to 13% for managed farms.

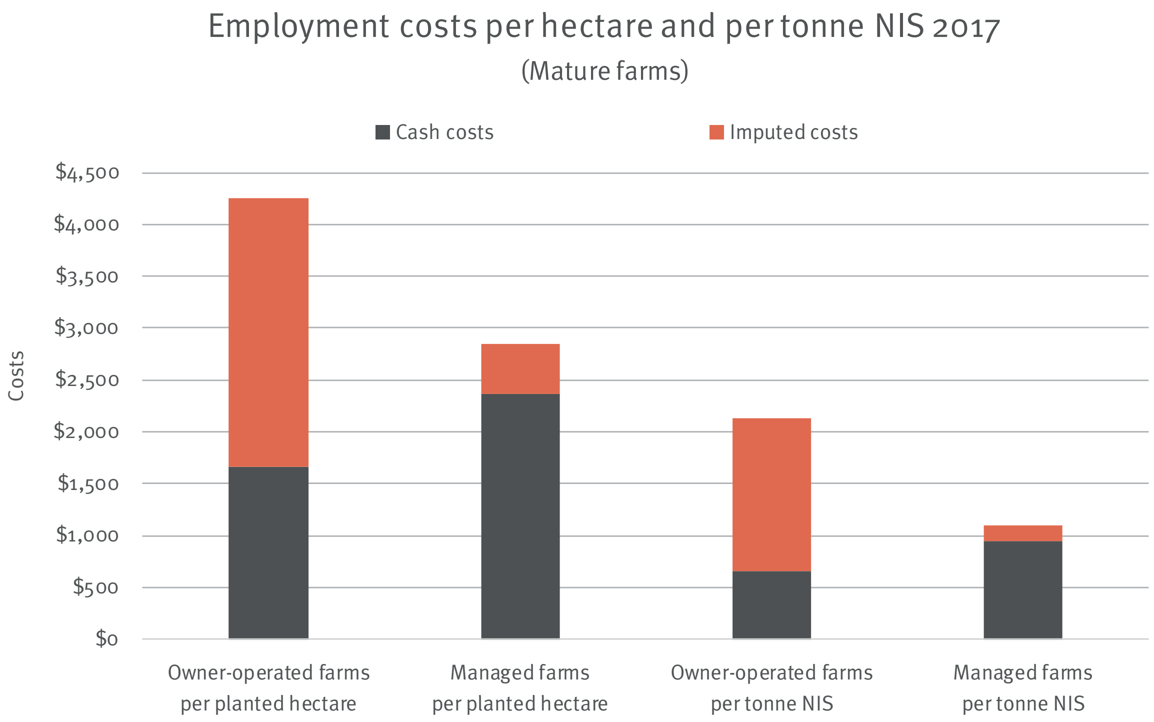


Figure 7: Cash and imputed employment costs per planted hectare and per tonne NIS for managed and owner-operated mature farms in 2017

Figure 8 shows production costs per hectare broken down into heads of expenditure. Average expenditure for the 2017 season is compared with the five-year average (2013 to 2017). As unpaid labour was not collected prior to 2017, all employment figures shown exclude unpaid labour.

Costs were higher across most heads of expenditure in 2017 compared with five-year average. The most substantial increases in 2017 were in leases (> $500/ha), crop nutrition (>$300/ha) and employment (> $260/ha). Fuel and oil, government charges and consultants costs were 10 to 20% lower in 2017 than the five-year average.

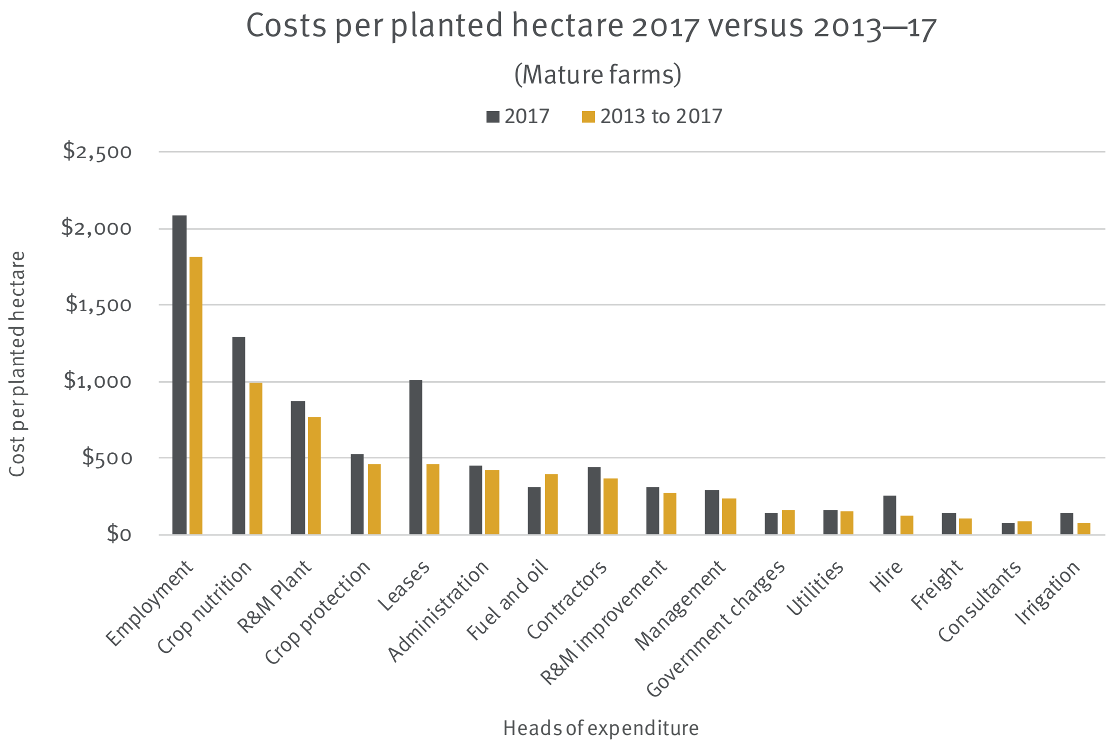


Figure 8: Major heads of expenditure per planted hectare for 2017 versus 2013 to 2017

Factors limiting production

As part of the data collection process, all benchmark participants were asked a series of questions about factors limiting production on their farm in 2017. These issues were also discussed and similar feedback sought during benchmark group meetings in each of the major production regions from August to November 2017.

242 farms responded to the question "What was the major factor limiting production in 2017?". In some cases respondents nominated multiple limiting factors, so the following figures show the proportion of each factor relative to the total number of responses received.

The most common factors reported as limiting production in 2017 across all regions were weather related. These included hot dry conditions and lack of water, through to storms, hail, floods and wet weather. Hot dry weather or lack of water or both accounted for 38% of responses, and limited more farms than storms or floods or wet weather which made up 21% of responses. Growers in some regions reported a combination of both extended dry periods followed by storms or wet weather events. After weather, the next most commonly reported limiting factor industry-wide was pests (16%).

Tree or limb removal and nutrition or poor soil limitations were the other replies that made up 4% or more of responses. "Other" responses from smaller numbers of farms included disease, orchard age, and crowded canopies.

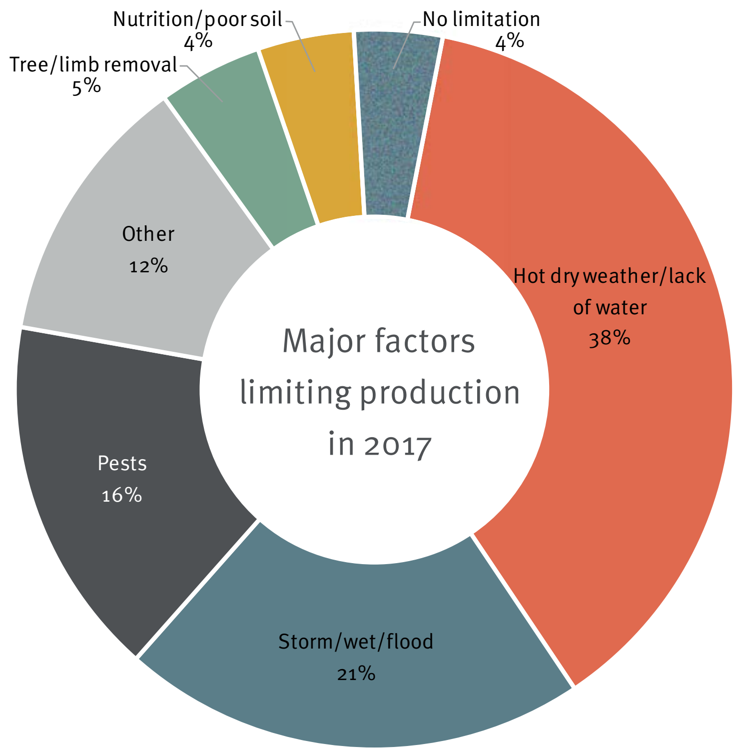


Figure 9: Major factors limiting production in 2017

Weather was the major factor nominated by benchmark participants as limiting production in the 2017 season. Some farms suffered a combination of both hot dry weather and storm or hail damage during 2017.

In Central Queensland (CQ) pests were reported as the top limitation to production followed by hot dry conditions. In South East Queensland (SEQ), Northern Rivers NSW (NRNSW) and Mid North Coast NSW (MNNSW) hot dry weather / lack of water was the leading limitation response. Storm / wet / flood limitation was the second largest individual limitation for these three regions. Pests were the third largest type of limitation for SEQ and NRNSW farms.

Nutrition was in the top three limitations only for the MNNSW (11%), while it was limiting but less so for CQ (9%). Tree / limb removal was a top three individual limitation for CQ (9%), and was reported as limiting in both NRNSW and MNNSW but less frequently.

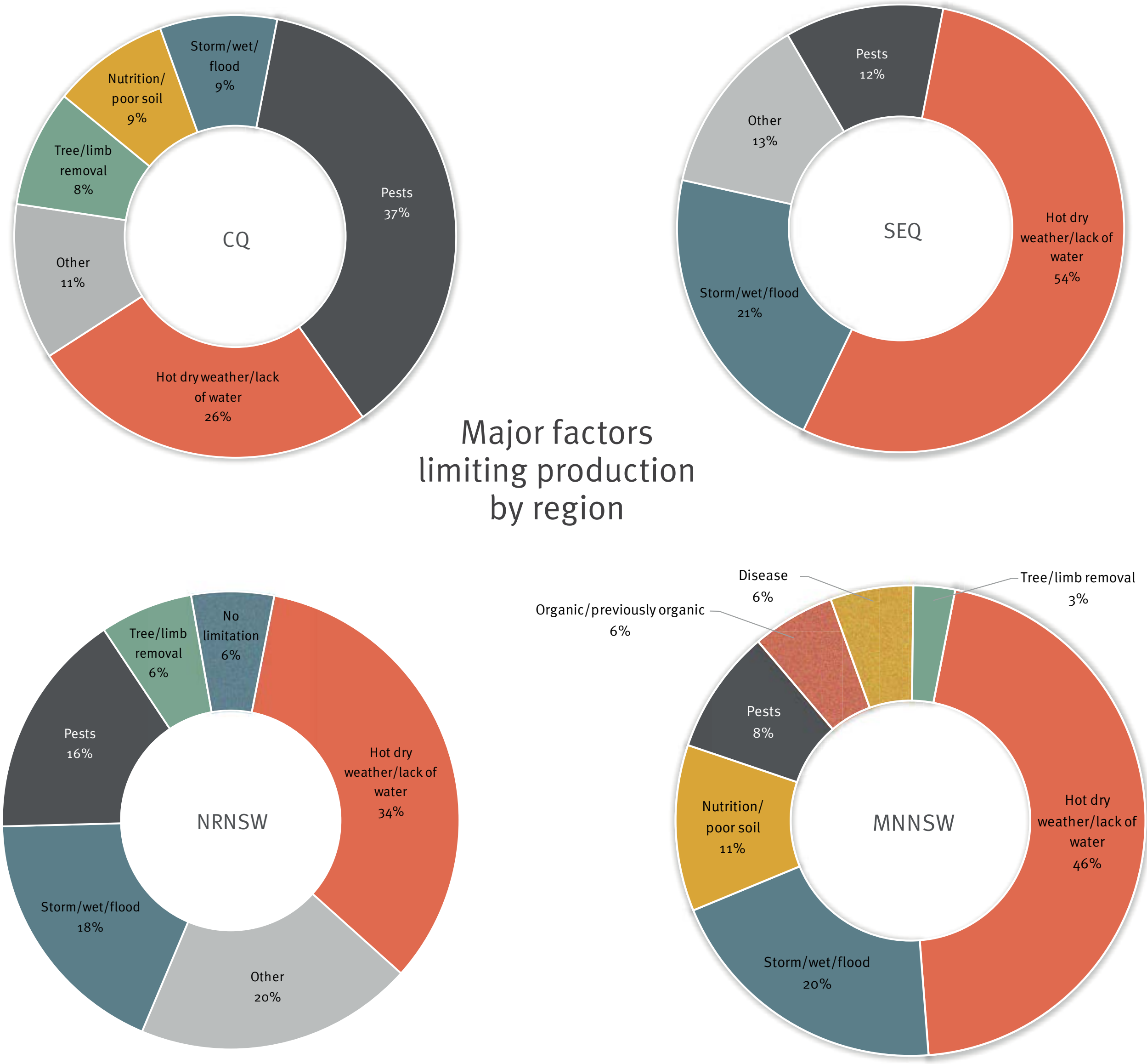


Figure 10: Major factors limiting production by region in 2017

Pest limitations

Figure 11 shows 219 responses from 193 farms to the question "Which was the most significant pest affecting production in 2017?". Across all regions, fruit spotting bug was identified as the major pest affecting production (43%), followed by Sigastus weevil (33%), lace bug (7%), and rats (7%).

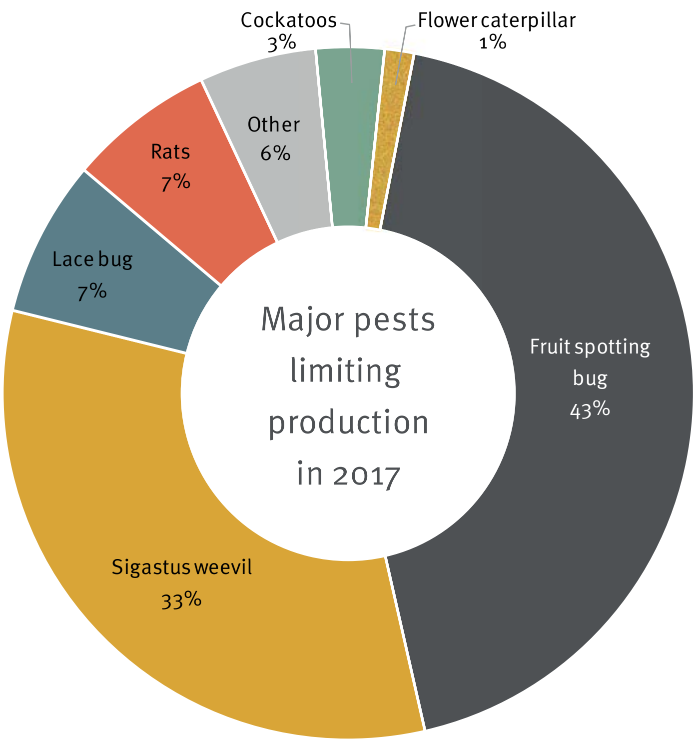


Figure 11: Major pests limiting production in 2017

Fruit spotting bug (FSB) was the most commonly reported pest in CQ, SEQ and MNNSW regions, and in NRNSW FSB was the second most commonly reported pest, making it a clear concern for the whole industry. In the CQ region FSB accounted for nearly 90% of all reported pest limitations.

Sigastus weevil was the most commonly reported pest in NRNSW, making up more reports than all the other pests combined in this region, at 59%.

Lace bug was the second most reported pest limitation for MNNSW growers, and the third for NRNSW growers. Rats ranked second in SEQ and third in MNNSW.

Other pests reported included nut borer, flower caterpillar, green vegetable bug, mistletoe, pigs and cockatoos.

Disease limitations

Figure 12 shows the distribution of 139 responses from 135 farms to the question "Which was the most significant disease affecting production in 2017?". Industry wide, Phytophthora accounted for half of reports of disease limitation (50%), followed by flower diseases (27%) and husk spot (17%).

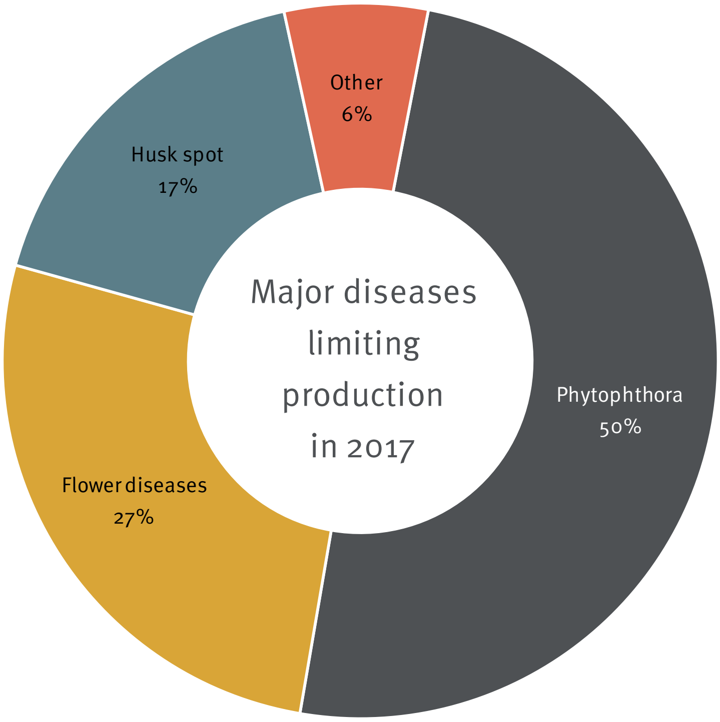


Figure 12: Major diseases limiting production in 2017

When split into regions, Phytophthora was the most common limiting disease problem in MNNSW (61%), NRNSW (51%) and SEQ (54%). It was ranked second in CQ (30%). Flower diseases (including Botrytis flower blight, and other unidentified flower diseases) were the most commonly reported disease problems in CQ (48%). They ranked second in SEQ (29%), and third in NRNSW (21%) and MNNSW (17%).

In NRNSW and MNNSW the second ranked disease limitation was husk spot (23% and 17% respectively). Husk spot (11%) was ranked third in SEQ.

Other diseases that were mentioned by smaller numbers of growers in NRNSW included husk rot and various fungal diseases. In MNNSW dieback was the only remaining limitation reported. Husk rot was also reported by SEQ growers. In CQ growers also mentioned Dothiorella and Abnormal Vertical Growth (AVG).

An Australian Pesticides and Veterinary Medicines Authority permit has now been issued for foliar and trunk application of phosphorous acid for the management of Phytophthora in macadamias. Always check the currency and conditions of the permit before application. A video on how to manage Phytophthora in macadamias is now available on macSmart and the Queensland Agriculture YouTube channel.

Factory losses

The value of factory reject kernel was estimated for all farms in the benchmark sample in 2017. Figure 13 shows a breakdown of estimated losses per hectare for each of the major factory reject categories. The weight of reject was derived from individual farm reject kernel recovery percentages adjusted to equivalent nut-in-shell (NIS) weights. The value of those rejects was derived using the price of $5.20 per kilogram of NIS. It is important to note that the averages shown in the figure are weighted according to NIS production, which means larger farms exert more influence on the average than smaller farms. This provides the most accurate estimate of the total weight of rejects across the benchmark sample.

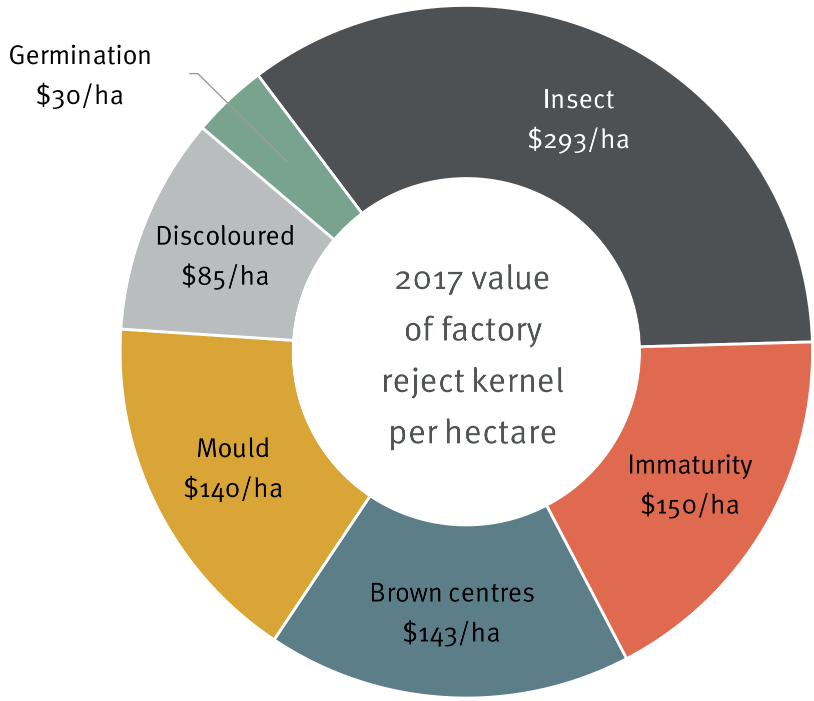


Figure 13: Estimated value of factory reject kernel for all farms in the benchmark sample in 2017

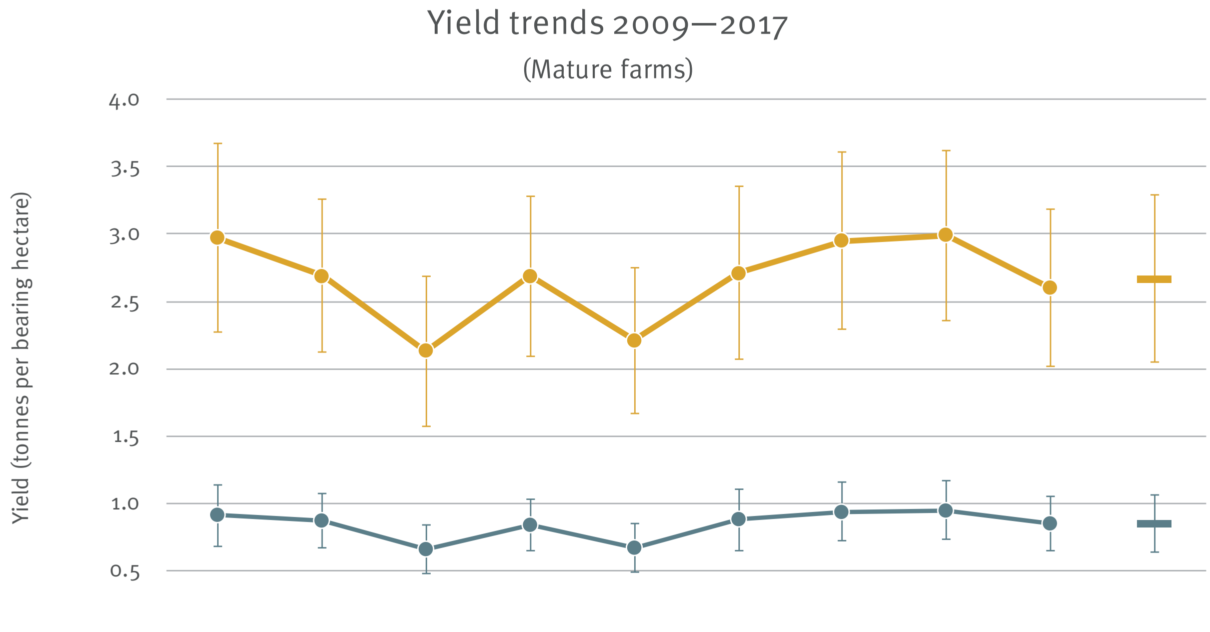
The combined value of factory losses due to reject kernel for all farms participating in benchmarking in 2017 was approximately $841 per hectare. When scaled up to all hectares in the 2017 benchmark sample the total value of reject was approximately $8.44 million. This excludes the weight of nuts lost or rejected prior to consignment, which may also significantly contribute to total farm rejects. It also excludes any handling or disposal costs incurred by processors or growers.

Insect damage accounted for more than one third of those rejects at a value of $293 per hectare, followed by immaturity ($150/ha) then brown centres ($143/ha).

Seasonal trends

This section shows seasonal orchard productivity and quality from 2009 to 2017. This provides insight into long-term trends as well as seasonal variability within the sample. Cost trends are also shown for each year in which cost of production data was collected (2013 to 2017).

Figure 14 shows trends in average nut-in-shell (NIS) and saleable kernel (SK) yield per bearing hectare for mature farms (10+ years old) in the benchmark sample. The vertical error bars show the standard deviation for each season. Larger error bars indicate higher variability between farms in the benchmark sample.



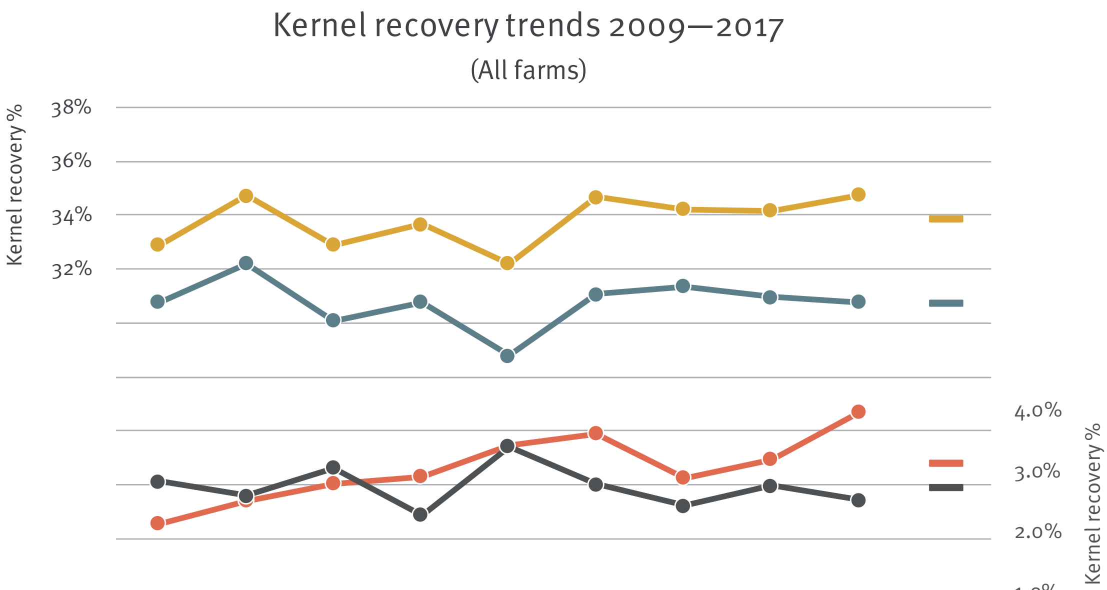
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
NIS yield	2.97	2.69	2.13	2.69	2.21	2.71	2.95	2.99	2.60	2.67
NIS Std.dev.	1.40	1.13	1.11	1.19	1.08	1.28	1.31	1.27	1.16	1.25
SK yield	0.91	0.87	0.66	0.84	0.67	0.88	0.94	0.95	0.85	0.85
SK Std.dev.	0.46	0.40	0.36	0.38	0.36	0.46	0.44	0.44	0.40	0.43

Figure 14: Nut-in-shell and saleable kernel yield trends for mature farms in the benchmark sample (2009 to 2017)

Productivity decreased slightly in 2017 following three successive seasons of increases from 2013–2016. The major factors limiting production reported by participants were weather related, including hot dry conditions as well as rain, hail, flood and storm events. Smaller-than-average nut size was reported by many growers during the 2017 season.

The standard deviation in NIS productivity averaged 1.25 tonnes per bearing hectare from 2009 to 2017, or approximately 47% of average NIS productivity. Standard deviation in SK productivity over this period was 0.43 t/ha, or approximately 50% of average SK production. There has been no significant change in either NIS or SK production variability since 2009.

Figure 15 shows trends in average kernel recovery for all farms in the benchmark sample from 2009–2017. The left axis shows trends in premium (or sound) kernel recovery (PKR) and saleable kernel recovery (SKR). SKR is the sum of premium and commercial grades. The right axis shows trends in commercial kernel recovery (CKR) and reject kernel recovery (RKR).



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
Premium KR%	30.76	32.20	30.08	30.76	28.78	31.05	31.34	30.95	30.78	30.72
Saleable KR%	32.88	34.71	32.88	33.67	32.20	34.67	34.22	34.15	34.75	33.84
Commercial KR%	2.13	2.51	2.80	2.91	3.42	3.62	2.89	3.20	3.97	3.12
Reject KR%	2.83	2.60	3.05	2.28	3.41	2.78	2.43	2.76	2.53	2.73

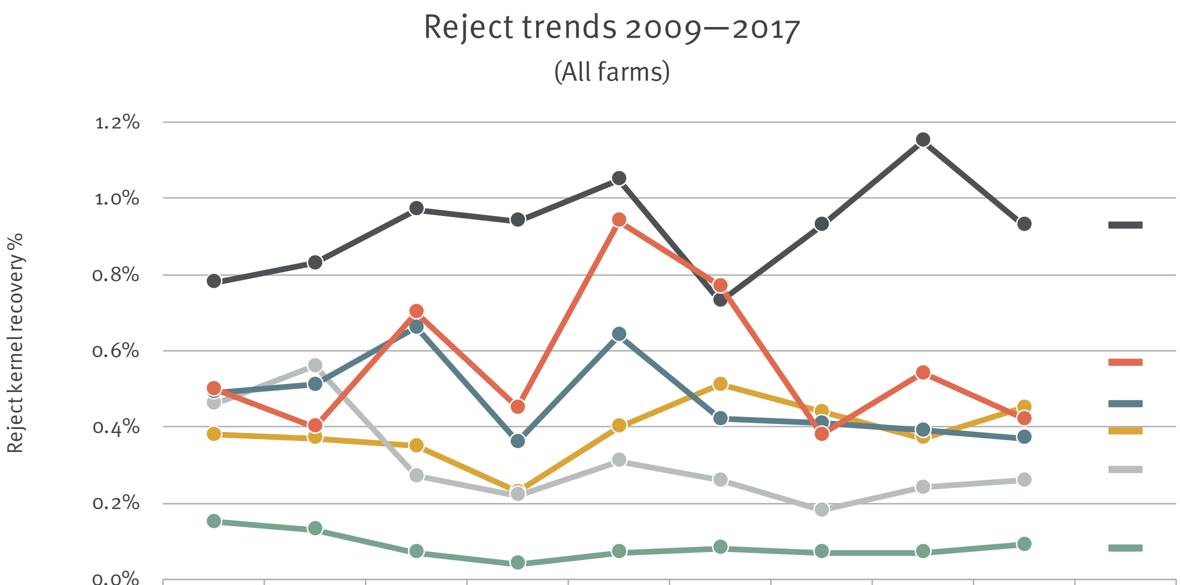
Figure 15: Kernel recovery trends for all farms in the benchmark sample (2009 to 2017)

Average RKR was slightly lower in 2017 than the long-term average for the benchmark sample. Average PKR and CKR were however higher in 2017 than the long-term average, which also resulted in higher-than-average SKR.

The increased average SKR in 2017 partially offset the reduced average NIS yield to result in an average saleable kernel yield that was consistent with the long-term average of 0.85 t/ha.

Productivity varies significantly between farms in the benchmark sample. Average nut-in-shell productivity for mature farms over the last nine seasons was 2.67 t/ha with a standard deviation of 1.25 t/ha, or 47% of the average.

Analysis of factory reject categories provides insight into the specific causes of post-harvest losses in any season. Figure 16 shows the averages of all major factory reject categories for farms in the benchmark sample from 2009 to 2017. It is important to note that these averages are unweighted, which means each farm in the sample exerts equal influence on the average regardless of its size or level of production.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
Insect	0.78	0.83	0.97	0.94	1.05	0.73	0.93	1.15	0.93	0.93
Mould	0.38	0.37	0.35	0.23	0.40	0.51	0.44	0.37	0.45	0.39
Discoloured	0.46	0.56	0.27	0.22	0.31	0.26	0.18	0.24	0.26	0.29
Brown centres	0.49	0.51	0.66	0.36	0.64	0.42	0.41	0.39	0.37	0.46
Immature	0.50	0.40	0.70	0.45	0.94	0.77	0.38	0.54	0.42	0.57
Germinated	0.15	0.13	0.07	0.04	0.07	0.08	0.07	0.07	0.09	0.08

Figure 16: Seasonal comparison of reject percentages for the whole benchmark sample (2009 to 2017)

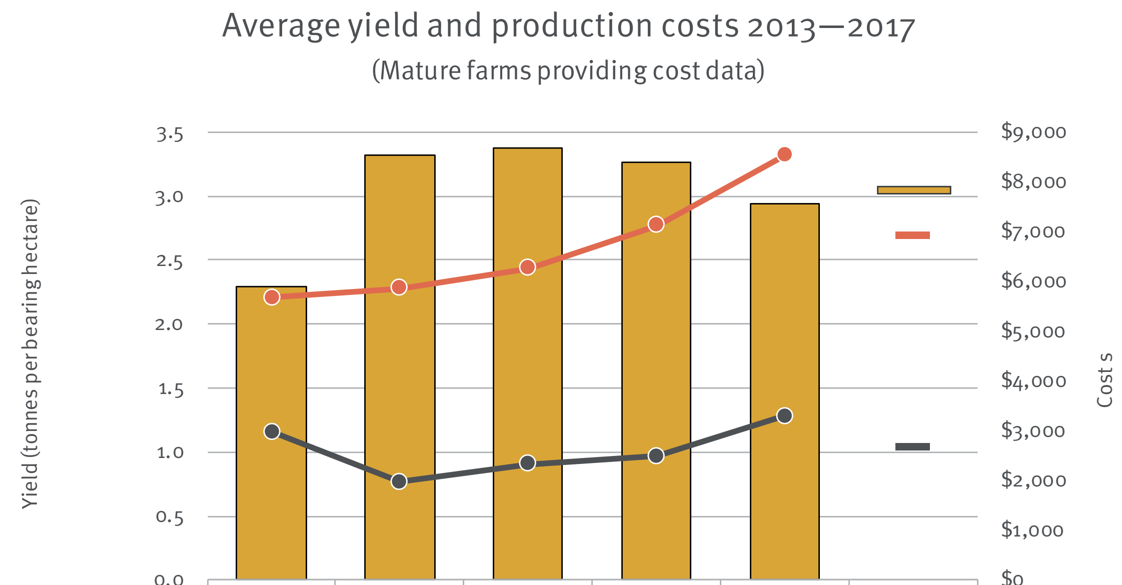
Insect damage has been the leading cause of factory reject across the benchmark sample in all years except 2014. Despite a decline in factory rejects due to insect damage in 2017, it remained the leading cause of reject in all regions other than CQ, where brown centres was the major cause of reject. Factory insect damage reject levels in 2017 were consistent with the long-term average of 0.93%.

Rejects due to mould were higher in 2017 (0.45%) than their long-term average (0.39%). All other rejects in 2017 were either below or consistent with long-term averages for the benchmark sample.

Figure 17 shows NIS productivity (t/ha) and average production costs (per hectare and per tonne of NIS) for mature farms (10+ years only) that provided cost data between 2013 and 2017. As collection of imputed labour data only commenced in 2017, the seasonal averages shown exclude imputed labour.

Average costs per hectare have increased each year since 2013, reaching their highest point in 2017 ($8531/ha). This equates to a 20% increase since 2016 and a 50% increase since 2013. The rise in costs per hectare may partially be related to recent high NIS prices, allowing businesses to reinvest in their orchards.

Despite annual increases in expenditure per hectare from 2013 to 2017, higher productivity has ensured average costs per tonne of NIS have remained relatively stable, particularly from 2014 to 2016. Lower average productivity in 2013 was a strong driver of the higher costs per tonne of NIS in that year. The higher costs per tonne of NIS in 2017 resulted from a combination higher expenditure per hectare and a decline in orchard productivity.



	2013	2014	2015	2016	2017	2013–17
NIS yield	2.29	3.32	3.37	3.26	2.94	3.03
Costs per hectare	$5,669	$5,854	$6,267	$7,116	$8,531	$6,937
Costs per tonne NIS	$2,972	$1,967	$2,322	$2,481	$3,295	$2,685

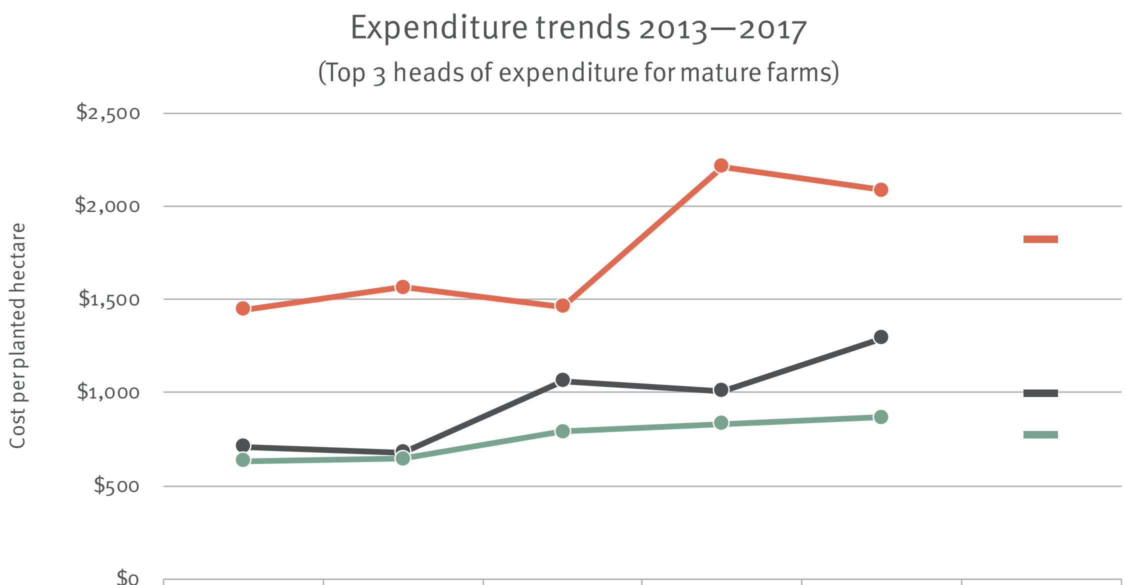
Figure 17: Yield and costs per hectare and per tonne of nut-in-shell (2013 to 2017)

Average productivity for farms providing cost data from 2009-2017 was just over 3 t/ha. At a NIS price of $5/kg this equates to an average net profit of around $8000/ha. At this same average productivity a minimum NIS price of around $2.30/kg would be required to cover costs.

In 2017 average total expenditure increased on farms in the Central Queensland (CQ), South East Queensland (SEQ) and Northern Rivers NSW (NRNSW) regions, while average costs were lower on farms in the Mid North Coast of NSW (MNNSW) region. From 2013 to 2017 the largest cost increases have been evident on farms in the 15–19 year age category (up 86%).

Figure 18 shows the top three heads of expenditure for mature farms from 2013 to 2017. Employment accounted for the largest proportion of total costs (26% excluding imputed labour). This is consistent with the previous On-farm Economic Analysis study from 2003–2006, with employment costs accounting for 24% of total costs at that time. This expenditure includes all costs associated with employment including permanent and casual wages, superannuation, training and expenses incurred as part of occupational health and safety and worker's compensation. It does not include unpaid labour costs which were not collected prior to 2017.

Analysis of 2017 cost data shows that employment costs account for approximately 36% of total costs when unpaid labour is included. This figure falls to 32% for managed farms and rises to 42% for owner-operated farms.



	2013	2014	2015	2016	2017	2013–17
Employment	$1,445	$1,565	$1,459	$2,210	$2,083	$1,821
Crop nutrition	$710	$680	$1,062	$1,007	$1,293	$992
R&M Plant	$633	$645	$789	$832	$868	$771

Figure 18: Annual cost trends per planted hectare by head of expenditure for mature farms (2013 to 2017)

Crop nutrition was the next highest average cost (excluding imputed labour) from 2013 to 2017 (14%) followed by repairs and maintenance of plant (11%).

In each season there are significant differences between farms in both total costs and the breakdown of those costs. This variation is related to individual farm characteristics, periodic farm management activities and the stage of development within the orchard.

The most significant increase in average costs for mature farms from 2016 to 2017 was leases, which increased from about $270/ha in 2016 to more than $1000/ha in 2017.

Top performing farms

The benchmarking study has revealed high variability in productivity between farms and also between seasons for individual farms. Analysis of the top performing farms in the sample is included to determine any trends associated with high orchard productivity.

To be regarded as a top performing farm, high orchard productivity must be sustained over a minimum of four seasons, including the most recent production season of 2017. These farms are then ranked according to their average saleable kernel productivity (t/ha) over all seasons for which they have submitted data. Only farms that fall within the top 25% of this group are regarded as top performing farms. As inclusion in this group is based on average performance over multiple seasons it is possible that some top performing farms may not have been among the most productive farms in a particular season.

Figure 19 shows a breakdown of the top performing farms (inner circle) by region and compares this with the regional breakdown of farms for the whole benchmark sample (outer circle).

The South East Queensland (SEQ), Northern Rivers of New South Wales (NRNSW) and Mid North Coast of NSW (MNNSW) regions were all proportionately represented within the top performing farms group. The Central Queensland (CQ) region was less represented among top performing farms, however it's important to remember that farms in this region are younger on average than other regions and therefore yet to reach full yield potential.

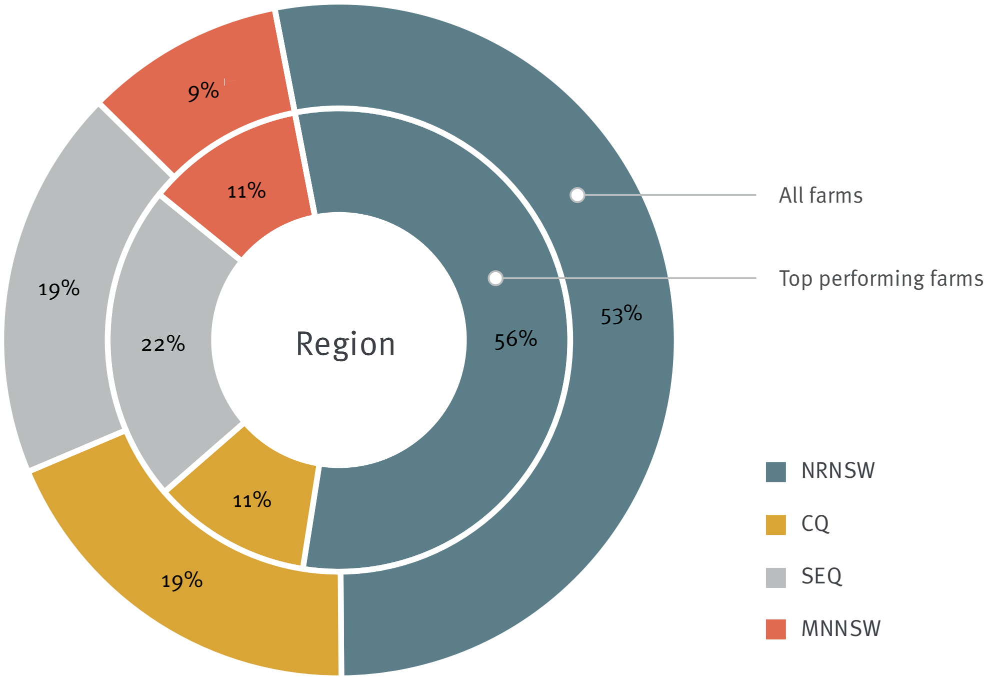


Figure 19: Top performing farms versus the whole benchmark sample by region (2009 to 2017)

Figure 20 shows a breakdown of the top performing farms by farm size and compares this with the whole benchmark sample.

Although small to medium farms make up the majority of top performing farms, all farm size categories are represented. A total of 67% of top performing farms were less than 20 hectares in size compared with 55% for the whole benchmark sample. It is important to remember that many larger farms in the benchmark sample are, on average, younger than smaller farms and therefore yet to reach their bearing potential.

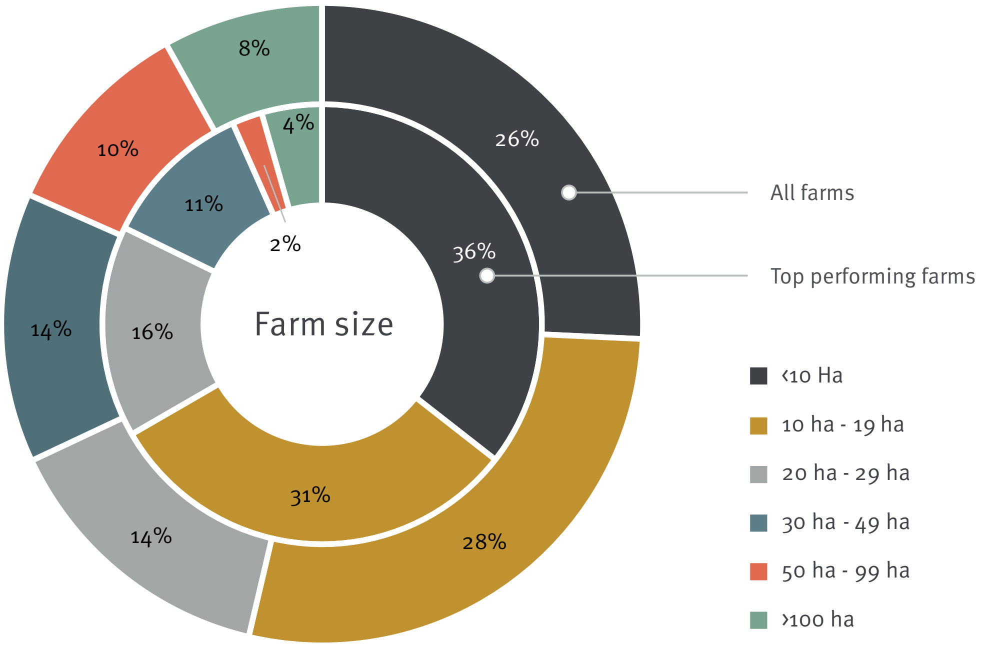


Figure 20: Farm size categories of top performing farms versus the whole benchmark sample (2009 to 2017)

Figure 21 shows a breakdown of the top performing farms by tree age and compares this with the whole benchmark sample.

Farms with an average tree age of 25 to 29 years were the most strongly represented among the top performing farms (44%) compared with the wider benchmark sample (22%).

Approximately 4% of top performing farms had an average tree age less than 15 years. By comparison, 25% of the whole benchmark sample had an average tree age of less than 15 years.

Conversely, 7% of top performing farms had an average tree age of 30 years or more. This is important to note as it demonstrates that high productivity is being maintained in some older orchards.

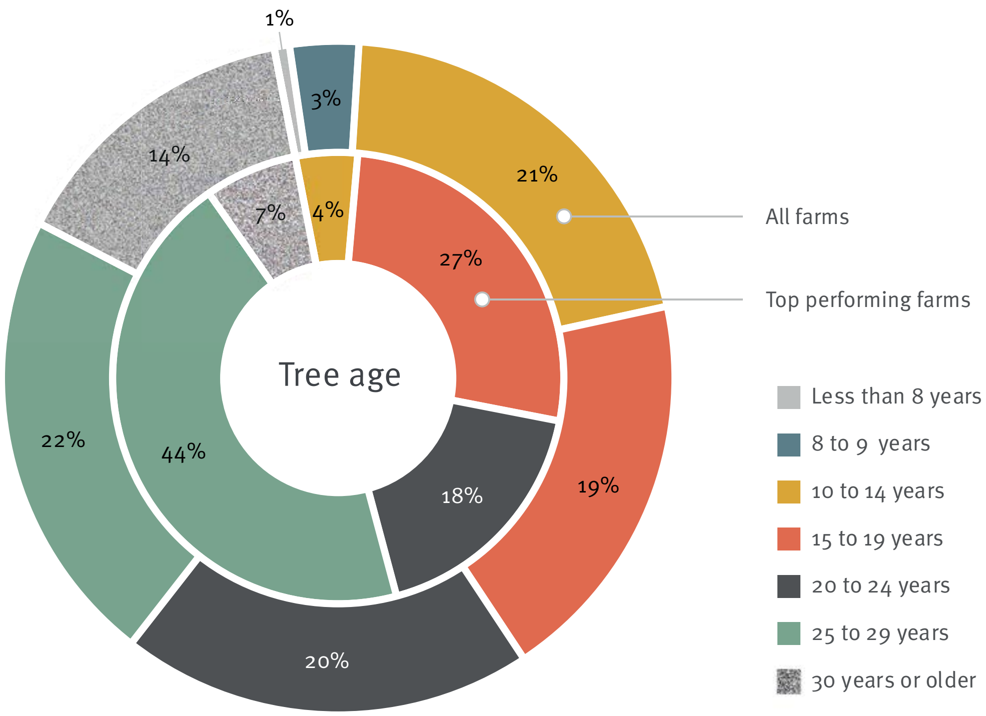
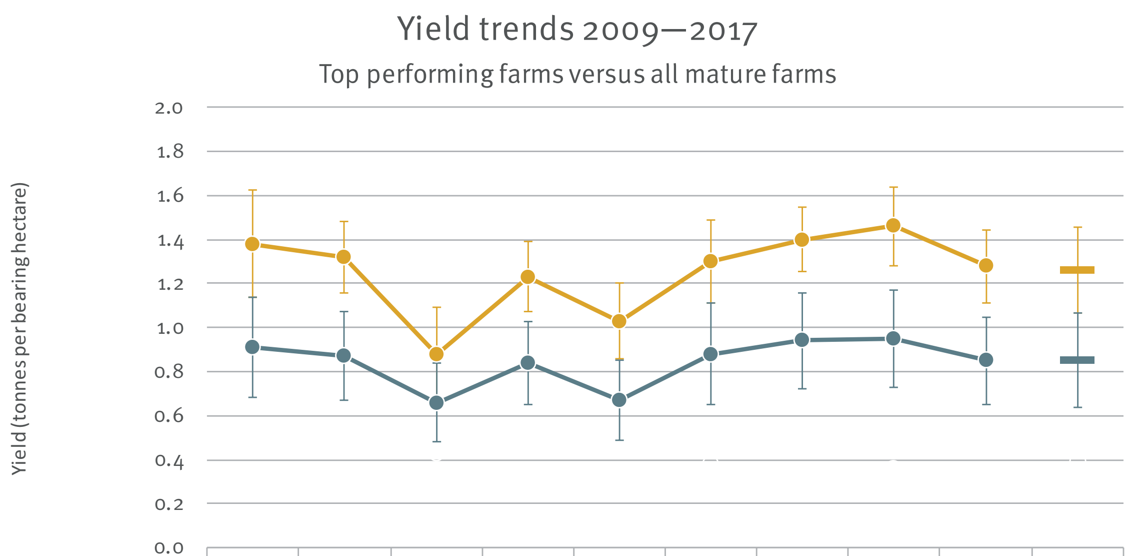


Figure 21: Tree age of top performing farms versus the whole benchmark sample (2009 to 2017)

Figure 22 shows the average saleable kernel (SK) yield per bearing hectare for the top performing farms from 2009 to 2017 and compares these with all mature farms in the benchmark sample. Farms aged less than 10 years are excluded from both groups for consistency. The error bars on the chart represent the standard deviations from these average yields.

It is important to remember that top performing farms must have provided data for at least four years, including 2017, to be considered for inclusion within this group.

This chart confirms that top performing farms, like the broader benchmark sample, experience seasonal yield fluctuations. It also shows that the pattern of this fluctuation is reasonably consistent between the two groups from season to season. Yield in 2017 for both groups was similar to long-term averages from 2009–2017.



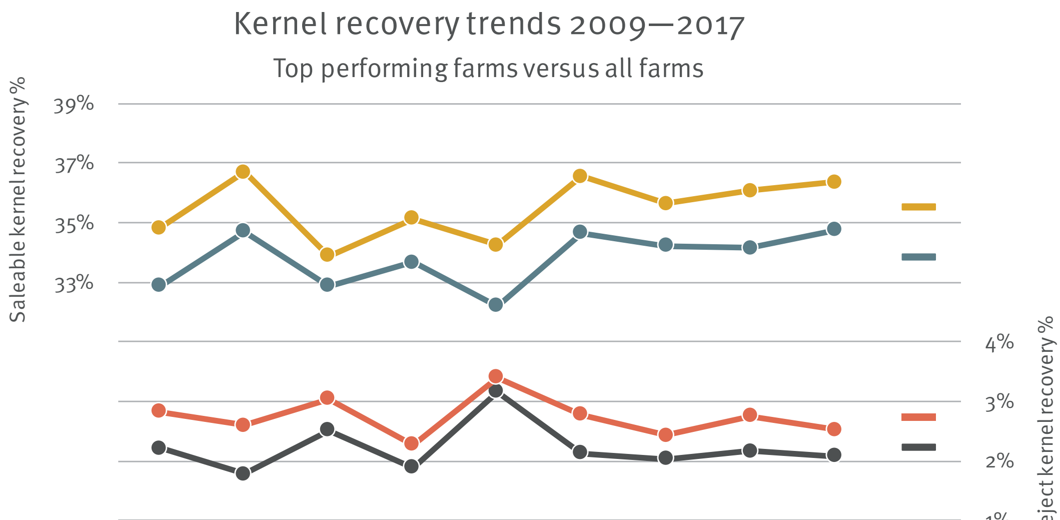
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
SK yield (TPF)	1.38	1.32	0.88	1.23	1.03	1.3	1.4	1.46	1.28	1.26
Std.dev. (TPF)	0.49	0.32	0.43	0.32	0.34	0.38	0.29	0.36	0.33	0.39
SK yield (All farms)	0.91	0.87	0.66	0.84	0.67	0.88	0.94	0.95	0.85	0.85
Std.dev. (All farms)	0.46	0.40	0.36	0.38	0.36	0.46	0.44	0.44	0.40	0.43

Figure 22: Saleable kernel yield for top performing farms versus all mature farms in the benchmark sample (2009 to 2017)

The error bars show that even low yields for farms in the top performing farms group rarely overlap with average yields in even the best cropping years for all mature farms in the benchmark sample.

The top performing farms averaged 1.26 tonnes of saleable kernel per bearing hectare over the nine years from 2009 to 2017, compared with 0.85 tonnes for all farms in the benchmark sample with an average tree age of 10 years or more. This is an increase of 410 kilograms of SK per bearing hectare, or 48%, for top performing farms.

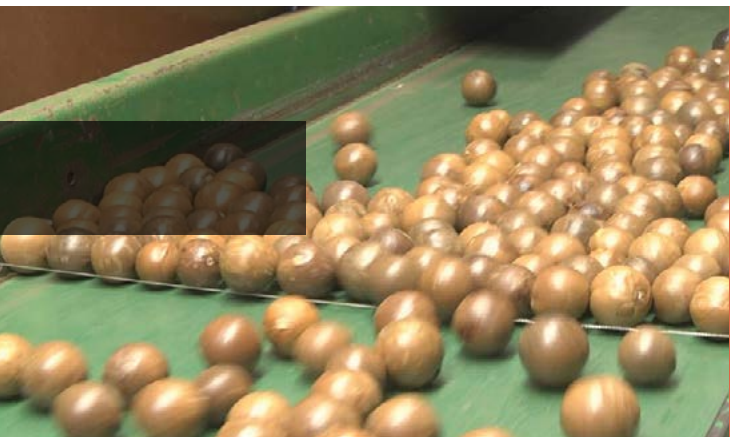
Figure 23 compares average kernel recovery trends from 2009 to 2017 for the top performing farms with all farms in the benchmark sample. The top performing farms consistently achieved lower average reject kernel recovery (RKR) than the benchmark average over the last nine seasons (2.23% vs 2.73%). The difference in average RKR between the two groups during this time ranged from 0.25% to up to 0.81%.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
SKR% (TPF)	34.82	36.71	33.90	35.13	34.24	36.56	35.65	36.07	36.36	35.55
SKR% (All farms)	32.88	34.71	32.88	33.67	32.20	34.67	34.22	34.15	34.75	33.84
RKR% (TPF)	2.22	1.79	2.52	1.89	3.16	2.13	2.04	2.17	2.09	2.23
RKR% (All farms)	2.83	2.60	3.05	2.28	3.41	2.78	2.43	2.76	2.53	2.73

Figure 23: Kernel recovery for the top performing farms versus all farms in the benchmark sample (2009 to 2017)

The top performing farms (based on average yield per hectare) consistently achieved a higher average saleable kernel recovery (SKR) than all mature farms in the benchmark sample across all seasons. The top performing farms averaged 35.55% SKR over the past nine years, compared to 33.84% for all mature farms. This is a difference of 1.71% in SKR. The difference in SKR varied from 1.02% in 2011 to 2.04% in 2013. The SKR difference means that the top performing farms also achieved a higher price per kilogram of nut-in-shell (NIS) each year than the average for mature farms in the benchmark sample.



In addition to higher average saleable kernel yield, top performing farms also achieved higher average saleable kernel recovery and lower average reject kernel recovery than the average of all farms in the benchmark sample.

Figure 24 shows the average percentage of rejects by reject category for the top performing farms compared with all farms in the benchmark sample from 2009 to 2017. These averages are unweighted, which means that each farm in the data sample exerts equal influence on the average regardless of size or amount of production.

The top performing farms had similar seasonal reject patterns with lower average rejects in each category compared with all farms in the benchmark sample over the nine seasons. Insect damage was the dominant reject category for most seasons from 2009 to 2017 for both top performing farms (average 0.77%) and all farms in the benchmark sample (average 0.93%).

Insect damage and brown centres were the two reject categories that showed the greatest average differences between the top performing farms and all farms in the benchmark sample, over the nine seasons. Those differences were 0.16% and 0.10% respectively.

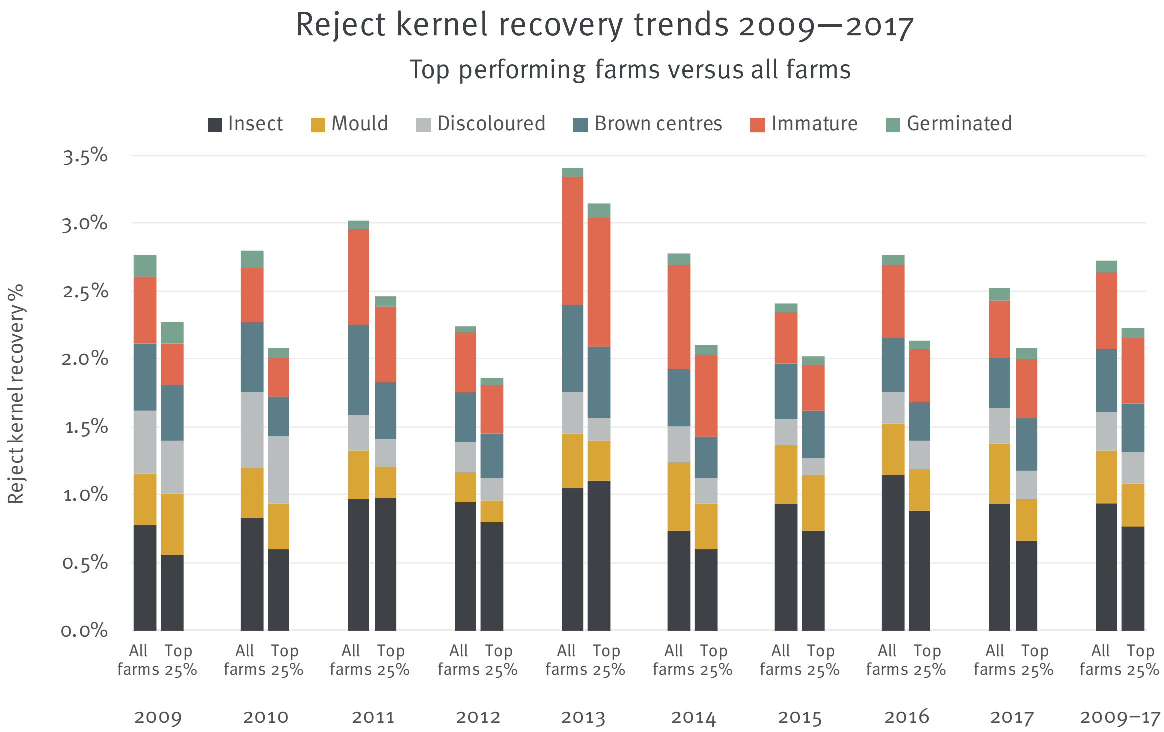


Figure 24: Reject breakdown for top performing farms versus all farms (2009 to 2017)

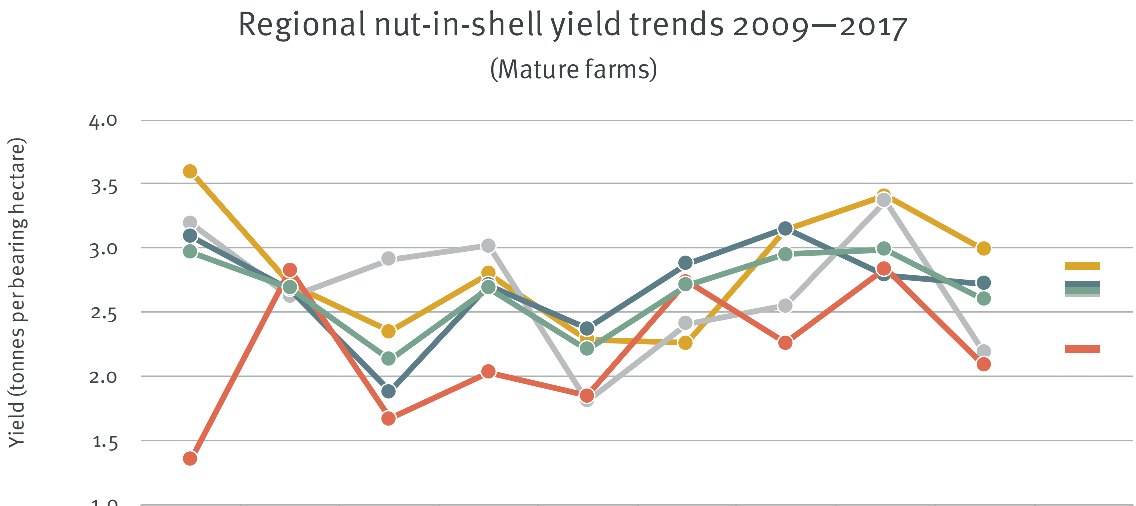
Seasonal trends by region

Yield and quality results were compared across the four major production regions of Central Queensland (CQ), South East Queensland (SEQ), Northern Rivers of NSW (NRNSW) and the Mid North Coast of NSW (MNNSW). Figure 25 compares average annual nut-in-shell (NIS) yield per bearing hectare for mature farms (10 or more years old) in each of these regions. These averages are unweighted meaning all farms exert equal influence regardless of their size.

The region with the highest average mature NIS yield over the last nine years was CQ (2.86 t/ha), followed by NRNSW (2.71 t/ha), SEQ (2.65 t/ha) then MNNSW (2.21 t/ha).

Farms in the CQ and NRNSW regions showed the highest average NIS per hectare in 2017 (2.99 and 2.72 t/ha respectively). All regions experienced a decline in yield in 2017. SEQ farms had the largest average decrease in 2017 (1.18 t/ha) while NRNSW farms had the smallest average decrease (0.07 t/ha). Across all regions average mature NIS yield fell to 2.60 t/ha in 2017 following a record high of 2.99 t/ha in 2016.

When compared with all farms in the 2017 benchmark sample, average NIS yield was higher for farms in CQ and NRNSW and lower for farms in SEQ and MNNSW.

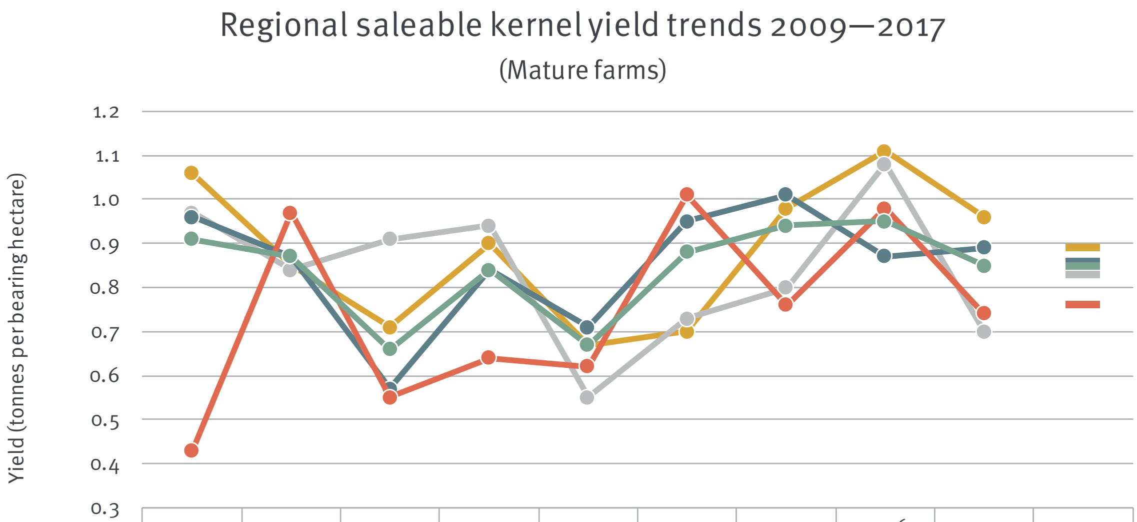


	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
CQ	3.59	2.72	2.35	2.80	2.29	2.26	3.14	3.41	2.99	2.86
SEQ	3.19	2.62	2.91	3.02	1.81	2.41	2.55	3.37	2.19	2.65
NRNSW	3.09	2.68	1.88	2.71	2.37	2.88	3.15	2.79	2.72	2.71
MNNSW	1.36	2.83	1.67	2.03	1.85	2.74	2.26	2.84	2.09	2.21
All regions	2.97	2.69	2.13	2.69	2.21	2.71	2.95	2.99	2.60	2.67

Figure 25: Regional nut-in-shell yields per bearing hectare for mature farms (2009 to 2017)

Figure 26 compares average yields of saleable kernel (SK) per bearing hectare from 2009 to 2017 for mature farms in each of the four regions in the benchmark sample. This chart shows a similar general trend to NIS productivity for this period, with some variation in specific regions and seasons due to variation in saleable kernel recovery.

Farms in the CQ region achieved the highest average SK productivity from 2009 to 2017 (0.89 t/ha), followed by NRNSW (0.86 t/ha), SEQ (0.83 t/ha) and MNNSW (0.76 t/ha). The SEQ region had the lowest average SK yield per bearing hectare in 2017 after achieving the second highest average yield in 2016.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
CQ	1.06	0.85	0.71	0.90	0.67	0.70	0.98	1.11	0.96	0.89
SEQ	0.97	0.84	0.91	0.94	0.55	0.73	0.80	1.08	0.70	0.83
NRNSW	0.96	0.87	0.57	0.84	0.71	0.95	1.01	0.87	0.89	0.86
MNNSW	0.43	0.97	0.55	0.64	0.62	1.01	0.76	0.98	0.74	0.76
All regions	0.91	0.87	0.66	0.84	0.67	0.88	0.94	0.95	0.85	0.85

Figure 26: Regional saleable kernel yields per bearing hectare for mature farms (2009 to 2017)

Figure 27 compares average regional saleable kernel recovery (SKR) for farms in each major production region from 2009 to 2017. SKR is the sum of premium kernel recovery (PKR) and commercial kernel recovery (CKR).

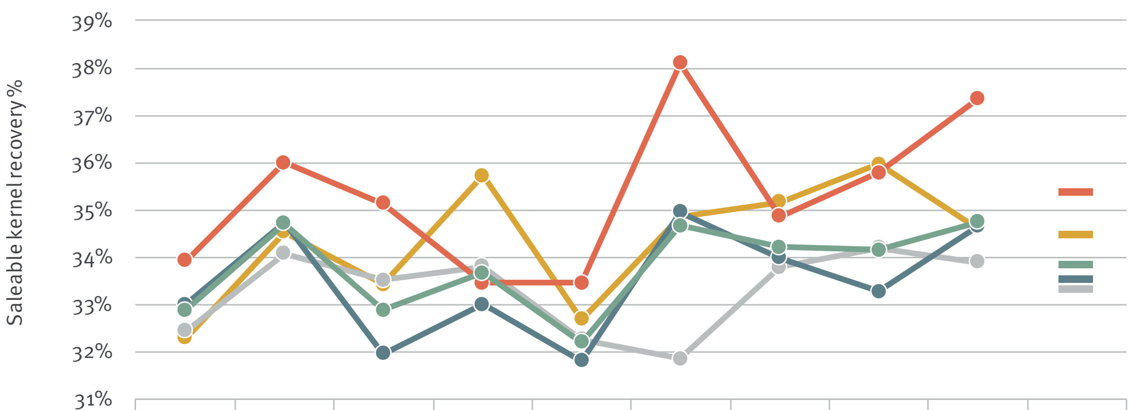
Average SKR was slightly higher across the benchmark sample in 2017 (34.75%) than the previous season (34.15 %). Both the MNNSW and NRNSW regions showed SKR increases in 2017 (up 1.55% and 1.37% respectively). CQ experienced the largest drop in average SKR in 2017, falling to 34.62%, which was 1.34% down from 2016. SKR in SEQ dropped slightly between 2016 and 2017.

The MNNSW region had the highest average SKR of all regions for the 2009 to 2017 period (35.40%) followed by CQ (34.49%), NRNSW (33.53%) and SEQ (33.34%). The high average SKR in the MNNSW region is influenced by the high percentage of “A” series cultivars grown in this region, which tend to have high kernel recoveries.

Table 1 shows that trees in CQ are, on average, younger than those in the other production regions. Analysis of productivity data by tree age shows farms with a younger average tree age tend to have higher SKR.

Regional saleable kernel recovery trends 2009—2017

(All farms)



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
CQ	32.30	34.53	33.42	35.72	32.69	34.86	35.16	35.96	34.62	34.49
SEQ	32.44	34.07	33.52	33.81	32.26	31.86	33.79	34.20	33.90	33.34
NRNSW	33.01	34.74	31.96	33.01	31.81	34.95	33.98	33.28	34.65	33.53
MNNSW	33.92	35.99	35.14	33.45	33.45	38.10	34.87	35.79	37.34	35.40
All regions	32.88	34.71	32.88	33.67	32.20	34.67	34.22	34.15	34.75	33.84

Figure 27: Regional saleable kernel recoveries for all farms (2009 to 2017)

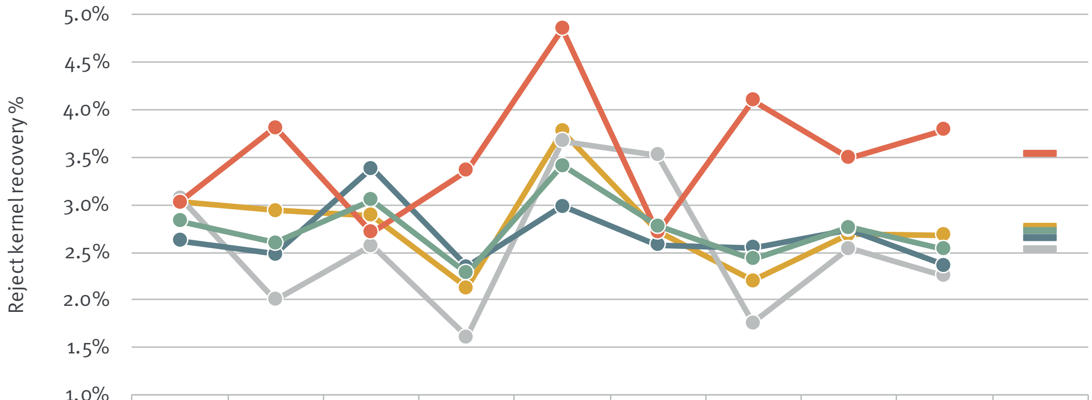
Figure 28 compares average reject kernel recovery (RKR) for each region from 2009 to 2017.

Across the benchmark sample average RKR was lower in 2017 (2.53%) compared with the previous season (2.76%). All regions apart from MNNSW experienced a reduction in RKR in 2017, which was mainly due to reduced average insect damage in CQ, SEQ and NRNSW. In 2017 MNNSW farms showed an increase in average RKR, rising to 3.79%. This was attributed to increases in insect damage, immaturity and germination.

The MNNSW region had the highest long-term average RKR of all regions for the 2009 to 2017 period (3.54%) followed by CQ (2.77%), NRNSW (2.65%) and SEQ (2.54%).

Regional reject kernel recovery trends 2009—2017

(All farms)

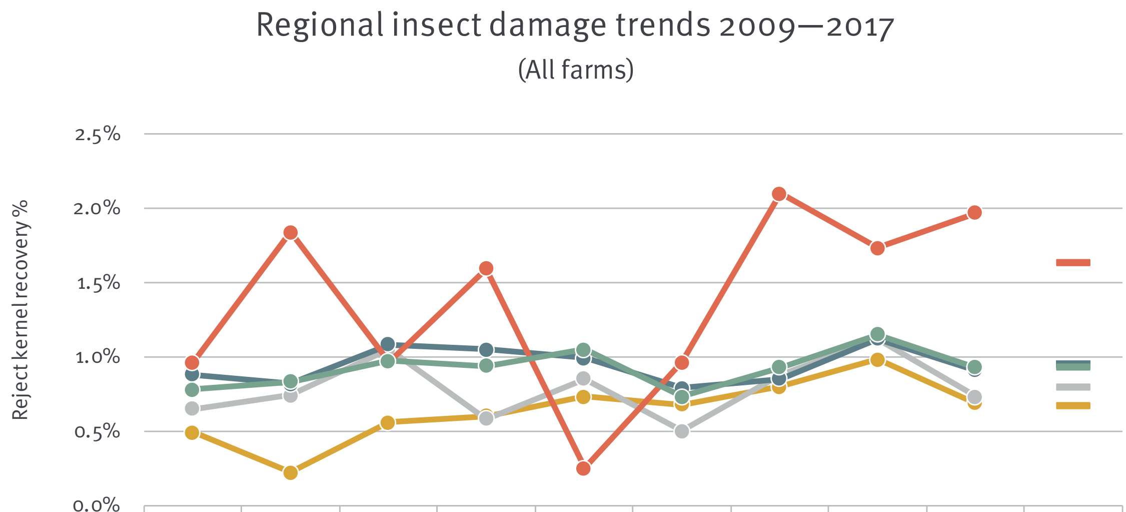


	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
CQ	3.03	2.94	2.89	2.13	3.77	2.72	2.20	2.69	2.68	2.77
SEQ	3.07	2.00	2.57	1.61	3.67	3.52	1.76	2.54	2.25	2.54
NRNSW	2.62	2.48	3.38	2.35	2.98	2.58	2.55	2.74	2.36	2.65
MNNSW	3.03	3.81	2.71	3.36	4.85	2.71	4.10	3.49	3.79	3.54
All regions	2.83	2.60	3.05	2.28	3.41	2.78	2.43	2.76	2.53	2.73

Figure 28: Regional reject kernel recoveries (2009 to 2017)

Figure 29 shows average factory rejects due to insect damage for participating farms in each of the four major production regions from 2009 to 2017.

In 2017 average insect damage dropped to 0.93%, which was equal to the average for all regions for 2009 to 2017. CQ, SEQ and NRNSW regions all showed a reduction in insect damage in 2017, although insect damage remained the leading cause of factory reject kernel across all regions in that year. Average insect damage levels have remained substantially higher in MNNSW than in all other regions since 2015.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
CQ	0.49	0.22	0.56	0.60	0.73	0.68	0.80	0.98	0.69	0.67
SEQ	0.65	0.74	1.05	0.58	0.85	0.50	0.88	1.12	0.73	0.80
NRNSW	0.88	0.82	1.08	1.05	0.99	0.79	0.85	1.12	0.91	0.95
MNNSW	0.96	1.84	0.96	1.59	0.25	0.96	2.10	1.73	1.97	1.63
All regions	0.78	0.83	0.97	0.94	1.05	0.73	0.93	1.15	0.93	0.93

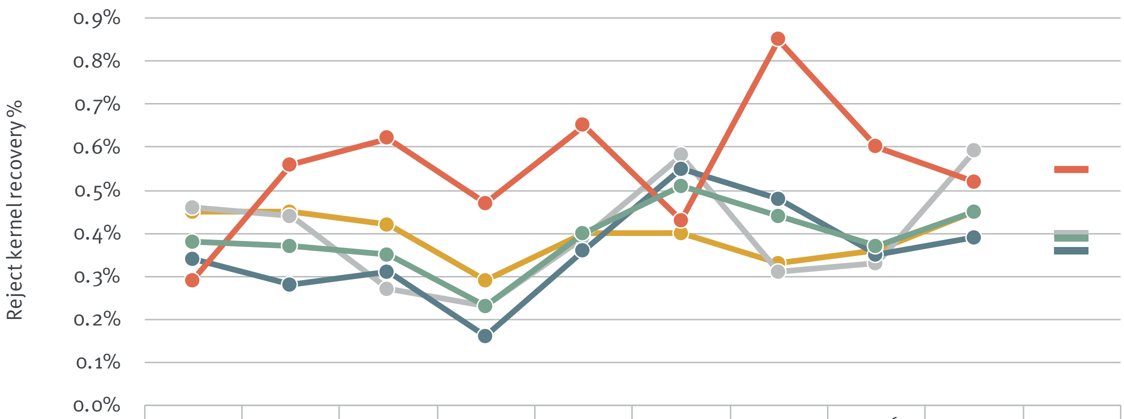
Figure 29: Regional insect damage rejects (2009 to 2017)

Figure 30 shows average factory rejects due to mould from 2009 to 2017 for each of the four regions in the benchmark sample.

CQ, SEQ and NRNSW showed an increase in mould rejects in 2017. The most significant increase was in SEQ which rose to 0.59% in 2017 from 0.33% in 2016. Mould rejects in MNNSW dropped in 2017 for the second season in a row after record levels in 2015.

Regional mould trends 2009—2017

(All farms)

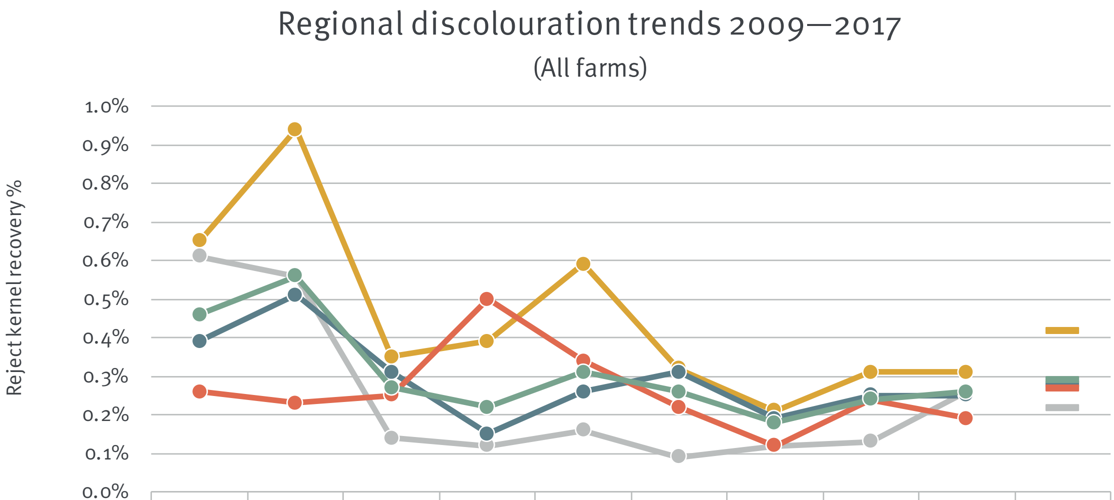


	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009-17
CQ	0.45	0.45	0.42	0.29	0.40	0.40	0.33	0.36	0.45	0.39
SEQ	0.46	0.44	0.27	0.23	0.39	0.58	0.31	0.33	0.59	0.40
NRNSW	0.34	0.28	0.31	0.16	0.36	0.55	0.48	0.35	0.39	0.36
MNNSW	0.29	0.56	0.62	0.47	0.65	0.43	0.85	0.60	0.52	0.55
All regions	0.38	0.37	0.35	0.23	0.40	0.51	0.44	0.37	0.45	0.39

Figure 30: Regional mould rejects (2009 to 2017)

Figure 31 shows average factory rejects due to discolouration from 2009 to 2017 for each of the four regions in the benchmark sample.

Average discolouration rejects were similar between 2016 and 2017 for CQ and NRNSW. MNNSW showed a reduction in discolouration rejects in 2017 to 0.19% which was the lowest of all regions. Despite SEQ being the only region that showed an increase in discolouration rejects in 2017 it achieved the lowest long-term reject level for this category. CQ displayed the highest long-term average for this reject category.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009-17
CQ	0.65	0.94	0.35	0.39	0.59	0.32	0.21	0.31	0.31	0.42
SEQ	0.61	0.56	0.14	0.12	0.16	0.09	0.12	0.13	0.26	0.22
NRNSW	0.39	0.51	0.31	0.15	0.26	0.31	0.19	0.25	0.25	0.28
MNNSW	0.26	0.23	0.25	0.50	0.34	0.22	0.12	0.24	0.19	0.27
All regions	0.46	0.56	0.27	0.22	0.31	0.26	0.18	0.24	0.26	0.29

Figure 31: Regional discolouration rejects (2009 to 2017)

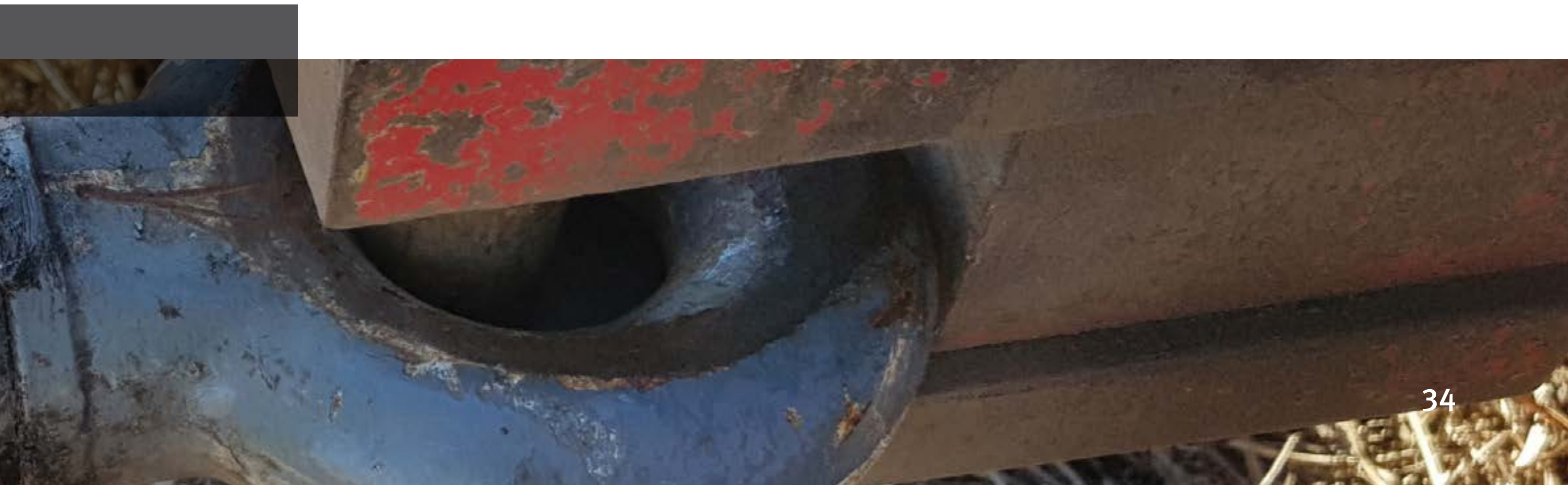
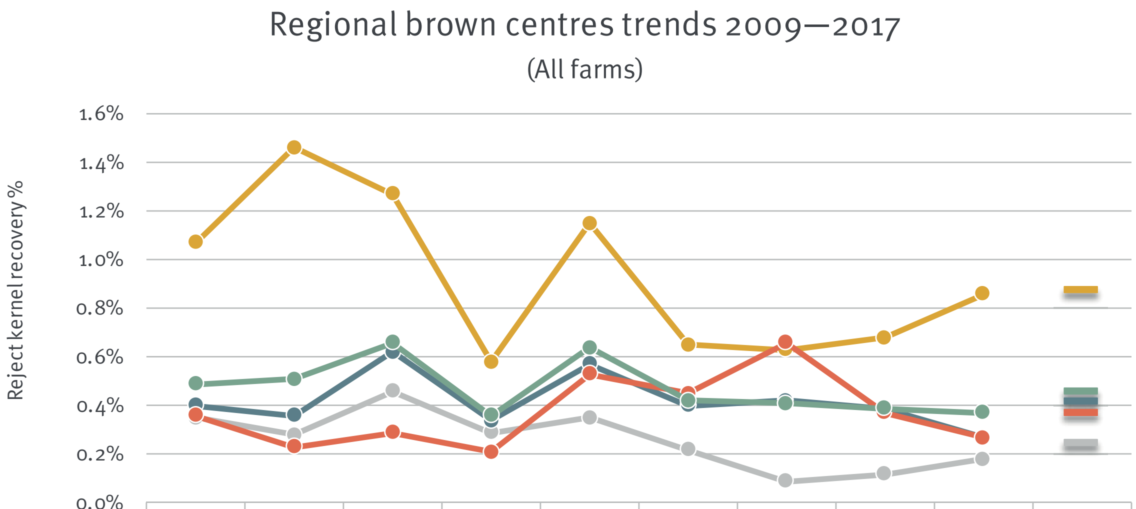


Figure 32 shows average factory rejects due to brown centres from 2009 to 2017 for each of the four regions in the benchmark sample.

In 2017 average rejects due to brown centres increased slightly among Queensland farms for the second year in a row. The most notable increase was in CQ rising to 0.86% in 2017 which was similar to the long-term average for this region. NSW farms showed a decrease in brown centre rejects in 2017 with both NRNSW and MNNSW regions dropping to 0.27%, which was below the long-term average for these regions. SEQ produced the lowest levels of brown centres for the fifth year in a row.

In 2017 and in most previous seasons, farms in the CQ region have had higher average rejects due to brown centres than those in other regions. Benchmark data has shown that CQ farms are, on average, much larger than farms in the other regions. Grower surveys from the Macadamia Kernel Quality project (MC07008) found that on average brown centres increased with increasing farm size, maximum silo size and nut storage bed depth.



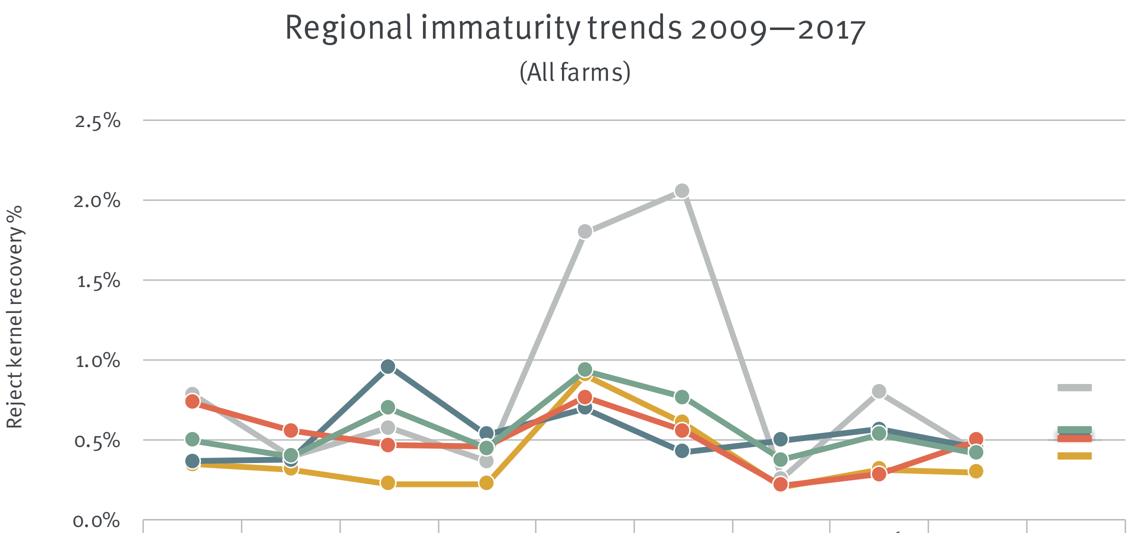
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
CQ	1.07	1.46	1.27	0.58	1.15	0.65	0.63	0.68	0.86	0.88
SEQ	0.35	0.28	0.46	0.29	0.35	0.22	0.09	0.12	0.18	0.25
NRNSW	0.40	0.36	0.62	0.34	0.57	0.40	0.42	0.39	0.27	0.42
MNNSW	0.36	0.23	0.29	0.21	0.53	0.45	0.66	0.37	0.27	0.37
All regions	0.49	0.51	0.66	0.36	0.64	0.42	0.41	0.39	0.37	0.46

Figure 32: Regional brown centres rejects (2009 to 2017)

Farms in the benchmark sample from the Central Queensland region are, on average, younger and larger than farms from New South Wales and South East Queensland.

Figure 33 shows average factory rejects due to immaturity from 2009 to 2017 for each of the four regions in the benchmark sample.

In 2017 average rejects due to immaturity decreased in CQ, SEQ and NRNSW despite anticipated high levels following extended dry periods during the nut development period. MNNSW was the only region to experience an increase in this reject category in 2017. SEQ had the highest levels of immaturity between 2009 and 2017. Previous high immaturity levels in SEQ in 2013 and 2014 have largely been attributed to very dry conditions leading to moisture stress during nut growth and oil accumulation stages. Prior to 2012 much of the immaturity in SEQ and NSW was attributed to premature nut drop caused by husk spot. Husk spot was not as prevalent during 2012 to 2017 and was not considered a major cause of immaturity in these seasons.

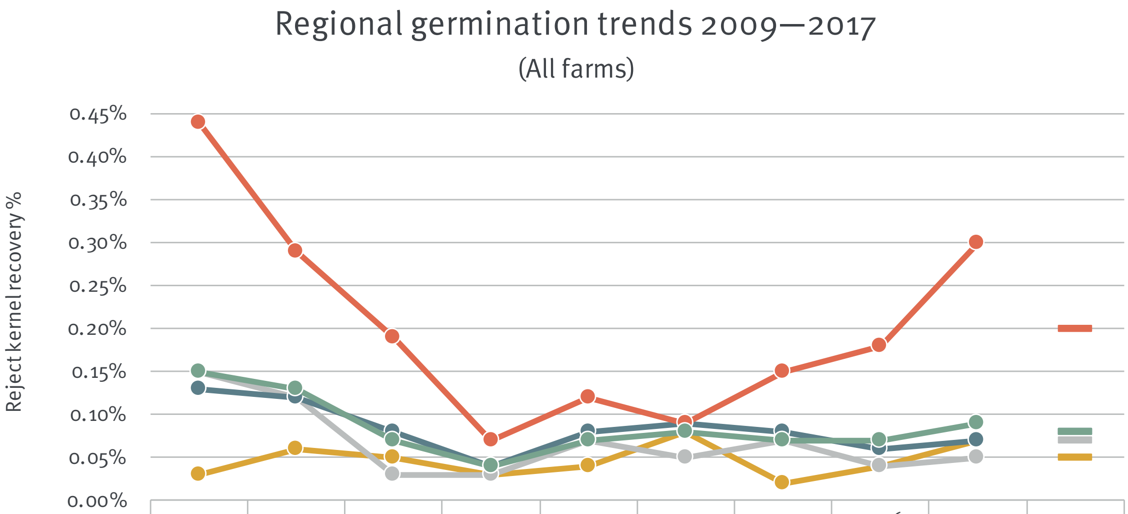


	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009-17
CQ	0.35	0.32	0.23	0.23	0.91	0.61	0.21	0.32	0.30	0.40
SEQ	0.79	0.40	0.58	0.37	1.80	2.06	0.26	0.80	0.43	0.83
NRNSW	0.37	0.38	0.96	0.54	0.70	0.43	0.50	0.57	0.45	0.54
MNNSW	0.74	0.56	0.47	0.46	0.77	0.56	0.22	0.29	0.50	0.51
All regions	0.50	0.40	0.70	0.45	0.94	0.77	0.38	0.54	0.42	0.57

Figure 33: Regional immaturity rejects (2009 to 2017)

Figure 34 shows average factory rejects due to germination from 2009 to 2017 for each of the four regions in the benchmark sample.

Average germination rejects have remained low across most regions since 2012. The most significant increase in 2017 was in MNNSW which increased to 0.3%. Despite this, average losses due to germination remained the least prevalent type of reject across the benchmark sample from 2009 to 2017.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
CQ	0.03	0.06	0.05	0.03	0.04	0.08	0.02	0.04	0.07	0.05
SEQ	0.15	0.12	0.03	0.03	0.07	0.05	0.07	0.04	0.05	0.07
NRNSW	0.13	0.12	0.08	0.04	0.08	0.09	0.08	0.06	0.07	0.08
MNNSW	0.44	0.29	0.19	0.07	0.12	0.09	0.15	0.18	0.30	0.20
All regions	0.15	0.13	0.07	0.04	0.07	0.08	0.07	0.07	0.09	0.08

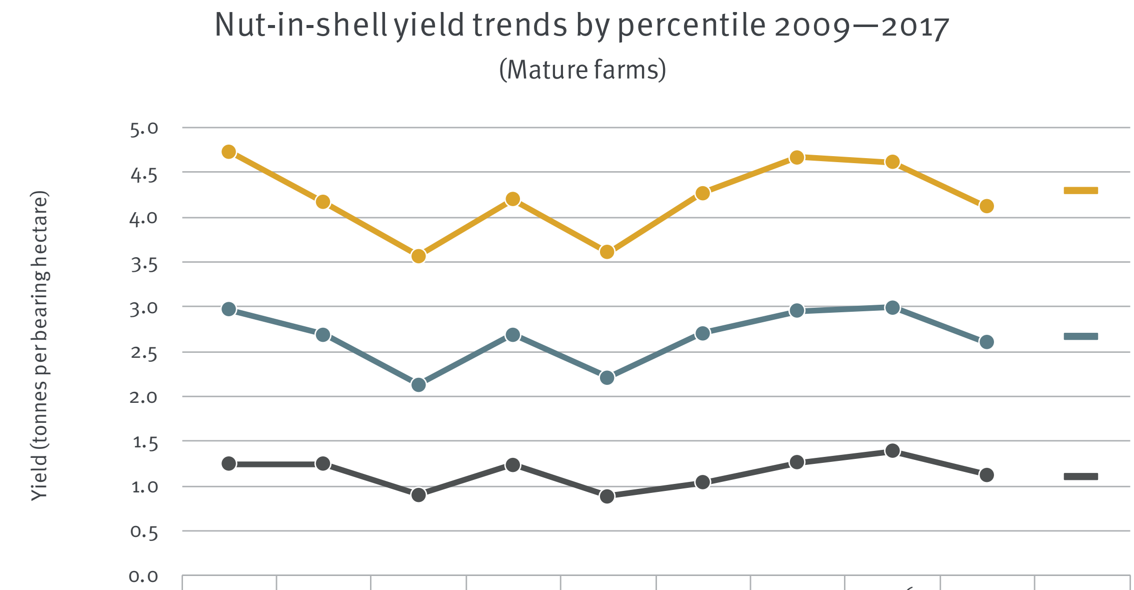
Figure 34: Regional germination rejects (2009 to 2017)

Productivity and quality percentiles

In this section yield and quality information is presented as percentiles, i.e. averages for the top 25% and bottom 25% of the benchmark sample are compared with the overall sample average. It is important to note that the farms included in percentile averages are different for each yield or quality attribute. This means for example that the top 25% of farms for nut-in-shell (NIS) production in any given season may not be the same farms as the top 25% for saleable kernel (SK) production. This is quite different to the top performing farms in the previous section, which are based on a static group of farms that returned consistently high SK production per bearing hectare over multiple seasons. Percentiles therefore provide insight into sample variability rather than providing indication of long-term performance. This is an important distinction between percentiles and top performing farms.

Substantial variability in both yield and quality was evident within the benchmark sample. Percentiles demonstrate the extent of this variability for various yield and quality attributes. Yield percentiles are based on mature farms to avoid the influence of young farms that are yet to reach full production. Quality percentiles are based on all farms in the benchmark sample.

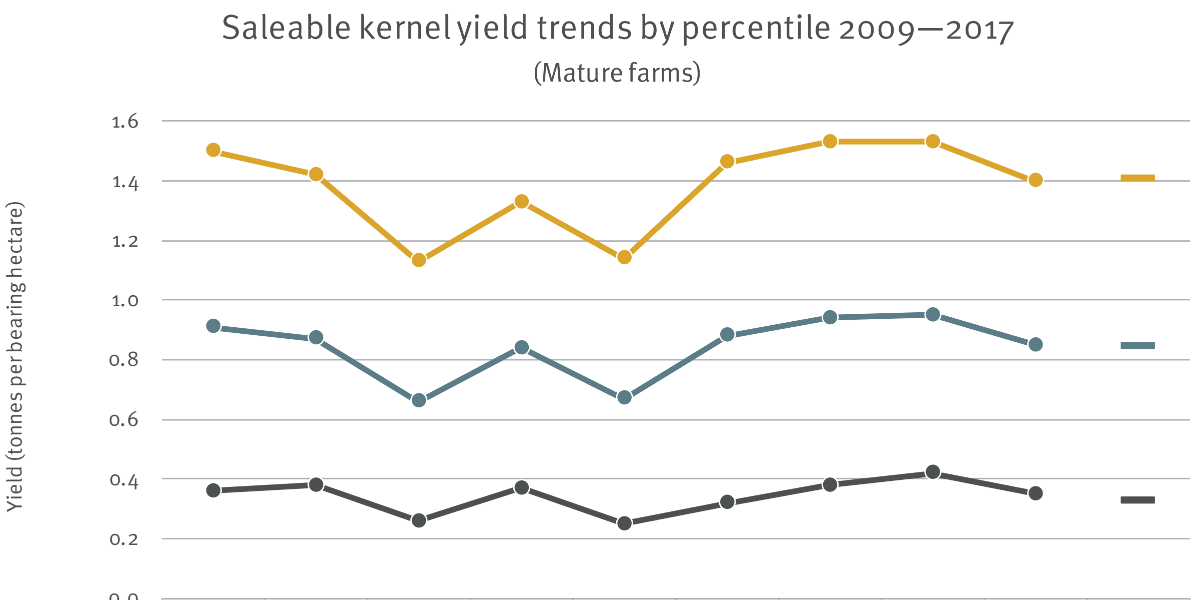
Figure 35 compares the average tonnes of NIS per bearing hectare for the top 25%, bottom 25% and all mature farms in the benchmark sample for each year from 2009 to 2017. The 2017 season recorded a decrease in average NIS yield across all percentile groups compared to the previous two seasons. This follows a steady increase in yield for all groups from 2013 to 2015, with it peaking in 2016 for the bottom 25% and the sample average. Average NIS yield for 2017 was also less than the long-term averages for both the top 25% and the average of all mature farms.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
Top 25%	4.73	4.17	3.57	4.20	3.61	4.27	4.67	4.61	4.12	4.30
All mature farms	2.97	2.69	2.13	2.69	2.21	2.71	2.95	2.99	2.60	2.67
Bottom 25%	1.25	1.25	0.90	1.24	0.89	1.04	1.26	1.39	1.13	1.11

Figure 35: Nut-in-shell yield per bearing hectare by percentile (2009 to 2017)

Figure 36 compares the average tonnes of SK per bearing hectare for the top 25%, bottom 25% and all farms in the benchmark sample for each year from 2009 to 2017. SK steadily increased across all groups from 2013, peaking in 2016. SK yield decreased in 2017 in each group compared to the previous two seasons. Despite this decrease, the 2017 season averages remain comparable to the long-term averages (2009–17).



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
Top 25%	1.50	1.42	1.13	1.33	1.14	1.46	1.53	1.53	1.40	1.41
All mature farms	0.91	0.87	0.66	0.84	0.67	0.88	0.94	0.95	0.85	0.85
Bottom 25%	0.36	0.38	0.26	0.37	0.25	0.32	0.38	0.42	0.35	0.33

Figure 36: Saleable kernel yield per bearing hectare by percentile (2009 to 2017)

SK yield decreased in 2017 compared to the previous two seasons, however quality averages improved, with an increase in saleable kernel recovery and decrease in reject kernel recovery across all percentile groups.

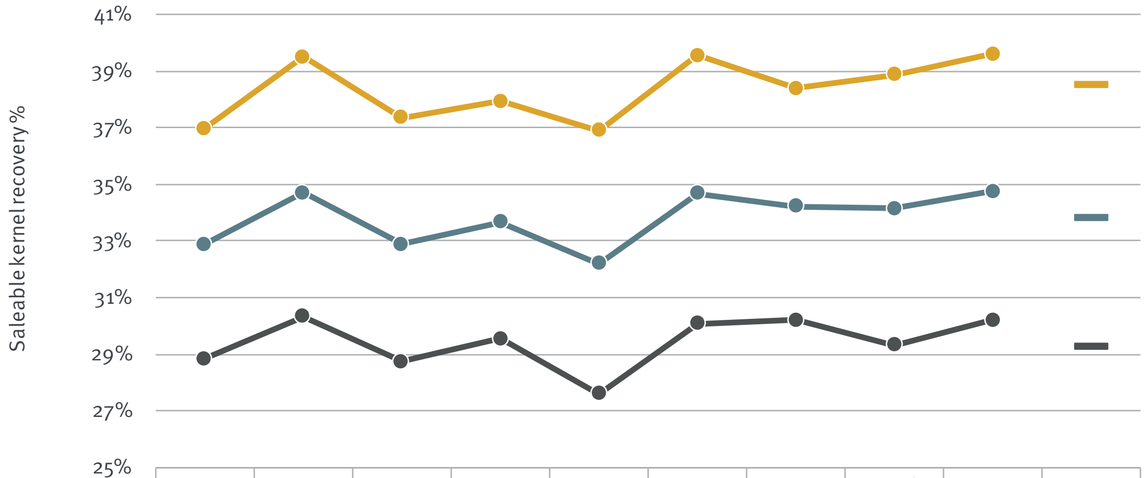
For the nine years from 2009 to 2017 average saleable kernel productivity for the top 25% of the benchmark sample (1.41 t/ha) has been more than four times higher than the bottom 25% of the sample (0.33 t/ha).

Figure 37 compares average saleable kernel recovery (SKR) for the top 25%, bottom 25% and all farms in the benchmark sample for each year from 2009 to 2017. SKR is equivalent to the sum of premium kernel recovery (PKR) and commercial kernel recovery (CKR).

In contrast to the decrease in yield in 2017, average SKR increased across all groups compared to the previous season. Seasonal comparison shows 2017 as recording the highest average SKR for the top 25% (39.60%) and all farms (34.75%). It also achieved higher SKR compared to the long-term averages. However, despite the increase in SKR in 2017, there remains substantial difference between the top and bottom 25% (9.4%).

Saleable kernel recovery trends by percentile 2009—2017

(All farms)

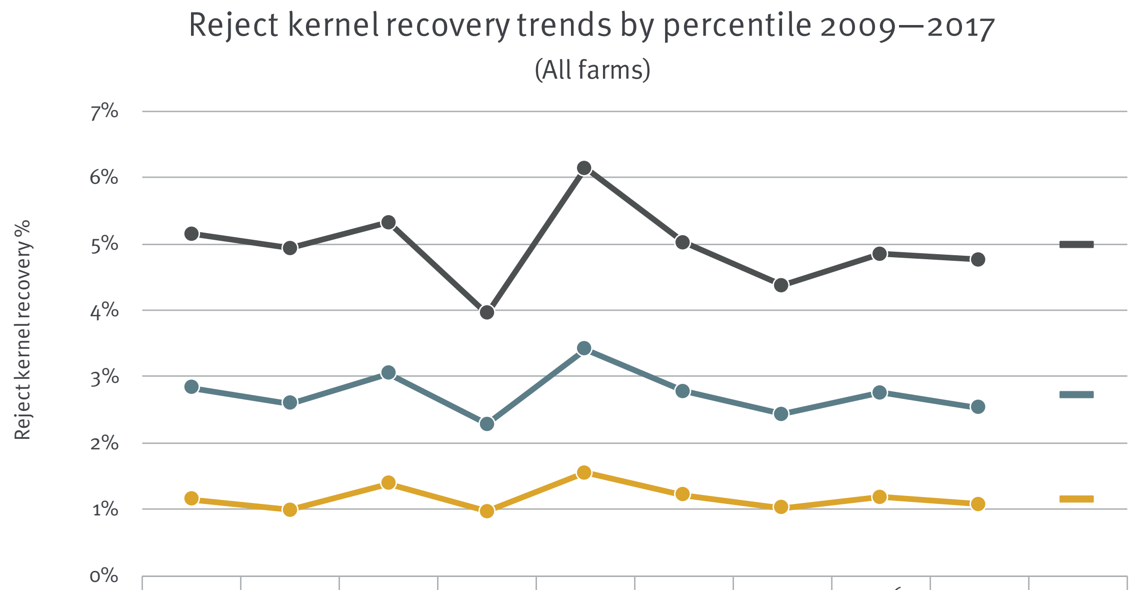


	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
Top 25%	36.98	39.50	37.35	37.93	36.90	39.54	38.40	38.86	39.60	38.52
All farms	32.88	34.71	32.88	33.67	32.20	34.67	34.22	34.15	34.75	33.84
Bottom 25%	28.85	30.32	28.73	29.54	27.60	30.09	30.21	29.32	30.21	29.29

Figure 37: Saleable kernel recovery by percentile (2009 to 2017)

Figure 38 compares average reject kernel recovery (RKR) for the top 25%, bottom 25% and all farms in the benchmark sample for each year from 2009 to 2017. RKR and associated reject category percentiles are inverted, as low RKR and individual reject levels represent better quality.

RKR decreased in 2017 compared to the previous season and recorded lower than the long-term averages (2009–17) across all groups. Over the nine seasons, average RKR levels were lowest in 2012 and peaked in 2013 across all percentile groups.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2009–17
Top 25%	1.15	0.99	1.39	0.97	1.55	1.22	1.02	1.18	1.08	1.16
All farms	2.83	2.60	3.05	2.28	3.41	2.78	2.43	2.76	2.53	2.73
Bottom 25%	5.15	4.93	5.32	3.95	6.14	5.02	4.37	4.85	4.76	4.98

Figure 38: Reject kernel recovery by percentile (2009 to 2017)

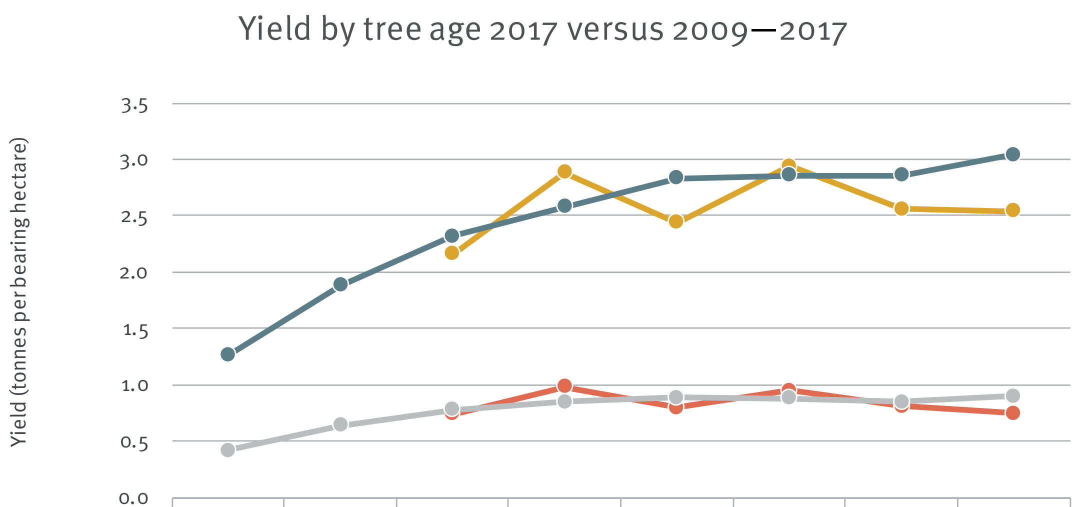
Productivity and quality by tree age

Yield and quality results were analysed according to tree age to identify age-related trends in orchard performance. It is important to note that all age-related analyses are based on weighted average tree age as very few farms record harvest results by individual block or tree age group. Some farms also have plantings of various tree ages and so weighted average tree age is calculated from planting data recorded for each farm. Tree age categories are then used to identify and compare data from farms of similar ages.

Tree ages may vary substantially both within and between production regions. Planting densities also vary between farms in various age categories and this may also impact on yields per hectare, particularly during the early bearing years before trees grow together within rows.

Figure 39 shows average yields of nut-in-shell (NIS) and saleable kernel (SK) per bearing hectare for 2017 and for all years from 2009 to 2017 for farms from various tree age categories. Results are presented only where sufficient data exists to maintain individual farm confidentiality (i.e. more than 10 data points).

In 2017, both NIS and SK yields varied around their long term averages without displaying a clear trend in relation to tree age. The long term average trend of NIS increased with tree age. The long term average trend of saleable kernel yield increased from 5 to 24 years and then levelled out between the trees aged 20 to 24 and the oldest trees.

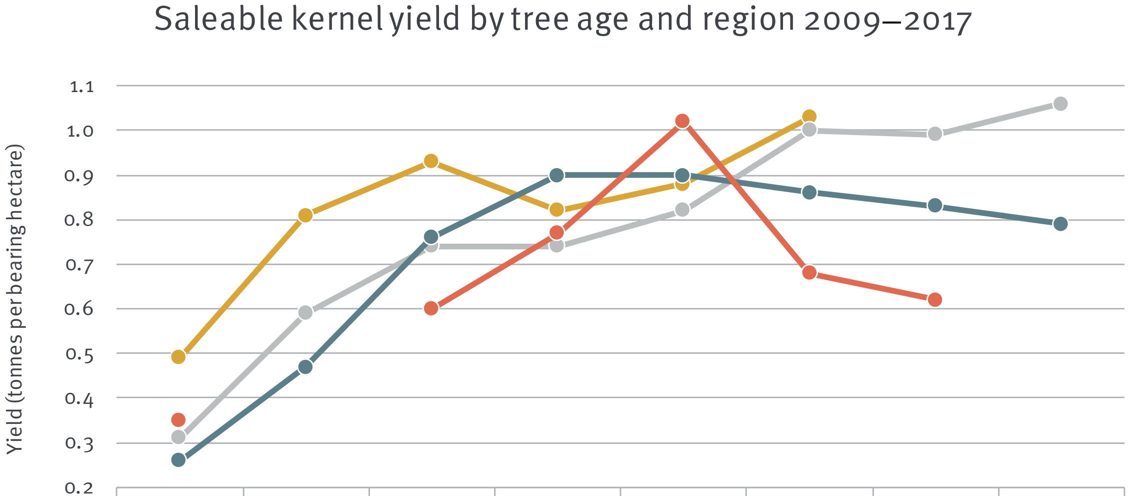


	5 to 7 years	8 to 9 years	10 to 14 years	15 to 19 years	20 to 24 years	25 to 29 years	30 to 34 years	35+ years
NIS yield (2017)			2.16	2.88	2.44	2.94	2.56	2.54
NIS yield (2009-17)	1.26	1.88	2.32	2.58	2.83	2.86	2.86	3.04
SK yield (2017)			0.74	0.98	0.80	0.95	0.81	0.75
SK yield (2009-17)	0.42	0.64	0.78	0.85	0.89	0.88	0.85	0.90

Figure 39: Yield by tree age category (2017 versus 2009 to 2017)

Figure 40 shows the average yield of SK per bearing hectare by tree age category for 2009 to 2017 across the major production regions. As insufficient data was available for individual tree age categories in some regions, it was not possible to plot beyond 25–29 years within the Central Queensland (CQ) region, or to plot 8 to 9 years and over 35 years on the Mid North Coast of NSW (MNNSW).

CQ farms with an average tree age 14 years or younger had a higher average yield of SK per hectare than farms of the same age in the other regions. In SEQ SK yields continue to increase as trees age to 25 years and older. By comparison, in the NSW regions SK yield per hectare peaked at ages 15 to 24 years then declined among older age groups.



	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	0.49	0.81	0.93	0.82	0.88	1.03		
SEQ	0.31	0.59	0.74	0.74	0.82	1.00	0.99	1.06
NRNSW	0.26	0.47	0.76	0.90	0.90	0.86	0.83	0.79
MNNSW	0.35		0.60	0.77	1.02	0.68	0.62	

Figure 40: Saleable kernel yield by tree age category and region (2017 versus 2009 to 2017)

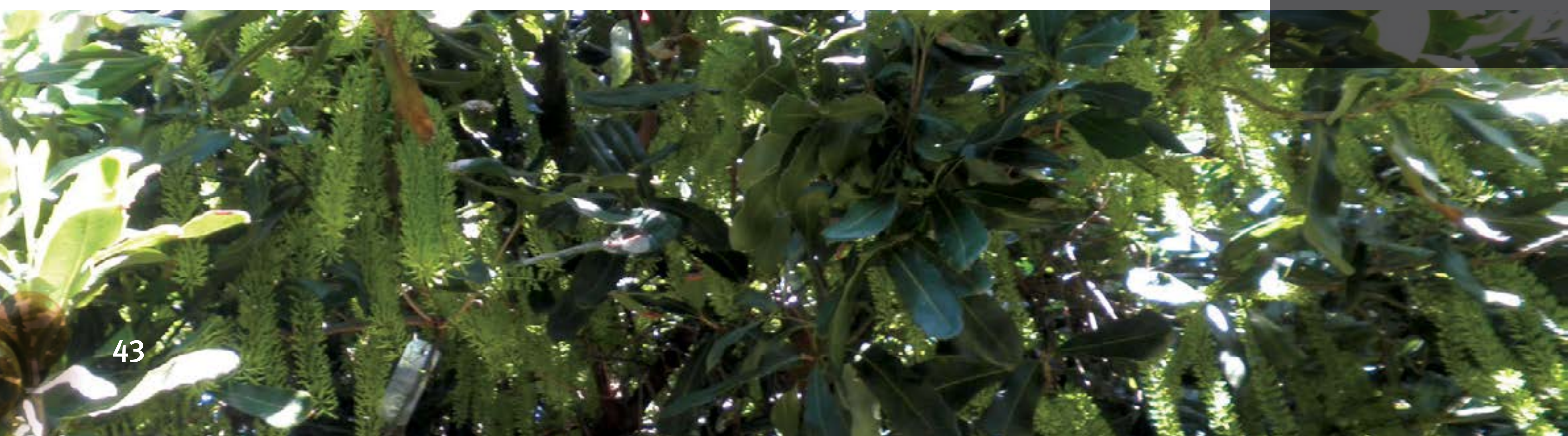
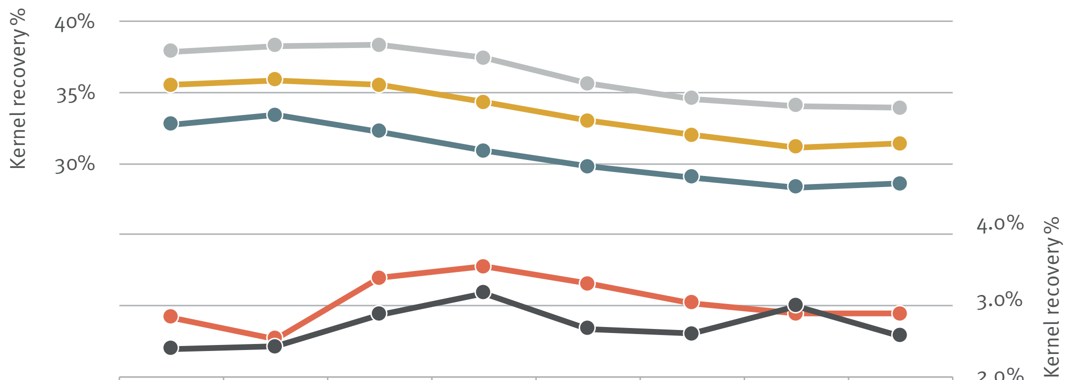


Figure 41 shows the averages from 2009 to 2017 of kernel recoveries by tree age category, including total kernel recovery (TKR), saleable kernel recovery (SKR), premium kernel recovery (PKR), commercial kernel recovery (CKR) and reject kernel recovery (RKR). TKR is the sum of premium, commercial and reject kernel recovery. Saleable kernel recovery is the sum of premium kernel recovery and commercial kernel recovery.

Farms in the younger age categories achieved higher average TKR, SKR and PKR than farms in the older age categories. For farms aged between 14 and 34 years, average TKR, SKR and PKR decreased with increasing tree age. Farms with an average tree age younger than 15 years achieved an average TKR of 38.2%. By comparison, farms older than 15 years achieved an average TKR of 35.6%. Varietal selection is one of the major factors influencing kernel recovery. Many macadamia varieties planted on younger farms have higher potential kernel recoveries than many of the varieties planted on older farms.

Farms with an average tree age between 10 and 24 years had the highest average CKR (3.3%). Farms aged 15–19 had the highest average RKR (3.09%), most of which was due to insect damage. It is important to note that many smaller farms fall within this age category so these reject levels may be related to other factors such as farm size.

Kernel recovery by tree age 2009–2017



	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
Total KR%	37.89	38.28	38.34	37.43	35.64	34.58	34.09	33.94
Saleable KR%	35.53	35.89	35.53	34.34	33.02	32.02	31.17	31.41
Premium KR%	32.76	33.4	32.25	30.91	29.8	29.05	28.34	28.59
Commercial KR%	2.77	2.49	3.28	3.43	3.21	2.96	2.82	2.82
Reject KR%	2.36	2.39	2.81	3.09	2.62	2.56	2.92	2.53

Figure 41: Kernel recovery by tree age category (2009 to 2017)

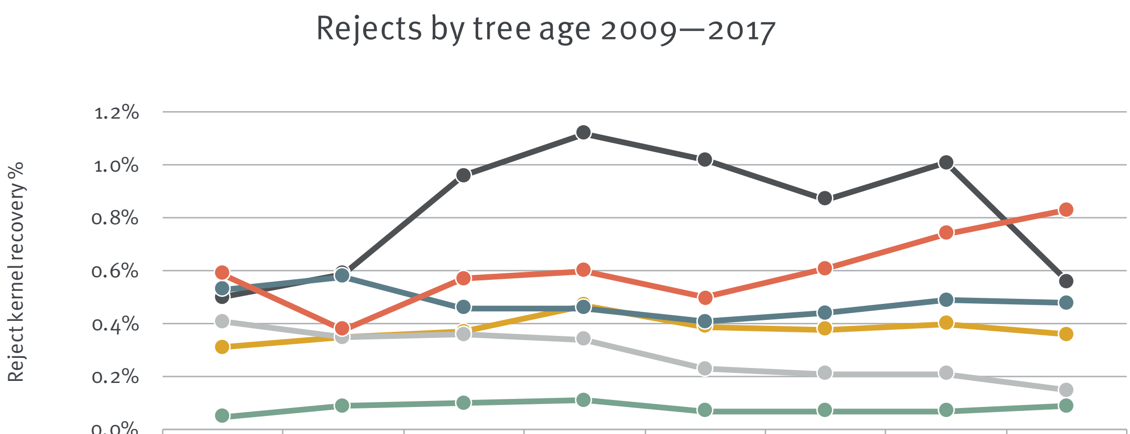
Average nut-in-shell yield generally increases with tree age. Lower average saleable kernel recovery among older farms means that saleable kernel production per hectare is less influenced by tree age.

Figure 42 shows a breakdown of factory rejects by category from 2009 to 2017 for farms of various average tree ages.

Insect damage was the major reject category for farms with an average tree age of 8 or more years. Average insect damage levels were highest among farms aged 15 to 19 years, although analysis of rejects by farm size revealed that most small farms fall within this age group, which may be a contributing factor to these high levels of damage. See the *Productivity and Quality by Farm Size* section within this report for more information.

Average immaturity levels were highest among farms aged over 25 years old. Some of this immaturity may be related to premature nut drop associated with husk spot damage. It is important however to note that in some seasons there have also been significant levels of immaturity in farms in this age group resulting from weather related moisture stress, such as farms in the SEQ region in 2013 and 2014.

Immaturity, brown centres and insect damage were the major reject categories amongst farms with an average tree age less than 8 years. Farms younger than 8 years had the highest average rejects due to discolouration. These differences could also be related to the fact that most farms in the benchmark sample with an average tree age less than 8 years are also larger farms and mostly located in the CQ region.



	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
Insect	0.50%	0.59%	0.96%	1.12%	1.02%	0.87%	1.01%	0.56%
Mould	0.31%	0.35%	0.37%	0.47%	0.39%	0.38%	0.40%	0.36%
Discolouration	0.41%	0.35%	0.36%	0.34%	0.23%	0.21%	0.21%	0.15%
Brown centres	0.53%	0.58%	0.46%	0.46%	0.41%	0.44%	0.49%	0.48%
Immaturity	0.59%	0.38%	0.57%	0.60%	0.50%	0.61%	0.74%	0.83%
Germination	0.05%	0.09%	0.10%	0.11%	0.07%	0.07%	0.07%	0.09%

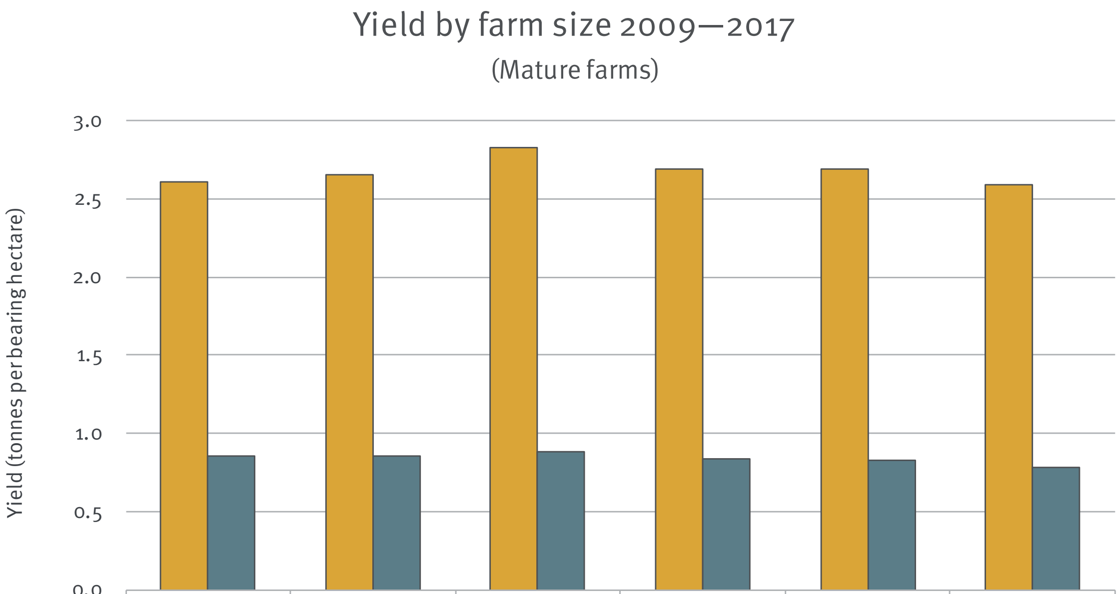
Figure 42: Breakdown of factory rejects by tree age category (2009 to 2017)

Productivity and quality by farm size

Analysis of yield and quality trends reveal some differences in kernel recovery related to farm size. It should be noted that certain farm sizes are more prevalent in particular regions. Larger farms within the benchmark sample also tend to be younger than smaller farms. Care must be taken when interpreting these results as regional or tree age factors may be involved.

Figure 43 shows average yield of nut-in-shell (NIS), saleable kernel (SK) per bearing hectare, for different farm size categories for all years from 2009 to 2017. These averages are based on mature farms in the benchmark sample (i.e. farms with an average tree age of 10 or more years).

Farms between 20 and 30 hectares had the highest NIS yield as well as the highest SK yields per hectare. Farms over 100 hectares had lowest average yields per hectare in terms of both NIS and SK. However these differences in NIS and SK yield for small and large farms were not large.



	‹ 10 ha	10 to 20 ha	20 to 30 ha	30 to 50 ha	50 to 100 ha	› 100 ha
NIS yield	2.61	2.65	2.83	2.69	2.69	2.59
SK yield	0.86	0.86	0.88	0.84	0.83	0.78

Figure 43: Yield per bearing hectare by farm size (2009 to 2017)

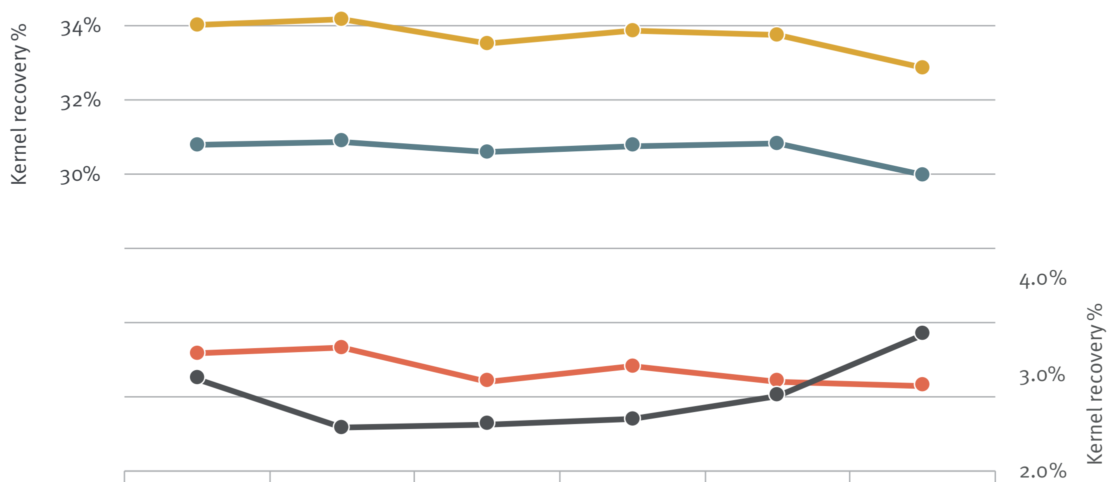
Figure 44 shows average commercial kernel recovery (CKR), saleable kernel recovery (SKR), premium kernel recovery (PKR), and reject kernel recovery (RKR) for all years from 2009 to 2017 for different farm size categories in the benchmark sample. These kernel recovery trends are based on all farms in the benchmark sample.

Farms between 10 and 20 hectares had the highest SKR and PKR. Farms greater than 100 hectares had lower SKR and PKR when compared to farms up to 100 hectares.

Farms between 10 and 20 hectares had the highest average CKR (3.28%) of all the farm size categories. Farms between 10 and 50 hectares had lower RKR than both smaller and larger farms. Farms 100 hectares or larger had the lowest average CKR (2.89%) and highest average RKR (3.42%) of all the farm size categories.

Kernel recovery by farm size 2009—2017

(All farms)



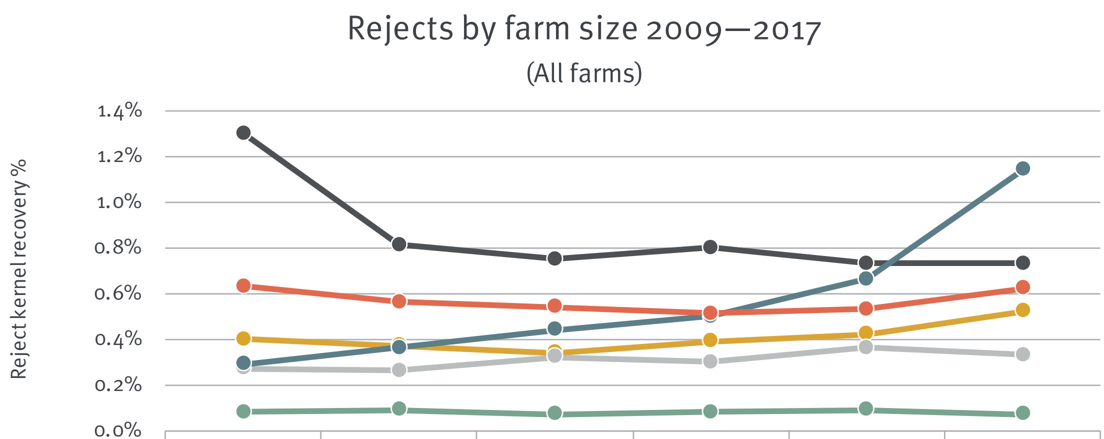
	< 10 ha	10 to 20 ha	20 to 30 ha	30 to 50 ha	50 to 100 ha	> 100 ha
Saleable KR%	34.01	34.17	33.52	33.86	33.74	32.86
Premium KR%	30.79	30.89	30.59	30.77	30.82	29.97
Commercial KR%	3.22	3.28	2.93	3.09	2.93	2.89
Reject KR%	2.96	2.45	2.49	2.54	2.78	3.42

Figure 44: Kernel recovery by farm size (2009 to 2017)

Figure 45 shows the average reject percentage and breakdown for the different farm size categories in the benchmark sample for all years from 2009 to 2017. These averages are again based on all farms in the benchmark sample.

Rejects due to brown centres increased with increasing average farm size. Farms less than 10 hectares had average brown centres rejects of 0.29% compared with 1.14% for farms greater than 100 hectares.

Rejects due to insect damage were again highest among smaller farms. Farms less than 10 hectares had average insect damage rejects of 1.30% compared with other farm size categories that ranged from 0.73% to 0.81%. Immaturity, discolouration and germination rejects did not vary as much with farm size as insect damage and brown centres.



	< 10 ha	10 to 20 ha	20 to 30 ha	30 to 50 ha	50 to 100 ha	> 100 ha
Insect	1.30	0.81	0.75	0.80	0.73	0.73
Mould	0.40	0.37	0.34	0.39	0.42	0.52
Discolouration	0.27	0.26	0.32	0.30	0.36	0.33
Brown centres	0.29	0.36	0.44	0.50	0.66	1.14
Immaturity	0.63	0.56	0.54	0.51	0.53	0.62
Germination	0.08	0.09	0.07	0.08	0.09	0.07

Figure 45: Rejects by farm size (2009 to 2017)

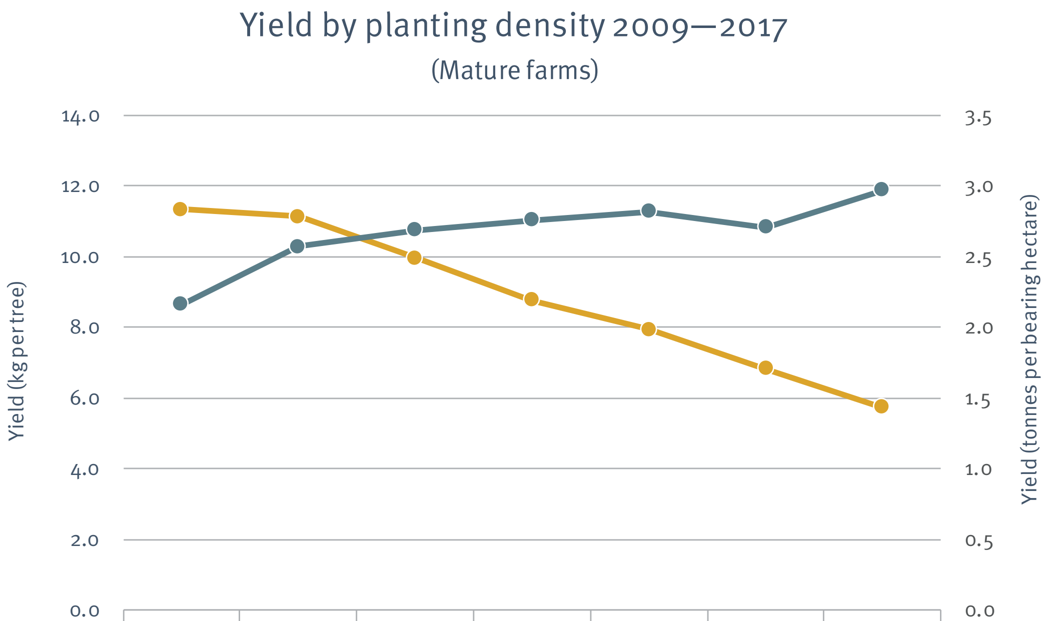
Factory rejects due to brown centres increased with increasing farm size. By comparison, rejects due to insect damage were highest amongst smaller farms, particularly those less than 10 hectares.

Productivity and quality by planting density

Figure 46 shows average nut-in-shell (NIS) productivity in tonnes per hectare and kilograms per tree for mature farms at a range of planting densities. Weighted average planting density is calculated for each farm from tree spacing information provided. NIS rather than saleable kernel (SK) productivity is shown, to exclude the influence of variable kernel recoveries.

This year's updated analysis shows that NIS productivity per tree still declines markedly with increasing planting density, particularly at planting densities above 250 trees per hectare. Average NIS productivity per hectare clearly increases from 100 to 200 trees per hectare, and appears to increase more gradually at higher planting densities. The relationship between planting density and yield per tree appears to be stronger than that between planting density and yield per hectare.

The weighted average planting density for mature farms in the benchmark sample is 327 trees per hectare.



	100-200	201-250	251-300	301-350	351-400	401-450	› 450
NIS yield (Kg/Tree)	11.34	11.13	9.96	8.77	7.95	6.84	5.74
NIS yield (T/Ha)	2.16	2.57	2.69	2.76	2.82	2.71	2.97

Figure 46: Productivity by planting density (2009 to 2017)

Analysis methods

Percentiles

A percentile is a statistical measure indicating the value below which a given percentage of observations in a sample fall. For example, the 25th percentile in a data sample is the value below which 25% of the observations may be found. The 25th percentile is also known as the first quartile. Percentiles have been included in this report to identify differences between the top 25%, average and bottom 25% of farms or farm years.

For ease of understanding and to minimise skewing due to individual farm results, percentile groups used in this report are based on relatively uniform sample sizes. A standard approach was used to identify these groups. The following example shows how this process works on a 100 point data sample:

The sample is ranked according to a dependent variable such as tonnes of saleable kernel per bearing hectare. A marker is placed on the 25th data point and its value is identified. Adjoining points in both directions within the sample are iteratively compared with the current marker point to determine the nearest data point whose value is different to the current marker. If required, the marker is moved to reflect the closest unique data value (i.e. its value is different to at least one adjoining point). This becomes the cut point for the 75th percentile.

The above process is repeated on the 75th data point to determine a similar unique cut point for the 25th percentile. Values that fall above the cut point for the 75th percentile are grouped to form the top 25% and those that fall below the 25th percentile form the bottom 25%. As a result, the number of data points in each quartile is not always the same.

Weighted and unweighted averages

Weighted averages are calculated by dividing the total amount by the bearing hectares in each sample (e.g. the total weight of saleable kernel divided by the total bearing hectares for a region for a particular year).

This means that larger farms will have more influence on a weighted average than smaller farms. This is important for comparing results and trends on a whole industry or a whole region basis.

This analysis provides a different perspective to the unweighted averages (i.e. arithmetic means) which are used in most of the descriptive and statistical analyses throughout this report. Unweighted averages result in each farm in the data sample exerting equal influence on the average. In other words, the data for a 10 hectare farm will have just as much effect on the average as that of a 200 hectare farm.

Standard deviation

Standard deviation provides a measure of the amount of variation around the average or mean for a set of data. A low standard deviation means that most of the numbers in that set are very close to the average. A high standard deviation means that the numbers are spread out. Standard deviation provides an important measure of the amount of variability within the benchmark sample. For example, it is useful to know the average productivity for all farms in a given region or season, but the standard deviation of that average provides additional insight into how uniform productivity is among those farms.

Median

The median value of a data set represents the middle (or 50%) point in the data. In comparison the average, or mean is the sum of all values divided by the total number of data points. The average is very useful for understanding a given set of data when that data is normally distributed, however if data is skewed by extreme or outlying values these can influence the mean. For example, one very large farm in a region of otherwise small farms could raise the sample average above what is characteristic of most farms in that region. As the median comes from the middle point in a data set it is not influenced by such outlying or extreme data.

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Macadamia industry benchmark report

2009 to 2017 seasons

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