The Australian Wine Research Institute

AWRI Vineyard & Winery Practices Survey

May 2019

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AWRI Vineyard and Winery Practices Survey, May 2019
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Cover photo: Courtesy of Eric Wilkes.

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Preface

This report presents the results from the AWRI Vineyard and Winery Practices Survey conducted in 2016. The purpose of the survey was to provide an independent aggregate source of information on grape and wine production practices for producers and researchers to use.

The AWRI is indebted to the many grapegrowers and winemakers who took the time to fill out the web-based survey and to those that allowed the author to visit during 2017 and 2018 to follow up and put context around the statistics. The AWRI also thanks the many wine industry suppliers that provided information and the regional and national industry organisations that helped with survey distribution. The author thanks AWRI colleagues that helped with advice on various topics.

Preparation of the final report was supported by Australia's grapegrowers and winemakers through their investment body Wine Australia, with matching funds from the Australian Government. The AWRI is a member of the Wine Innovation Cluster in Adelaide, South Australia.

It is intended that this survey will be repeated every five or six years to track the adoption of new techniques. The next edition will likely be performed in 2022. Some adjustments will be made based on what worked well and what didn't in this first edition. Please contact the author if there are any topics that you believe should be included in the next iteration of the survey.

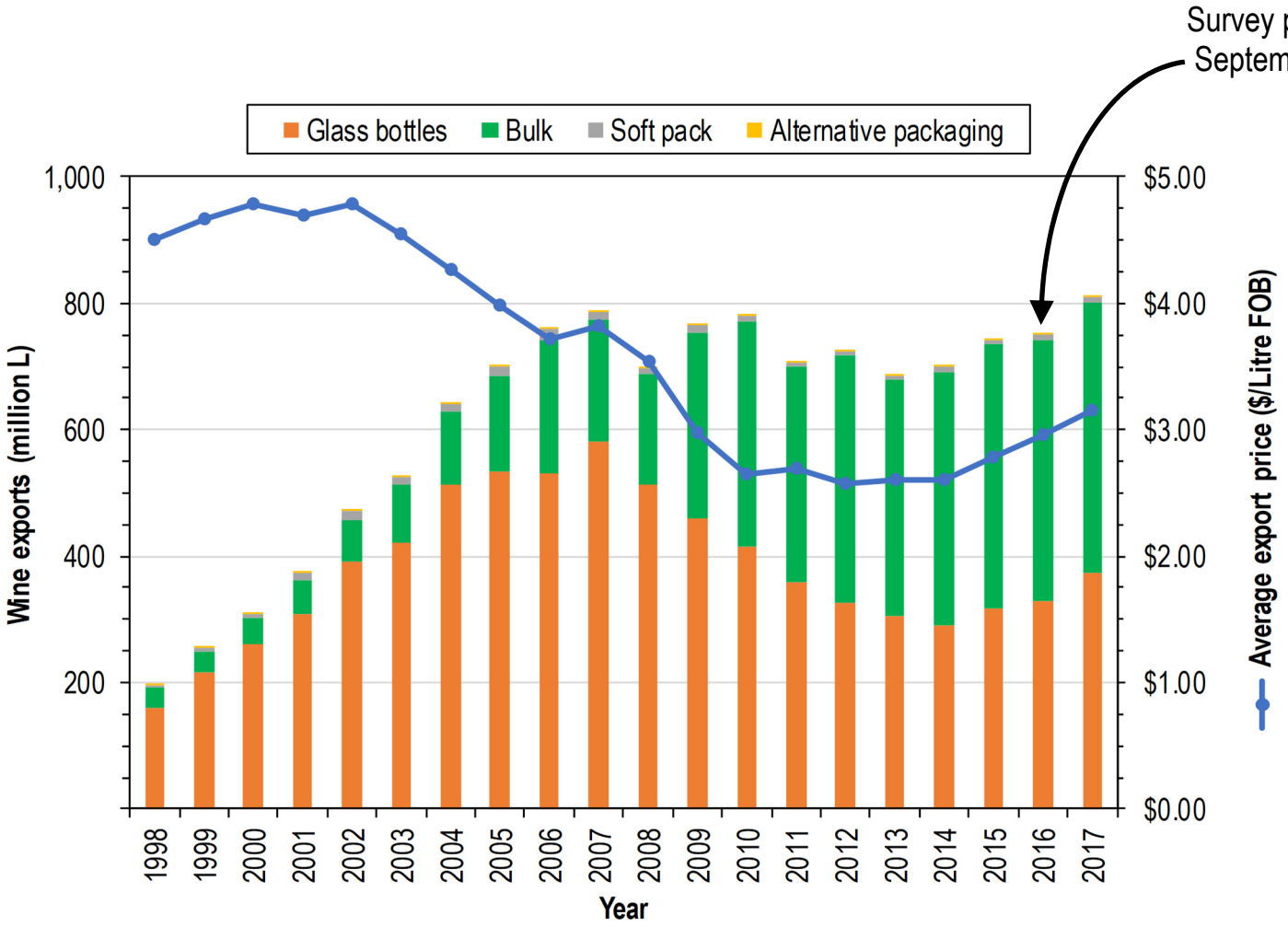
Preliminary results were reported at the ASVO Viticulture seminar in 2017, Crush Symposium in 2017, Winery Engineering Association Conference in 2018, and as part of AWRI extension events and newsletters. Some feedback from these events has also been used for comments in this report.

Dr Simon Nordestgaard
Senior Engineer
The Australian Wine Research Institute

The AWRI thanks Vinitech-Sifel for sponsoring a prize for one survey respondent to attend the 2016 edition of their exhibition in Bordeaux.

Vinitech-Sifel is a major biennial exhibition in Bordeaux featuring the latest vineyard and winery equipment.

Practices Survey timing in relation to Australian wine exports

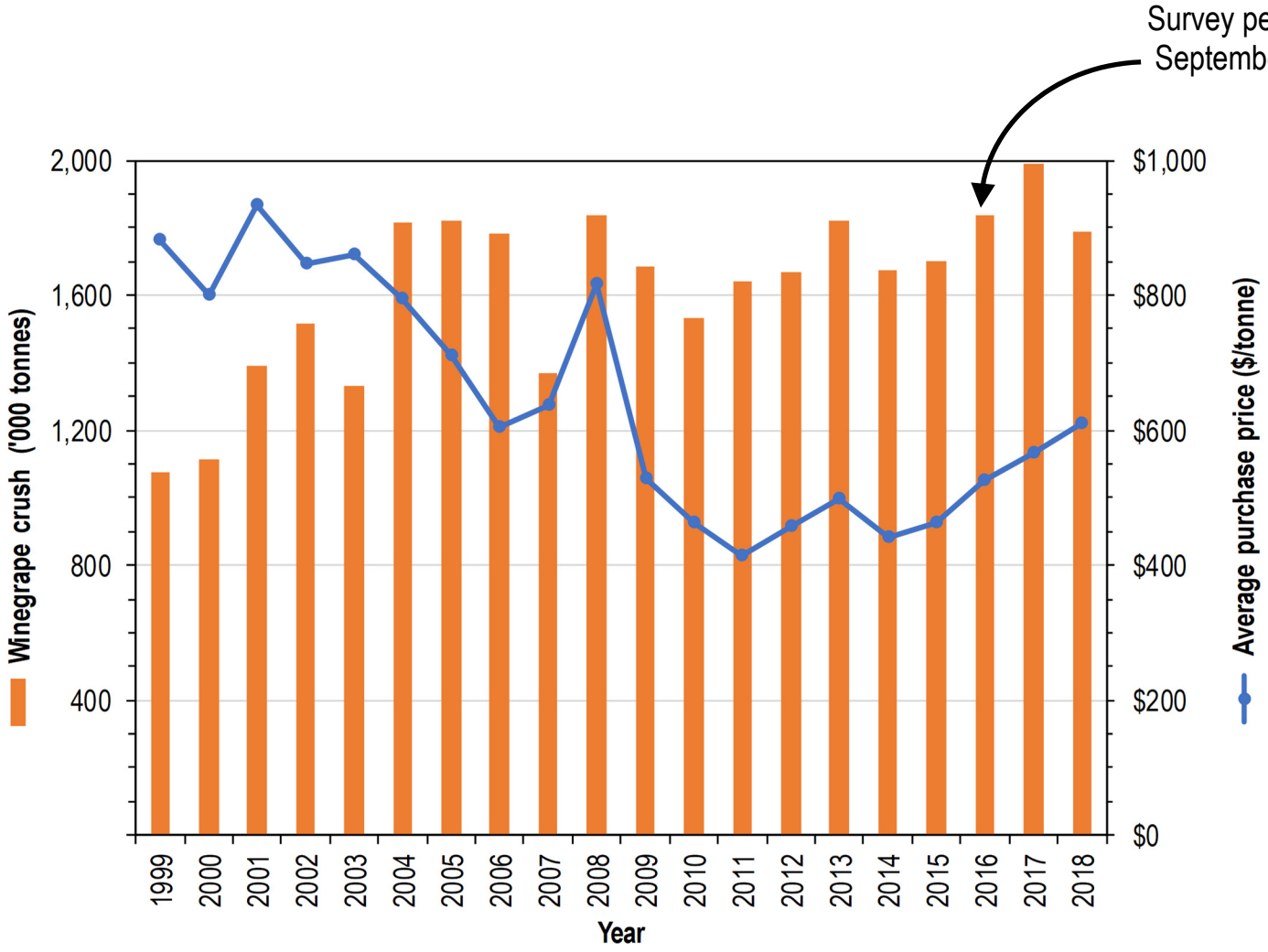


- Many advances in practices involve the purchase of equipment and opportunities to do this are more likely during times of profitability and expansion.
- It is therefore important to consider the timing of this survey in relation to industry cycles.
- The Australian wine industry saw a massive expansion in the 1990s and 2000s.
- Australian exports peaked in 2007 before declining, with considerable volume then shifting to bulk exports for in-market packaging.
- However, export volumes and value both began to increase noticeably again from 2015.

(continued next page…)

*Data from Wine Australia Export database. Valuations are free on board (FOB), so the value added from bottling is included for bottled exports but excluded for bulk exports.

Practices Survey timing in relation to grape crush size and price



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- Average grape prices also rose each year from 2015.
- Many of the questions in the survey relate to the 2016 vintage.
- Therefore, the survey was performed during the early stages of a positive upwards trend in industry profitability that has continued to the time of publication of this report, but this followed a long challenging period for the sector.
- Since the survey was conducted there are likely to have been further investments made at some sites.
- For detailed current production statistics please refer to wineaustralia.com and for detailed historical statistics please refer to Anderson. K. 2015. *Growth and Cycles in Australia's Wine Industry*. Available from: doi.org/10.20851/austwine.

*Data from WFA/Wine Australia Vintage reports and Wine Australia historical wine sector statistics.

Practices Survey structure

Vineyard Practices Survey

One response per business per GI region

Winery Practices Survey

One response per winery site

- The survey included separate vineyard and winery components.
- The vineyard survey requested one response to cover all wine-grape blocks owned by a business in a GI region.
- The winery survey requested one response per winery site, with a winery site being defined as any site that processes grapes, ferments grape juice or bottles wine.
- The survey was web-based and designed to take less than an hour to complete, with most questions not needing reference to detailed records.
- Follow-up visits were performed to some vineyards, wineries and industry suppliers to complement and validate data.
- The survey was not compulsory.
- Detailed methodologies and notes on data interpretation are provided in the Appendix.

Vineyard Practices Survey response rate

GI Region	Responses (n)	ABS (n)	% Growers	Responses (ha)	ABS (ha)	% Area
Adelaide Hills	21	192	11%	468	2,967	16%
Barossa Valley	41	369	11%	2,172	8,899	24%
Beechworth	9	17	53%	73	107	68%
Clare Valley	16	159	10%	2,013	4,200	48%
Coonawarra	16	90	18%	2,478	4,726	52%
Eden Valley	12	95	13%	558	1,799	31%
Geelong	10	33	31%	76	284	27%
Granite Belt	7	37	19%	194	237	82%
Great Southern	11	61	19%	697	1,886	37%
Heathcote	7	50	14%	138	1,159	12%
Hilltops	6	23	26%	300	566	53%
Hunter	17	145	12%	544	2,309	24%
Langhorne Creek	7	71	10%	1,535	5,282	29%
Macedon Ranges	8	37	22%	27	140	20%
Margaret River	16	209	8%	800	4,816	17%
McLaren Vale	42	357	12%	1,505	5,995	25%
Mornington Peninsula	8	94	9%	70	775	9%
Mudgee	7	57	12%	194	1,070	18%
Murray Darling	15	427	4%	1,510	15,511	10%
Orange	11	44	25%	906	1,098	82%
Riverina	12	341	3%	1,554	18,610	8%
Riverland	28	711	4%	1,948	18,774	10%
Rutherglen	6	19	32%	159	398	40%
Tasmania	27	117	23%	641	1,442	44%
Wrattonbully	7	50	14%	982	2,478	40%
Yarra Valley	13	126	11%	358	2,116	17%
Cool/temperate	*408*	*3662*	*11%*	*20277*	*79540*	*25%*
Warm inland	*55*	*1479*	*4%*	*5013*	*52895*	*9%*
Australia	**463**	**5,141**	**9%**	**25,289**	**132,436**	**19%**

463 responses (9% of Australia's growers)

25,289 ha (19% of Australia's vineyard area)

- Response rate was higher from larger growers and from cool/temperate regions.
- Largest respondent in each region typically accounted for around 40% of the total response area in the region.
- Data for individual regions has only been reported when there were ≥ 5 respondents.
- **Data quality should be considered in the context of response rates and data is not necessarily representative of the region.**
- Two aggregated regional production type categories were also included:
  - **Warm inland**: Riverland, Murray Darling, Swan Hill and Riverina.
  - **Cool/temperate**: All other regions

*ABS data from 1329.0.55.002, 2014-2015. Harvested areas are used in survey, while ABS data is bearing areas. Most but not all respondents completed all of the survey. Partially complete responses were counted relative to the fraction of the survey completed.

Winery Practices Survey response rate

Relative to 2011 ABS data from 1329.0, 2010-2011

Winery size (t)	Responses (n)	ABS (n)	% Wineries	Responses (t)	ABS-WA (t)	% Grapes
< 50	54	ABS only collected data for > 50 t		886		
50-1,000	99	239	41%	28,923	81,000	36%
1,000-10,000	50	97	52%	137,558	274,000	50%
≥10,000	24	30	80%	1,172,475	1,486,000	79%
Australia	**227 (173 > 50 t)**	**366 (> 50 t)**	**47% (> 50 t)**	**1,338,956 (> 50 t)**	**1,840,000**	**73%**

Relative to 2016 Wine Industry Directory data

Winery size (t)	Responses (n)	WID (n)	% Wineries
< 50	54	1,427	4%
50-1,000	99	807	12%
1,000-10,000	50	110	45%
≥10,000	24	28	86%
Australia	**173 (> 50 t)**	**945 (> 50 t)**	**18% (> 50 t)**

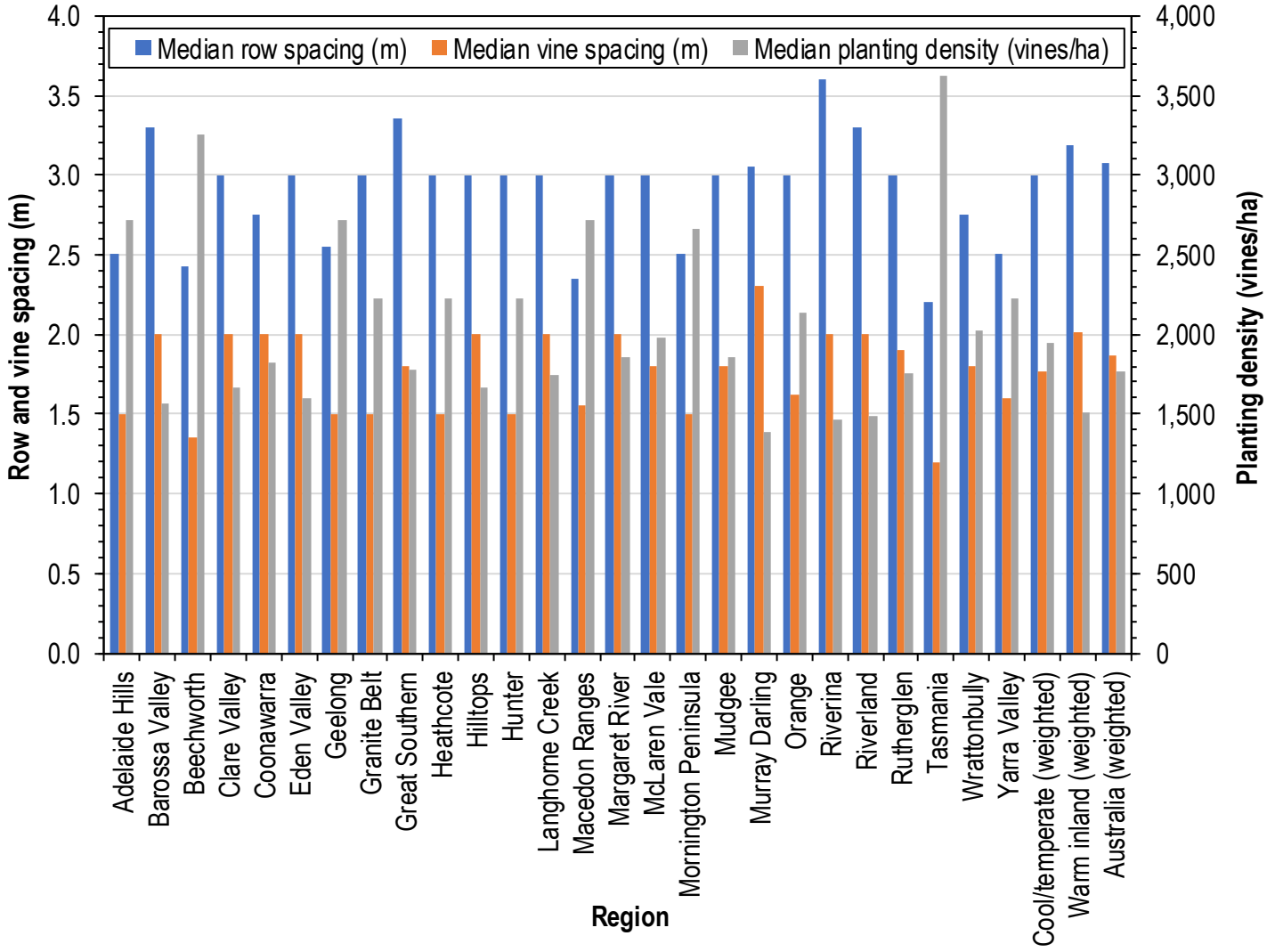
227 responses

1.34 million tonnes (73% of grapes crushed in Australia)

- Response rate was higher from larger wineries.
- The Wine Industry Directory (WID) suggests that there are ~3 times as many wineries as the Australian Bureau of Statistics (ABS).
- The WID-ABS data discrepancy is not critical for the current study but could be an issue for other industry analyses needing data on numbers of wineries.

*Most but not all respondents completed all sections of the survey. Partially complete responses were counted relative to the fraction of the survey completed. Detailed ABS size distribution data was only available at a business (n=325) not winery level (n=366). Seven additional known ≥ 10,000 t winery sites were added and the remaining 34 additional winery sites were assumed to be evenly split between the 50-1,000 t and 1,000-10,000 t categories. 2011 ABS tonnage data has been extrapolated to expected 2016 vintage values using total crush data from the 2011 and 2016 Wine Australia Vintage Reports. Detailed Wine Industry Directory (Winetitles) data was only available at a business not winery level. Forty-one additional winery sites were added in the same manner as for the ABS data. The reason for the large discrepancy between ABS and Wine Industry Directory data may relate to inclusion of some virtual wineries in the Wine Industry Directory data or other factors. It is not a consequence of year (The Wine Industry Directory reports 994 wine business crushing > 50 t in 2011 and 904 in 2016). The ABS data does seem slightly low despite the rigorous independent processes in place and compulsory nature of its data collection. 2011 was the last ABS data collection of this type. The ABS data has been assumed to be more reliable, but the discrepancy between these two data sources is very noticeable.

Planting density



Median values for Australia

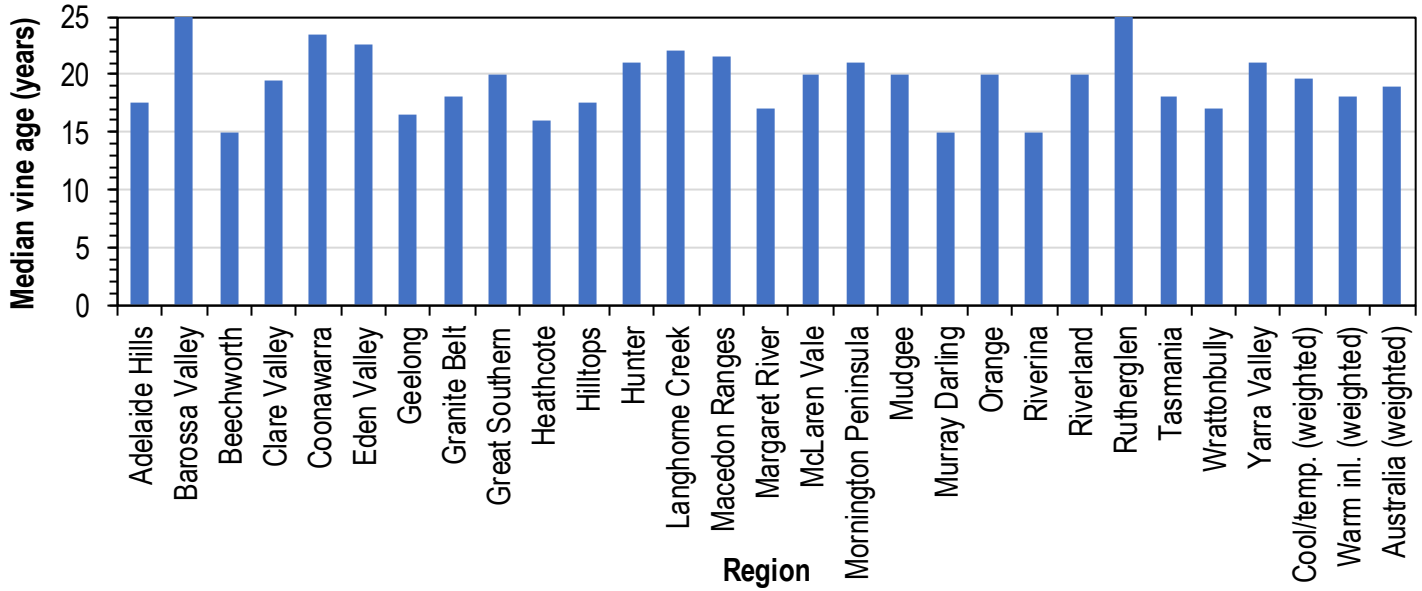
3.1 m row spacing
1.9 m vine spacing
1,760 vines/ha

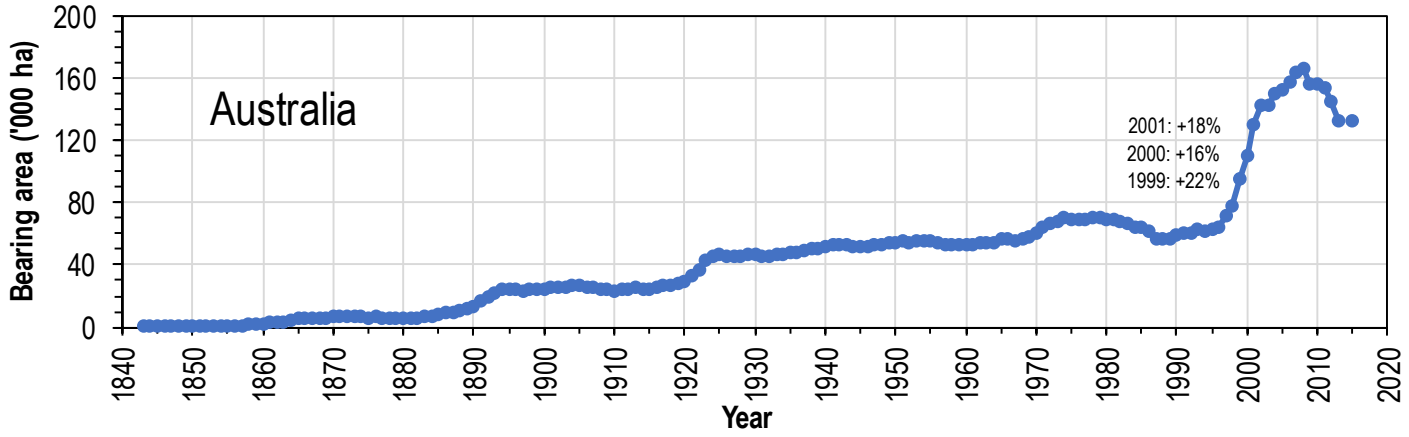
Factors mentioned:

- Grape and land prices
- Accommodating machinery from time of vineyard establishment and/or that is shared with other crops
- Wide rows to accommodate sprawling canopies in warm regions.

*The survey question asked for the most common row and vine spacings to the nearest 0.1 m. Planting density was calculated for each respondent based on their yield and most common row and vine spacing.

Vine age





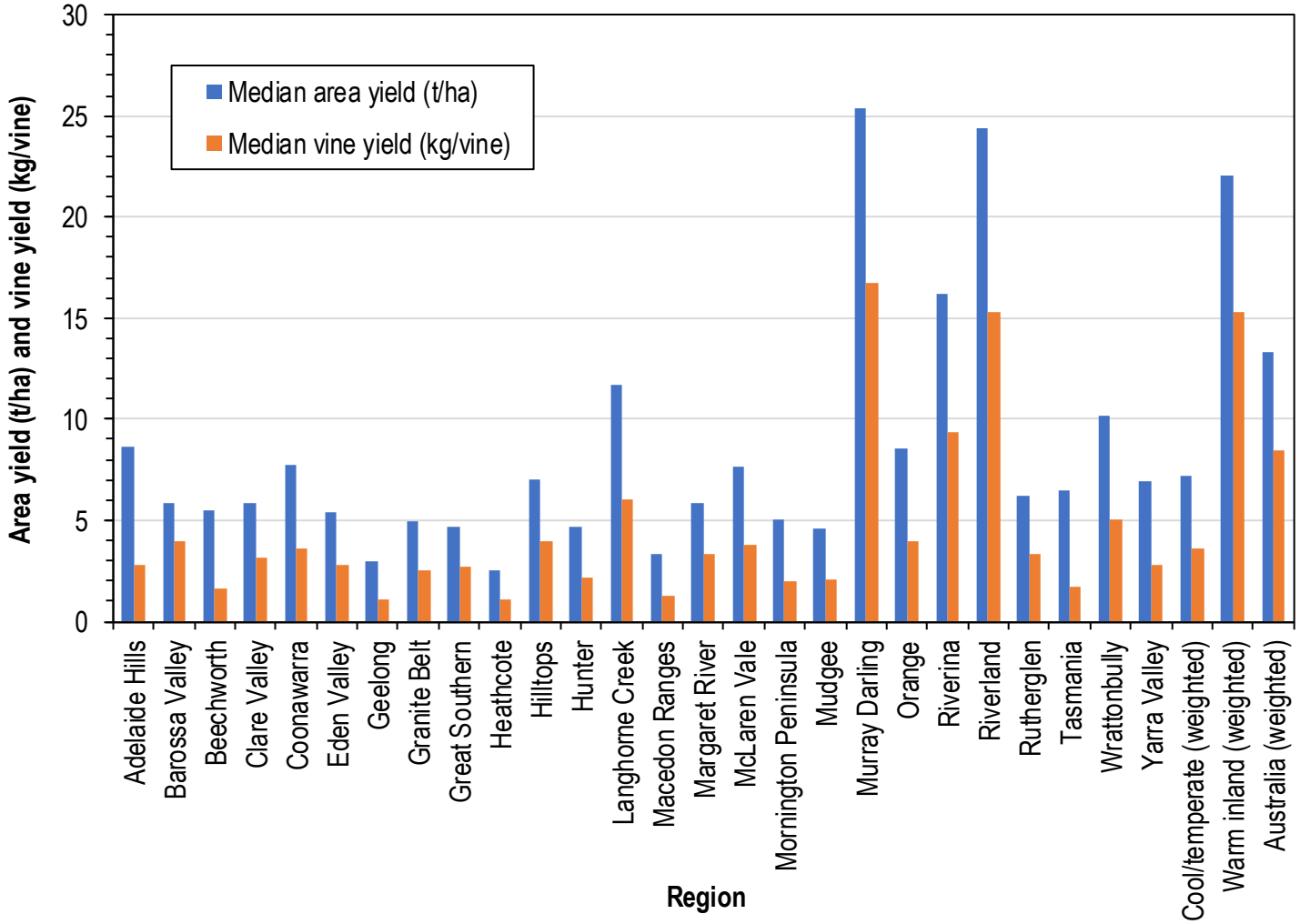
Median vine age for Australia

19 years old
(i.e. planted 1997)

- Regional medians varied from 15 to 25 years.
- The median vine age is consistent with the peak of the bearing area expansion in 1999 during the industry boom.
- One respondent noted that vineyard replenishment may be a big topic for the Australian wine industry in the near future.

*Question asked for the most common age of vines harvested in the 2016 vintage. Plot represents the median of responses in each region. Bearing area data principally from Anderson, K. (2015) *Growth and cycles in the Australian wine industry*.

Yield per hectare and per vine



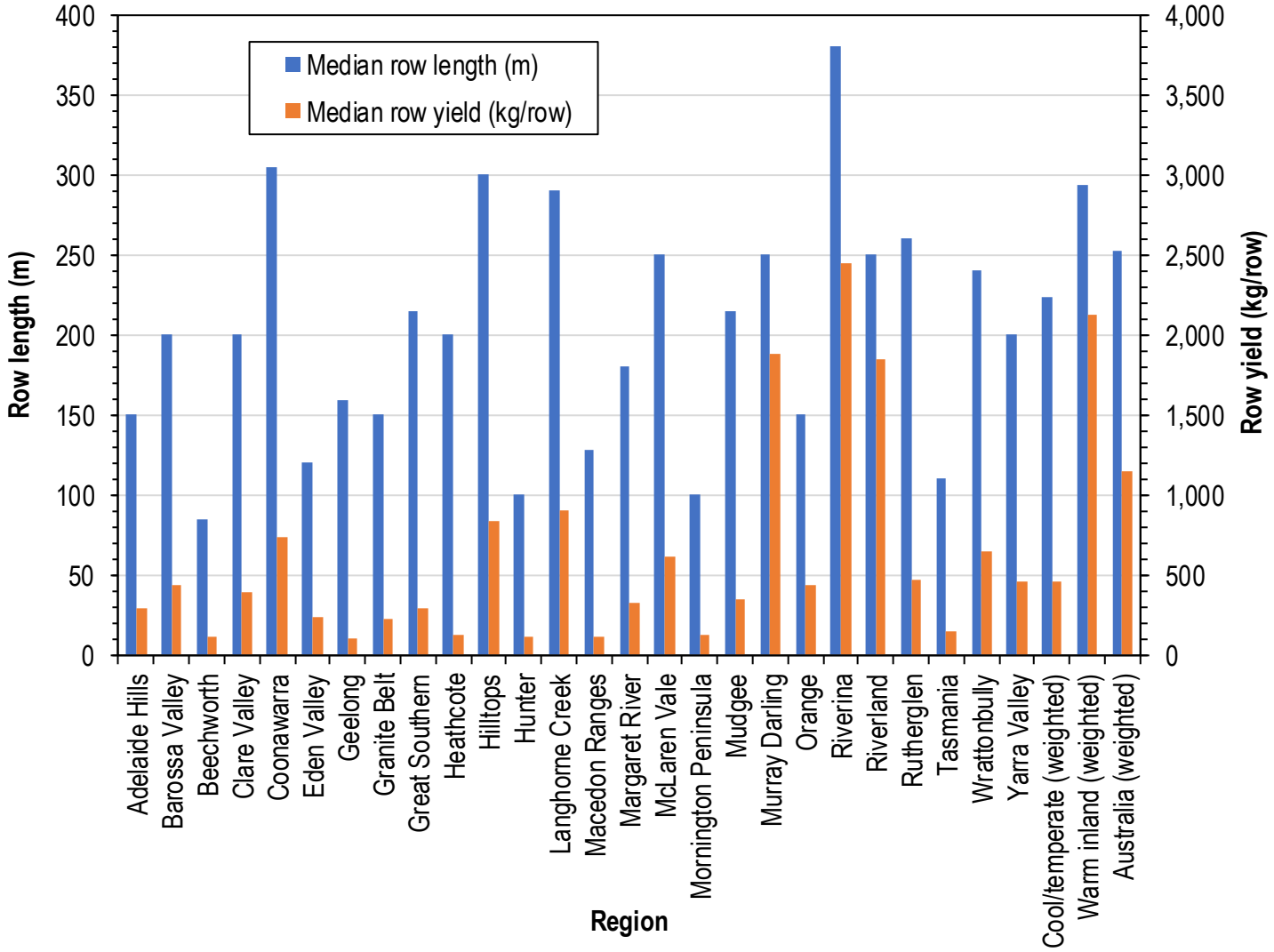
Median yield for Australia

13.3 t/ha
8.4 kg/vine

- Calculation of median planting density in each region allowed the t/ha yield to be converted to a kg/vine yield.

*Vine yields were calculated by dividing the area yield by the planting density for each respondent and the median was then calculated.

Row length and yield



Median row length and yield for Australia

253 m row
1,150 kg/row

Factors mentioned:

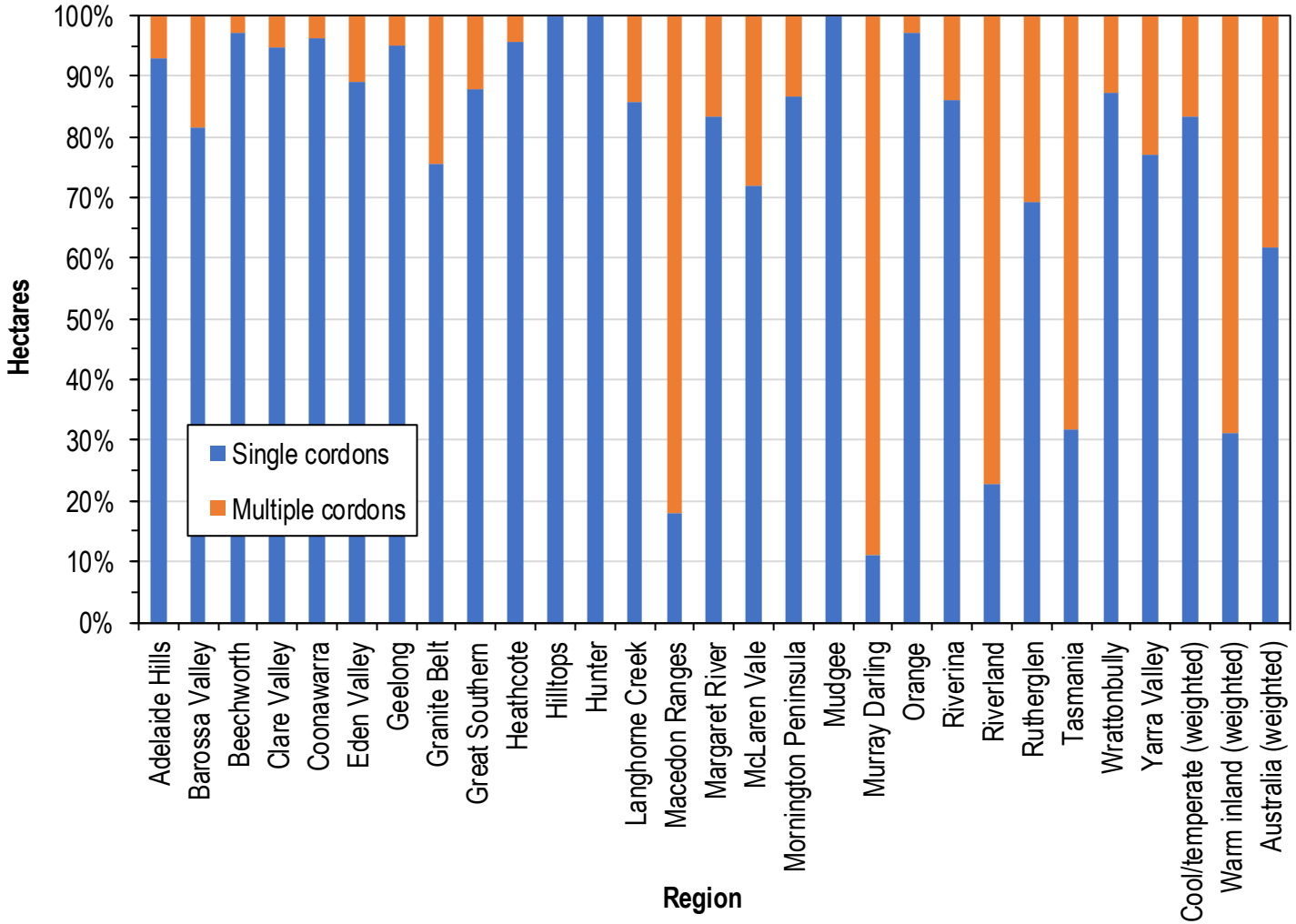
- Soil type and land flatness – expect longer rows in large flat areas with consistent soil
- Long rows more efficient
- Block shape and land value.

- Row length and yield are based on the median of a single estimate from each producer – row lengths can be highly variable (e.g. one producer had blocks with 3,000 kg/row, while the regional average was <1,000 kg/row).

- Row yield is important for machine harvesting with on-harvester bins (see page 68).

*The question asked for the most common row length. Row yield for each respondent was calculated based on the yield, row spacing and row length. The median values were then calculated for each region.

Single or multiple cordons



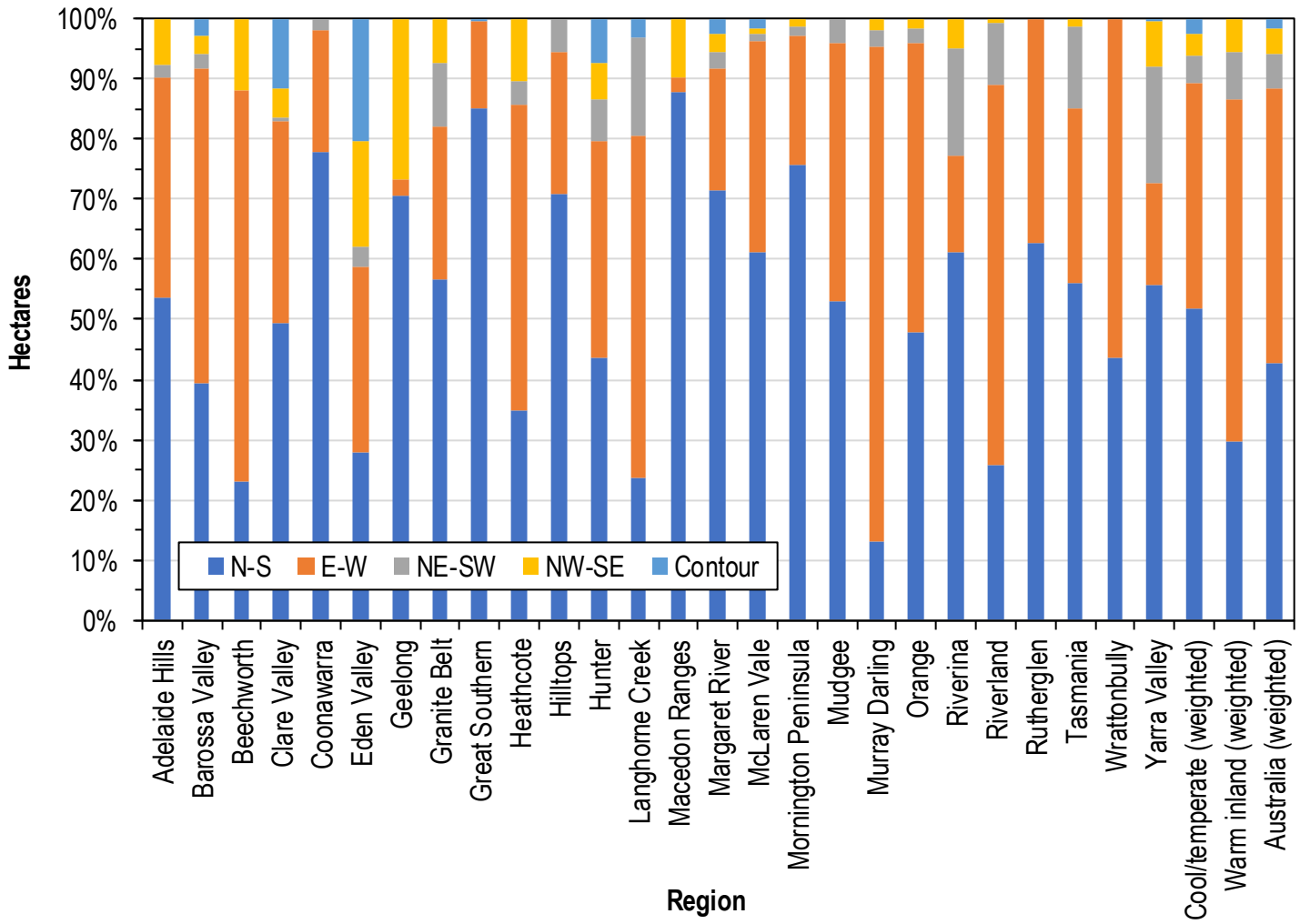
Cordons in Australia

62% single
38% multiple

- Greater use of single cordons in Riverina than in Riverland and Murray-Darling.
- Some respondents noted that single cordons are easier to prune with high-speed saws and limited hand clean-up, and that bigger canopies in multiple-cordon vineyards need more fungicide.
- Single-cordon vineyards are cheaper to establish as they require shorter posts, less wire and less vine training.

*The question asked if single (one permanent or two annually replaced cordons) or multiple cordons (two or more permanent cordons or three or more annually replaced canes) are used. If respondents selected both single and multiple, they were asked to enter the area of each.

Row direction



Vineyard row direction in Australia

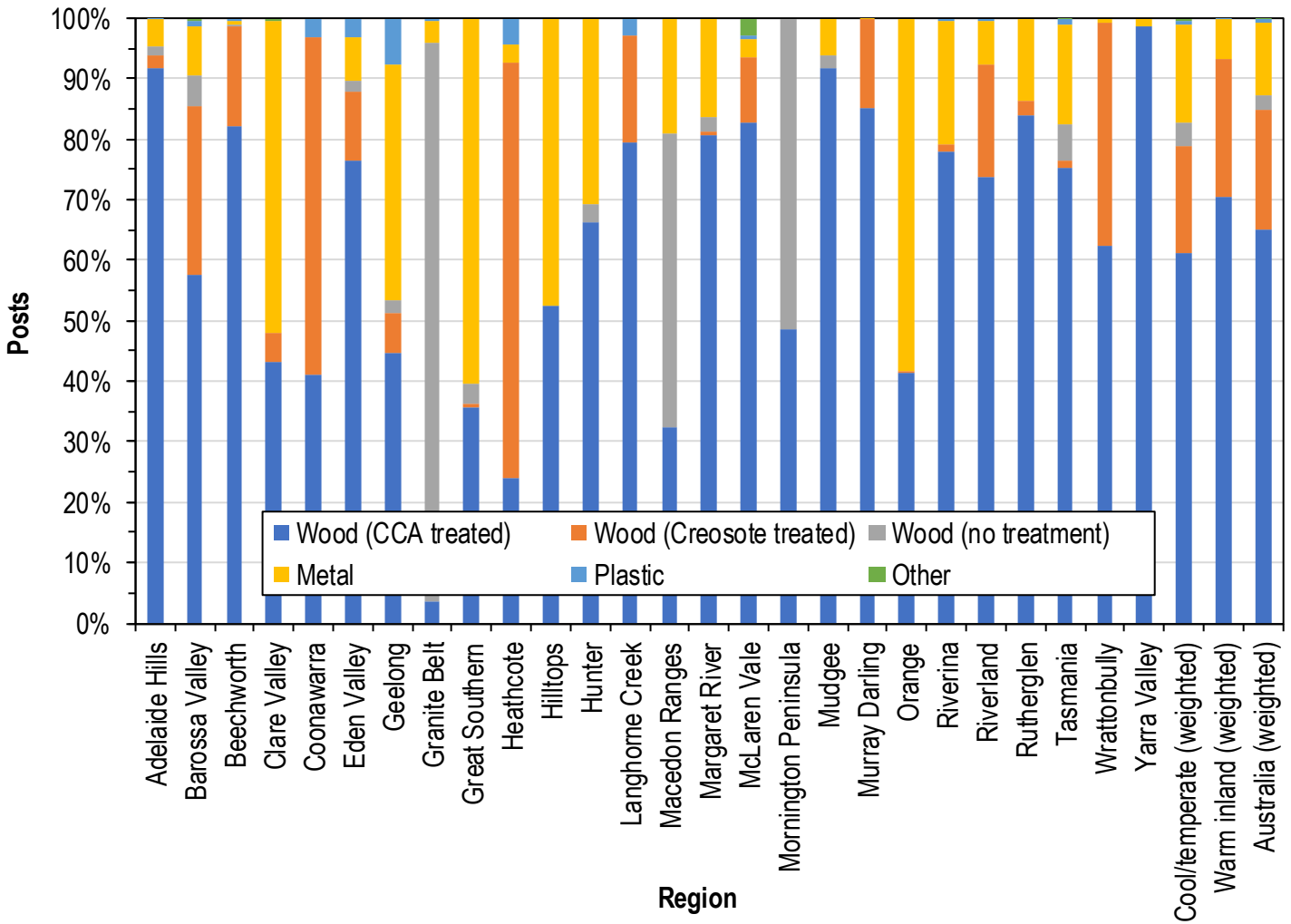
43% north-south
46% east-west

Factors mentioned:

- East-west to avoid hot afternoon sun
- Avoiding wind blowing over large sprawling canopies
- Compatibility with existing infrastructure (e.g. irrigation)
- Maximising row length for efficiency
- Historical reasons, such as north-south as in European vineyards, or properties/roads have always been arranged in that direction in the region.

*Respondents were first asked if all rows run in the same direction. If they answered yes, they were prompted to select one of the choices: N-S, E-W, NE-SW, NW-SE. If they answered no they were prompted to enter the specific areas of N-S, E-W, NE-SW, NW-SE or contour.

Vineyard post materials (excluding end assemblies and post extensions)



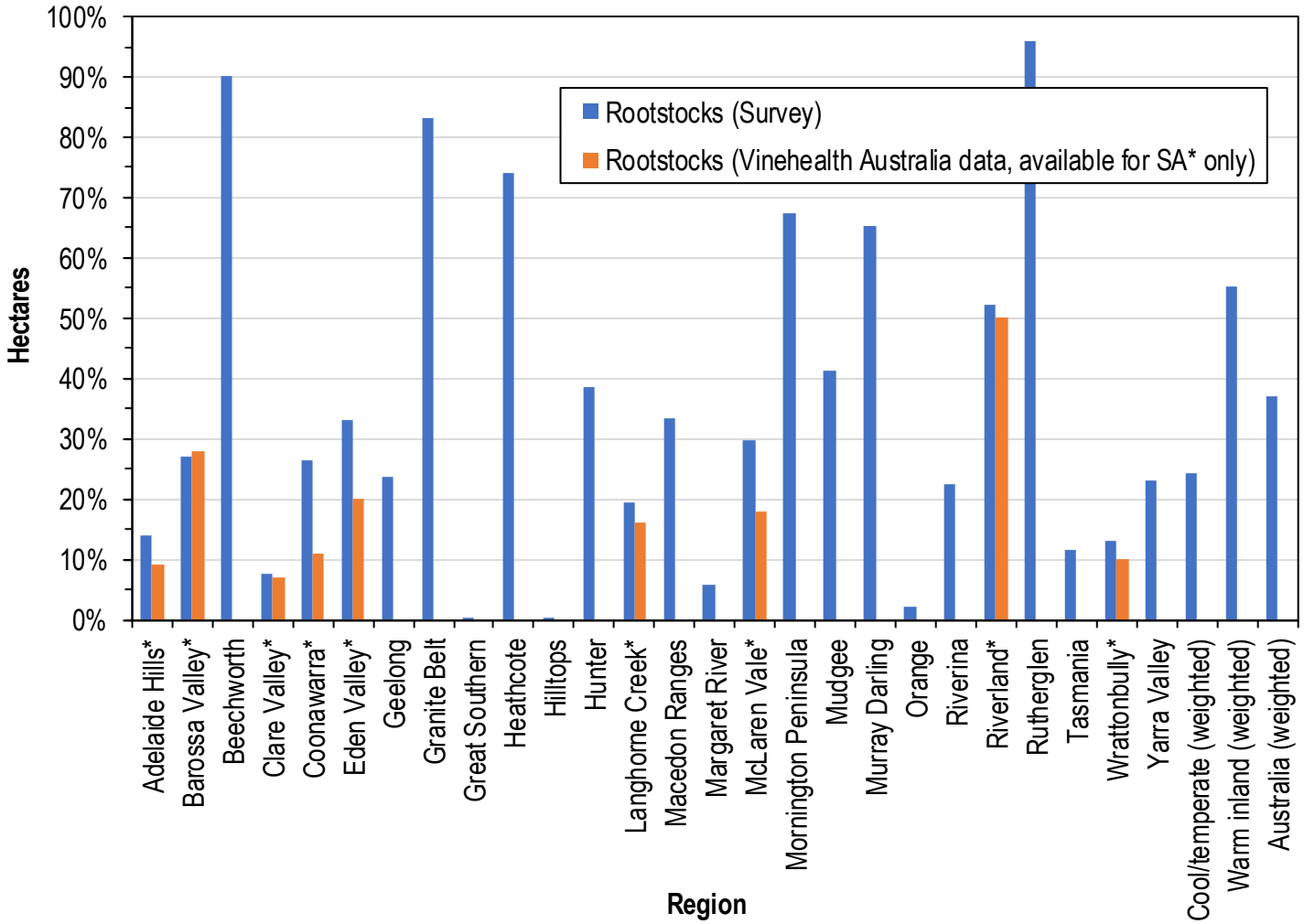
Vineyard posts in Australia

65% CCA-treated
20% creosote-treated
12% metal

- There are well-known disposal issues with copper chrome arsenate (CCA)-treated posts.
- Some respondents indicated that they were gradually changing to steel.
- Others noted that have tried many steel posts over the years but end up with them rusting and breaking.
- Others were positive on new steel post designs or using combinations of wood and steel in rows.
- Some stated that wooden posts are still very cost-effective and adaptable – “can’t put a nail in galvanised steel".
- Another respondent pondered whether increased mechanised cane pruning may increase uptake of steel.
- Metal may include use of intermediate star-droppers for some respondents.
- Median post-removal rate due to harvester damage was ~1%.

*Respondents were first asked the material of their vineyard posts, with the opportunity to select one of the materials listed, or to choose ‘more than one of the above/other material’. If they selected the latter they were able to enter the percentage of each type. Respondents were also asked what percentage of vineyard posts were removed in an average year in machine-harvested blocks because of breakages during harvesting and could select from different % options.

Rootstocks (includes comparison with definitive Vinehealth Australia data for SA regions)



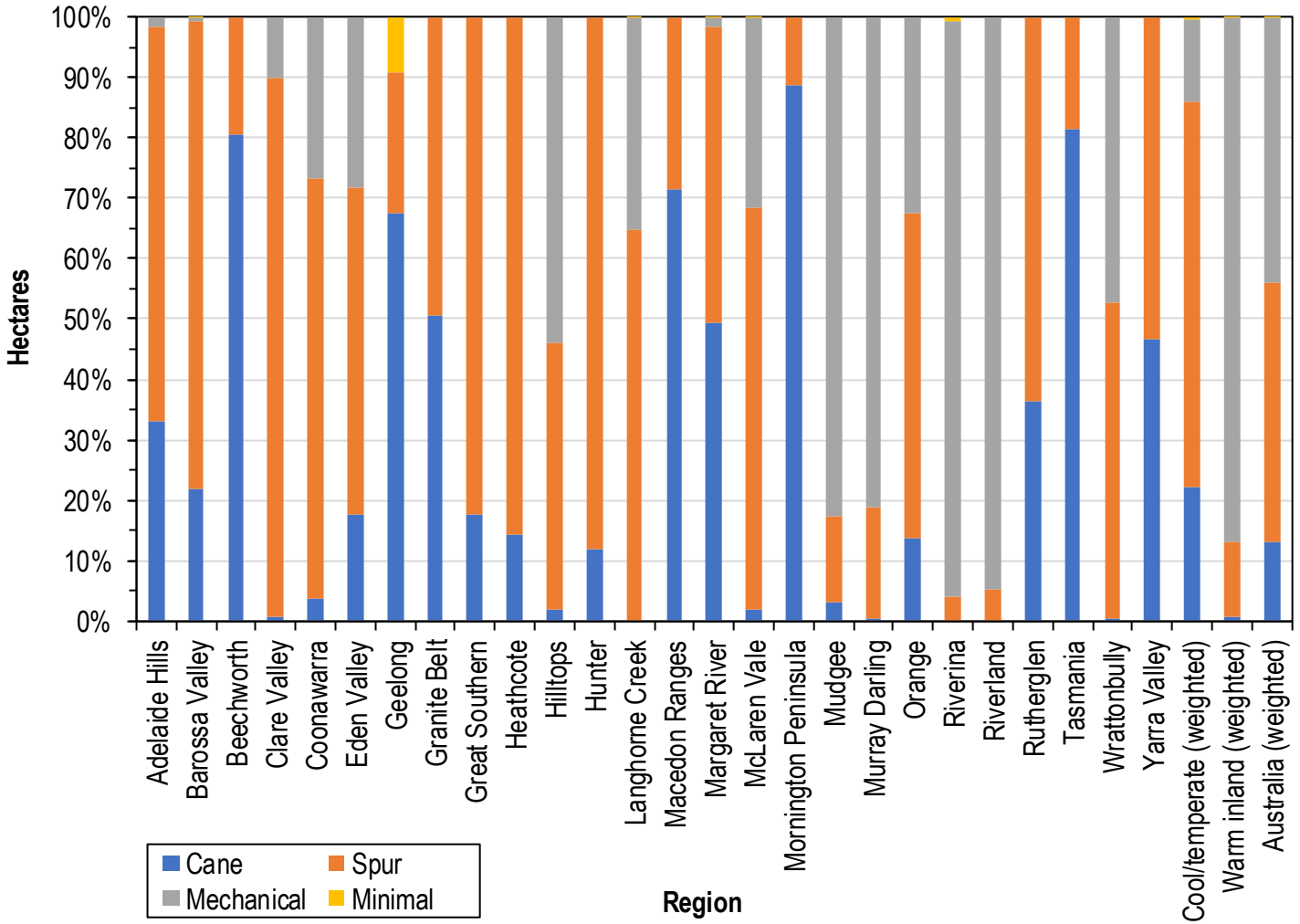
Rootstock use in Australia

37% on rootstocks

- Highest use of rootstocks was in Rutherglen and Beechworth, where the entire regions are classified as phylloxera infested.
- Similar (slightly higher) results for rootstock use in the survey compared with definitive Vinehealth Australia data for SA suggests that data for other regions is likely ok (subject to regional response rates).
- Reasons given for using rootstocks included phylloxera risk management, vigour management, nematode, salt and drought tolerance.
- Some producers indicated that they would still make new plantings on own roots, while others would make all new plantings on rootstocks to manage future phylloxera risks even when not in phylloxera zones.

†Respondents were asked what area was on non-*vinifera* rootstocks and what area was on own/*vinifera* roots. Reference data is from Vinehealth Australia (2016) *2015-2016 Annual report*.

Pruning method



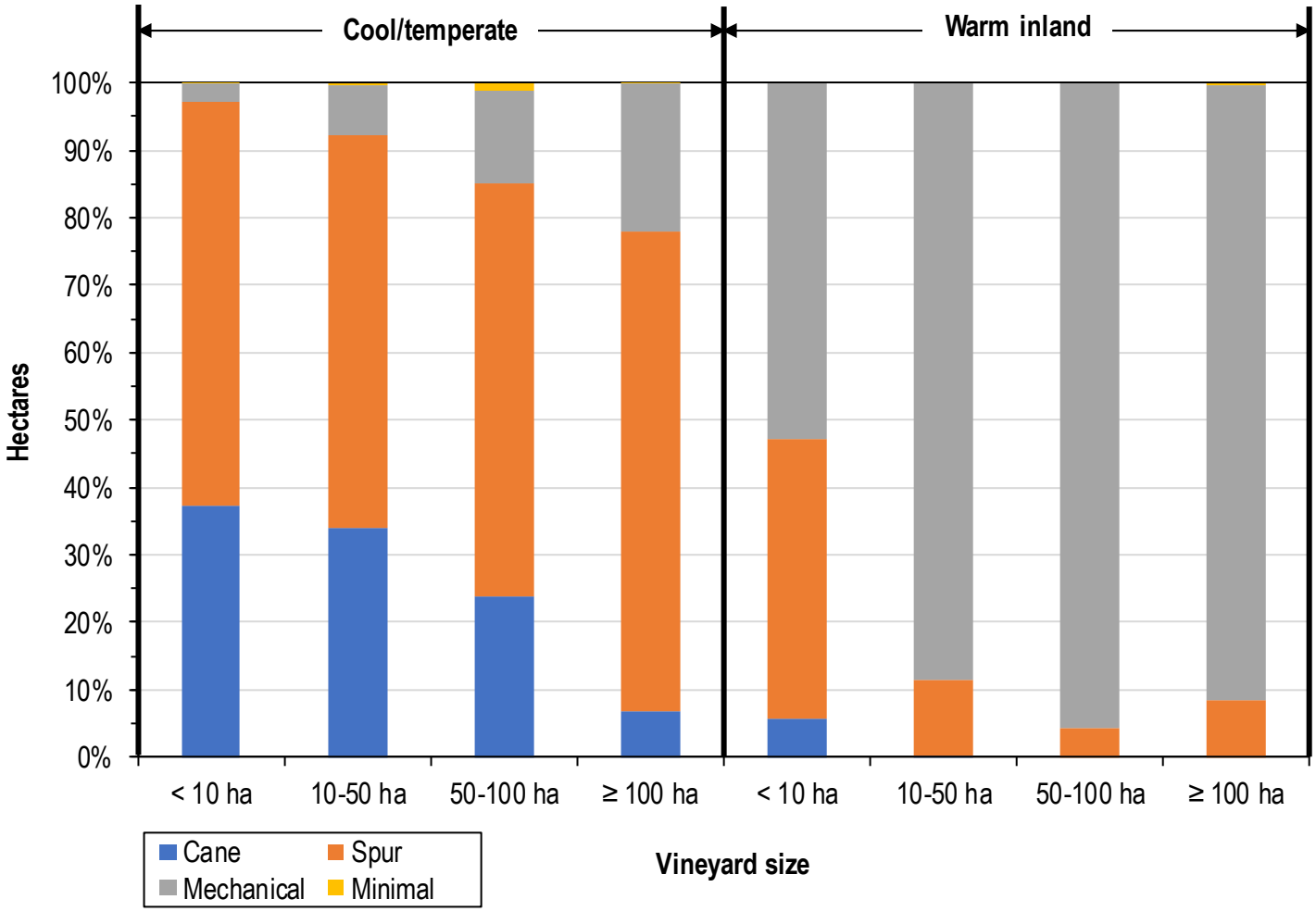
Pruning methods in Australia

13% cane
43% spur
44% mechanical

- Spur and cane pruning dominated in cool/temperate regions, whereas mechanical pruning was most common in warm inland regions.
- 91% of respondents indicated that pruning methods used in 2015/2016 were fairly typical of the last five years.
- Some respondents pondered whether the use of cane pruning may increase in future as a response to trunk disease issues.
- Some respondents noted that cane pruning is much more expensive than spur pruning, which is more expensive than mechanical pruning.
- Grape variety and other factors also influence choice.

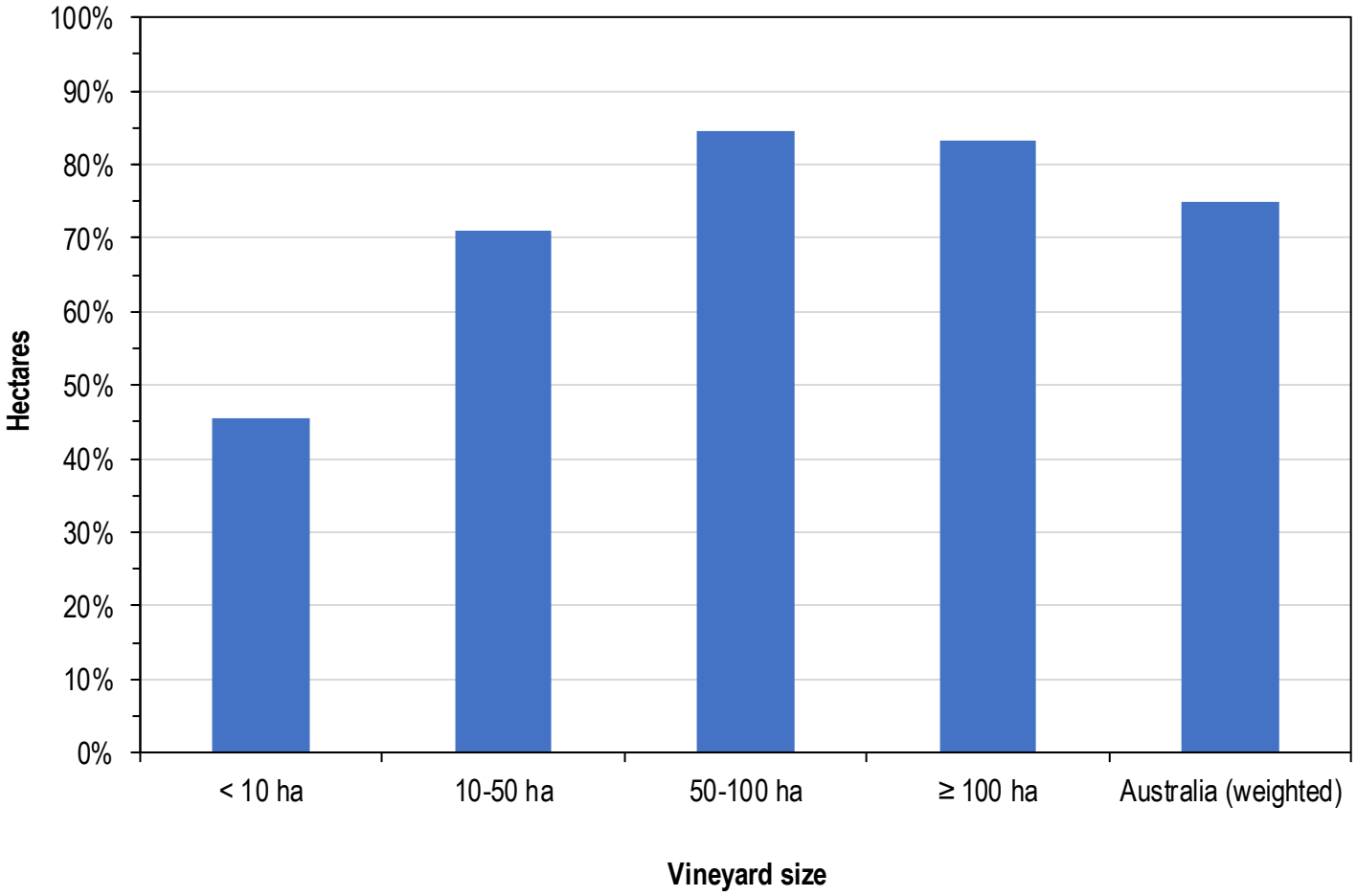
*The question asked for the area pruned by spur-by hand only, spur-mechanically pre-pruned with hand clean-up, mechanically pruned with hand clean-up, mechanically pruned with no hand clean-up, minimally pruned (not pruned or just skirted), cane-by hand only, cane-by hand with mechanical cut-cane removal (e.g. Klima). Sub-categories in each spur, cane and mechanical category have been aggregated. An earlier question asked if permanent cordons (spur, machine, or minimally pruned) or annually replaced cordons (cane/rod pruned) or some of each were used. Respondents only saw the spur/mechanical/minimal pruning options if they selected permanent cordons or some of each and only saw the cane pruning options if they selected annually replaced or some of each.

Pruning method (by region type and vineyard size)



- Pruning methods were very dependent on vineyard size.
- Smaller vineyards were more likely than larger vineyards to cane prune.
- Mechanical pruning relative to spur pruning also increased with vineyard size.

Mechanical pre-pruning for spur-pruned vines



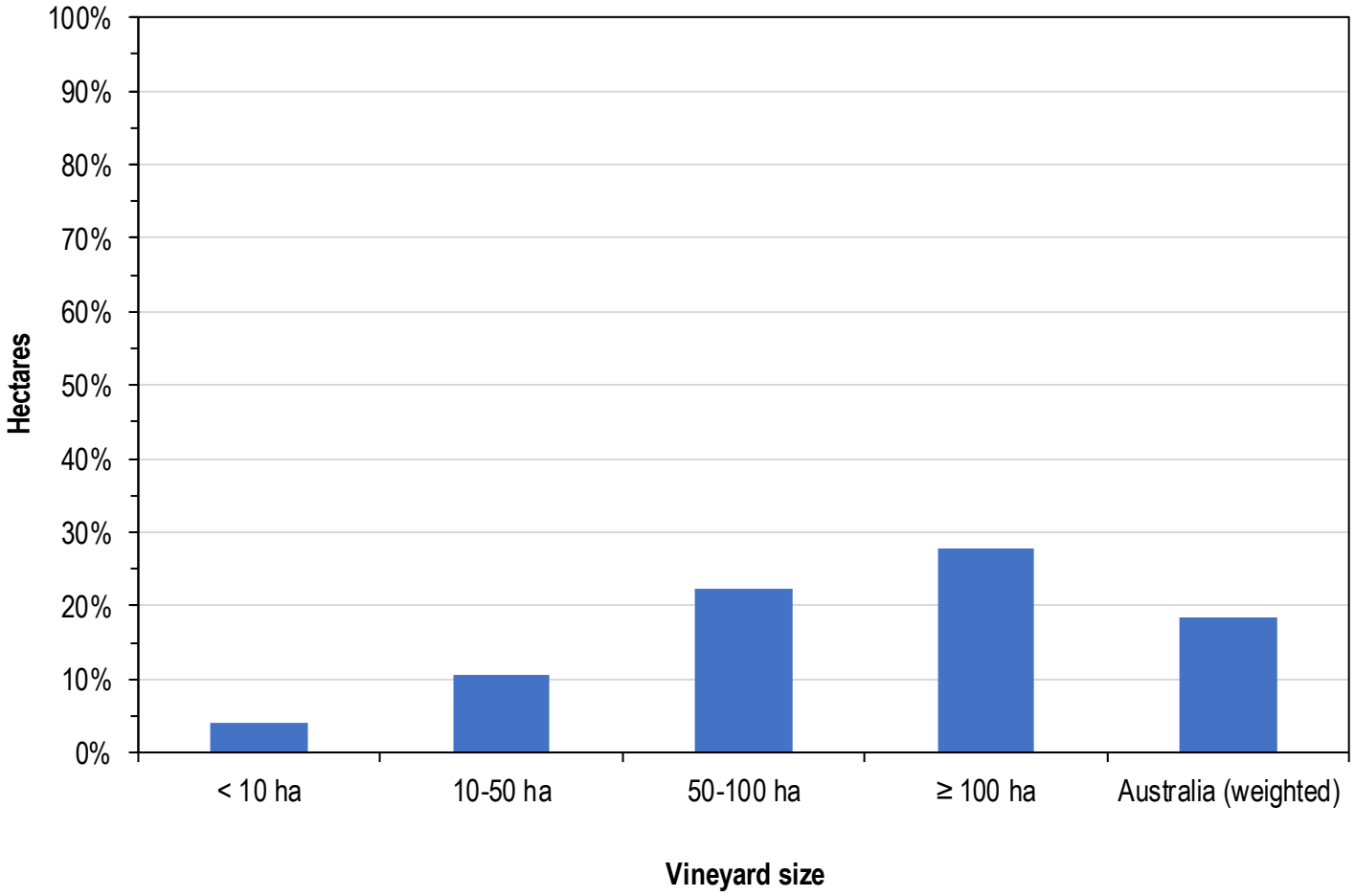
In Australia

75% of spur-pruned vineyard area was mechanically pre-pruned

- Mechanical pre-pruning was very common for spur-pruned vines, even in small vineyards.
- Use increased with vineyard size.
- Some respondents mentioned that hand pruning only is sometimes used because it is not possible to get a machine in.
- Another who conducted spur pruning by hand only mentioned weather as a factor in their region with risks of contractor equipment sinking unless it was brought in early in the season.
- The ability to do it all themselves instead of needing a contractor was another reason given for not performing mechanical pre-pruning.

*Calculated based on the area of spur-pruned vines mechanically pre-pruned with hand clean-up divided by the total area spur-pruned (both by hand and mechanically pre-pruned with hand clean-up).

Mechanical cane removal for cane-pruned vines – e.g. Klima



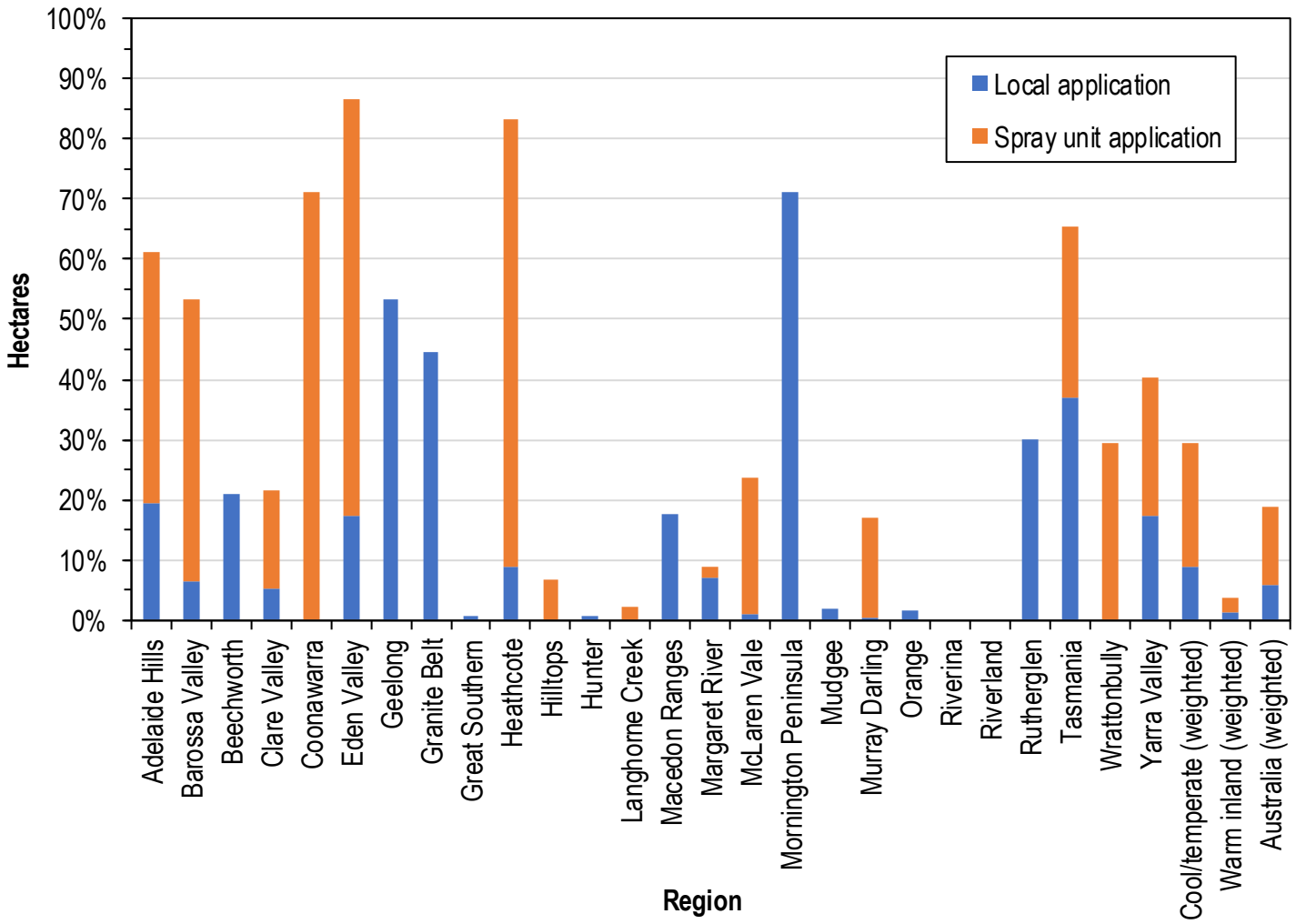
In Australia

18% of cane pruning was mechanical (e.g. Klima)

- Mechanical cut-cane removal increased with vineyard size but was not as common as mechanical pre-pruning before spur pruning.
- Some respondents commented that if more cane pruning was performed that there would be more demand for this technology.
- One respondent stated that this mechanisation had reduced the cost of cane pruning by one-third.

*Calculated based on the area cane pruned by hand with mechanical cut-cane removal (e.g. Klima) divided by the total area cane-pruned (both by hand only and with mechanical cut-cane removal).

Pruning wound treatment



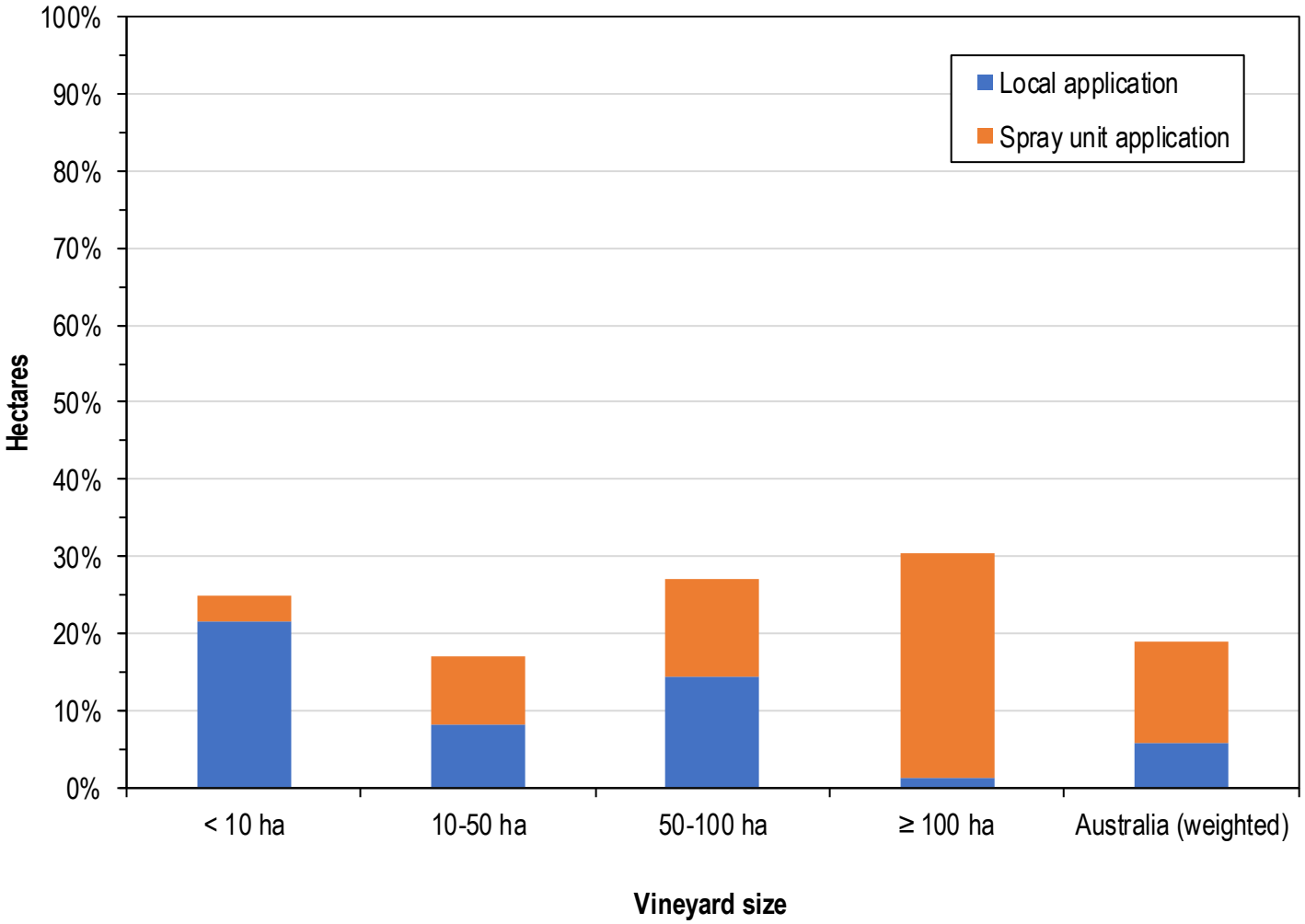
Pruning wound treatments in Australia

6% local application
13% by spray unit
81% no treatment

- High adoption of spray unit applied pruning wound fungicides in some regions.
- Some respondents noted that uptake of spray unit application of pruning wound fungicides was high in their region because they were involved in early research on the topic.
- Local applications may only have been on some major wounds.

*The question asked first whether any chemical treatments were applied to pruning wounds after pruning (painted or sprayed by hand, or by tractor spray unit). If respondents answered yes, they were then asked to enter the areas to which no treatment was applied, treatment was applied by hand, and treatment was applied with a spray unit.

Pruning wound treatment (by vineyard size)



- Application of pruning wound treatments was dependent on vineyard size.
- Small vineyards were more likely to use local treatments, while in very large vineyards application using a spray unit dominated.

Pest/disease impacts over the last five years

Pest / disease	Adelaide Hills	Barossa Valley	Beechworth	Clare Valley	Coonawarra	Eden Valley	Geelong	Granite Belt	Great Southern	Heathcote	Hilltops	Hunter	Langhorne Creek	Macedon Ranges	Margaret River	McLaren Vale	Mornington Peninsula	Mudgee	Murray Darling	Orange	Riverina	Riverland	Rutherglen	Tasmania	Wrattonbully	Yarra Valley	Cool/temperate (weighted)	Warm inland (weighted)	Australia (weighted)	Loschiavo et al. 2010
Powdery mildew	4	1	1	1	3	1	2	1	2	1	2	3	2	3	2	1	1	2	1	2	1	1	2	1	6	1	1	1	1	1
Botrytis and bunch rots	2	5	4	2	2	2		5	3	5	1	1	1	5	3	4	4	3	3	1	2	4	1	3	1	4	2	3	2	3
Downy mildew	3	3	3	5	3	4	3	3		2	4	2	5	2	4	6	2	1	3	3	4	2	3	4	5	2	3	2	3	2
Birds	1	4	2	4		2	1	2	1	3	3	5		1	1	2	3	3	5	3		6	6	2	4	3	5	6	4	7
Light brown apple moth (LBAM)	6	6	6	6	5	6	5	4		6	5	3	6			5	4	6	2	5	3	3	5		1	6	6	4	5	4
Trunk diseases	5	2	5	3	1	5	4		4	4	6		3	4	6	2	6	5		6	6		4	5	1	5	4	7	6	8
Mealy bugs and scale								6	6			6	4		5				6		5	5		6			7	5	7	10
Viruses/transmissible organisms					6																						8	8	8	6
Trunk boring insects							6		5					6													9	10	9	11
Root-knot and other nematodes																											10	9	10	5
Root rots																											11	11	11	12
Phylloxera																											12	12	12	9

Region (only top 6 shown for individual regions)

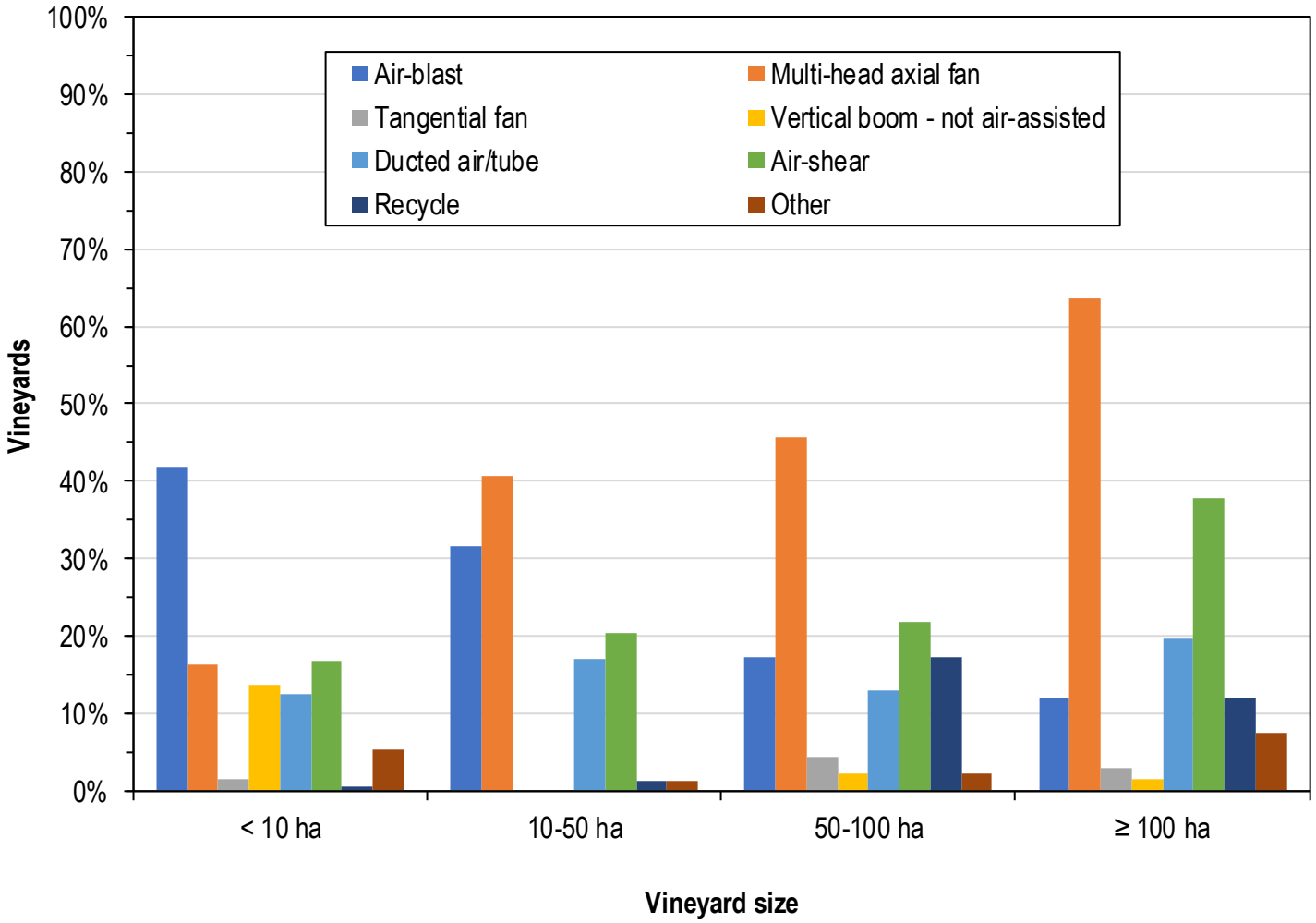
Pests/diseases in Australia

1. Powdery mildew
2. Botrytis/bunch rots
3. Downy mildew
4 Birds
5. LBAM

- Bird damage ranked highly in some regions. It was suggested that this relates to there being lots of bush around those regions and the high cost of netting.
- Different pressures are seen in different regions, so only the rankings are comparable, not the impacts.
- Other pests/diseases mentioned in comments included weevils, snails, earwigs, vine moths, wasps, grasshoppers, mites, kangaroos, emus and possums.
- Phylloxera ranked low overall, but some noted worries about the future.

*The question asked respondents to rank the impact of these 12 pests and disease over the last five years, using a drag and drop format. Users were forced to drag at least 5 of the 12 pests and diseases. (There were several comments that only the first couple had an impact.) Analysis involved assigning 12 points to a 1st ranking through to 1 point for a 12th ranking for each respondent, and then adding across respondents in the region and ranking. National rankings from a previous study are provided for comparison - Loschiavo, A., Scholefield, P., Morison, J., Ferris, M. (2010) *Assessment of economic cost of endemic pests and diseases on the Australian grape and wine industry*. GWRDC Project GWR 08/04. https://www.wineaustralia.com/research/search/completed-projects/gwr-08-04

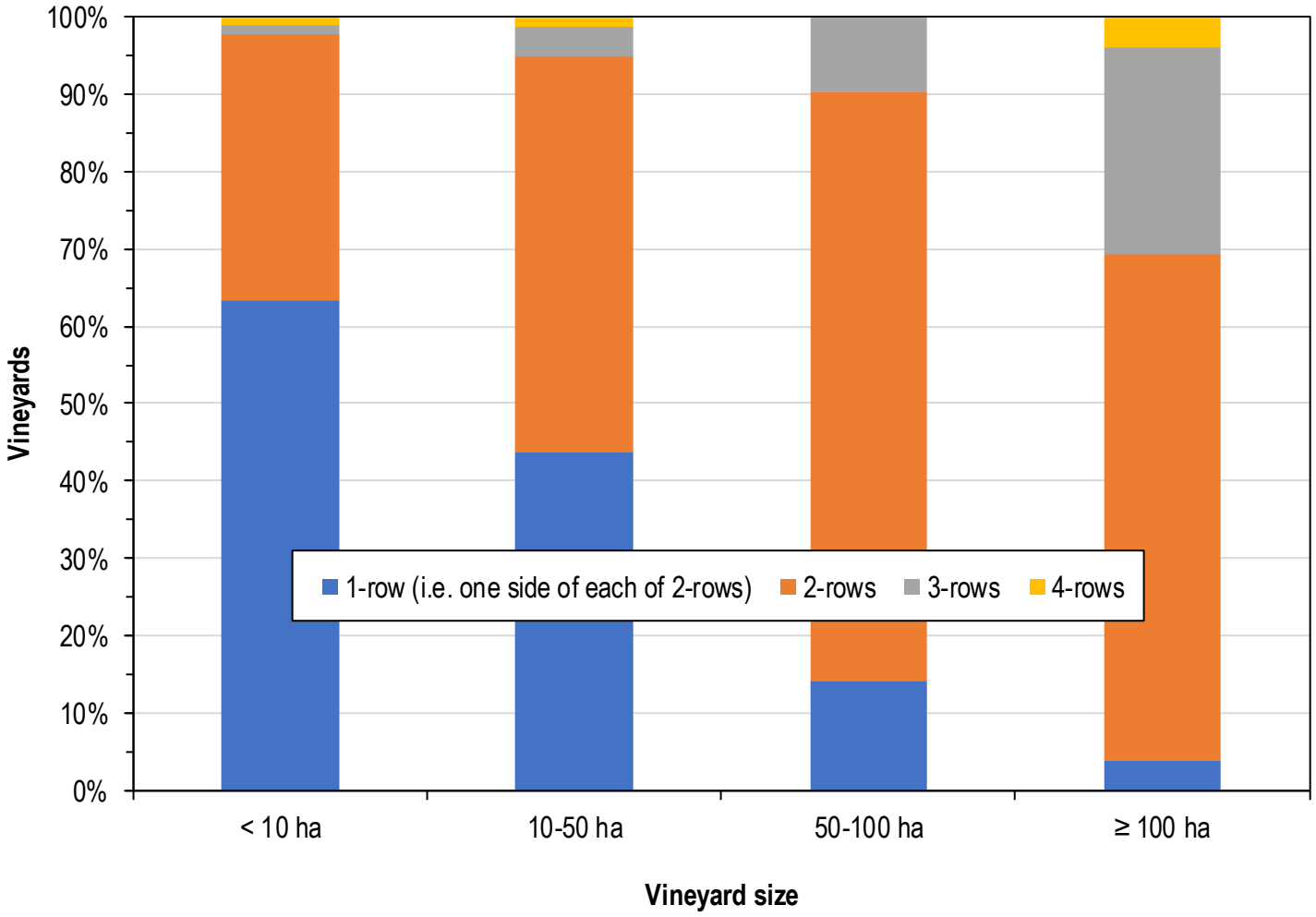
Canopy sprayer types (used at all)



- Air-blast sprayers were most common in small vineyards.
- Multi-head axial fan sprayers were most common in large vineyards.
- Air-shear sprayers were also common in large vineyards.
- Recycle sprayer use was higher in larger vineyards but still low overall.
- Some respondents were very positive about recycle sprayers because of the chemical savings and being able to spend more time spraying and less time filling tanks, particularly early in the season.
- Other respondents had concerns about the robustness of some recycle sprayers.

*The question asked the user to select all canopy sprayers used in the growing season.

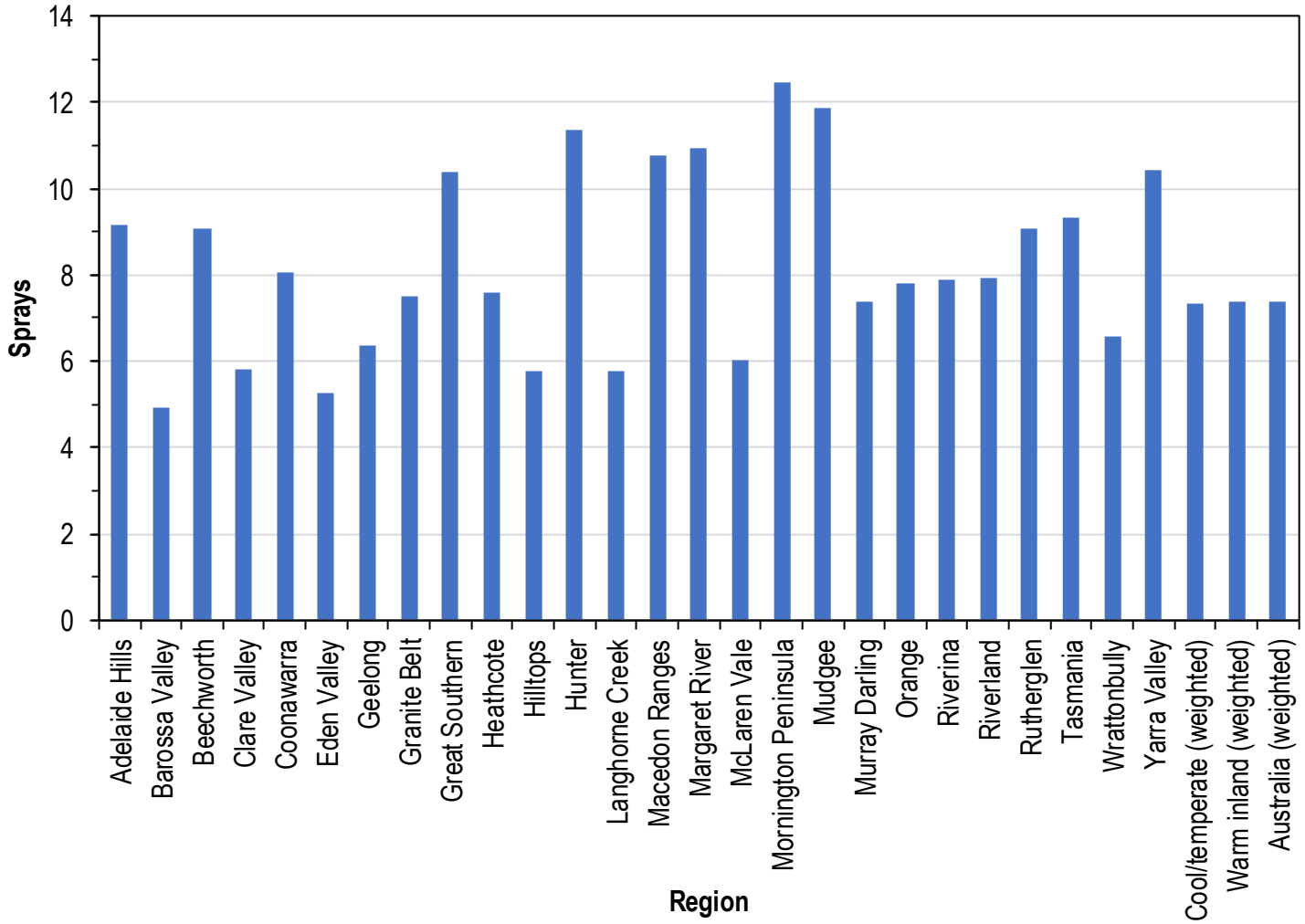
Size of canopy sprayer that covered the most area



- **New multi-row equipment was the technology most commonly nominated by vineyards as having had a positive impact on their operations over the last five years (see page 70).**
- 2-row sprayers were often the sprayer size that covered the largest area even in large vineyards.
- It was suggested that the dominance of this size may reflect that larger models would require larger headlands to turn around and equipment needs to be compatible with many different blocks.
- One reason given for not using 3-row sprayers (2 full rows + 2 half-rows) was a belief that the 2 half-row sprays would give uneven penetration; however, a respondent with a 3-row sprayer said that this was not the case.

*The question asked the respondent to select how many rows the sprayer that covered the most hectares in the growing season sprayed simultaneously.

Average number of canopy sprays



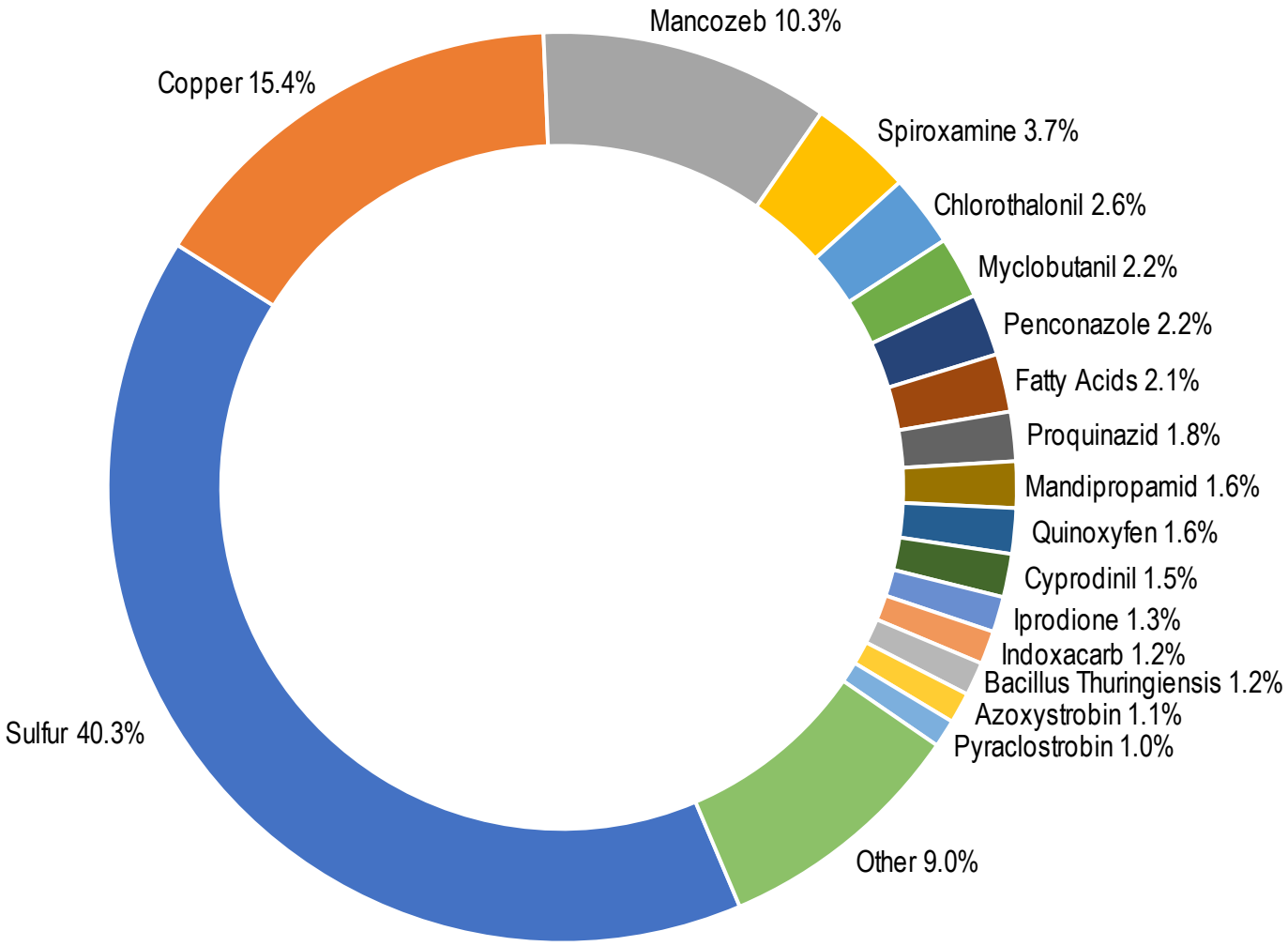
Average number of sprays in Australia

7.4 canopy sprays

- 75% of respondents indicated that the number of sprays used in 2015/2016 was fairly typical of the last five years, although some respondents from the Hunter that applied 11-15 sprays said that this was more than usual.

*The question asked the user to specify the areas that were sprayed 0, 1-2, 3-4, 5-6, 7-8, 9-10, 11-15 or more than 15 times in the growing season. Respondents were asked to count a tank mix of two or more chemicals as a single spray. An average number of sprays for each region was calculated by weighting data according to the relative areas and using the mid-point of each range (e.g. 7-8 becomes 7.5). Users were also asked to select how typical the number of sprays was of the last five years (a lot less, slightly less, fairly typical, slightly more, a lot more).

Fungicide and insecticide canopy sprays by active constituent – Grapeweb data



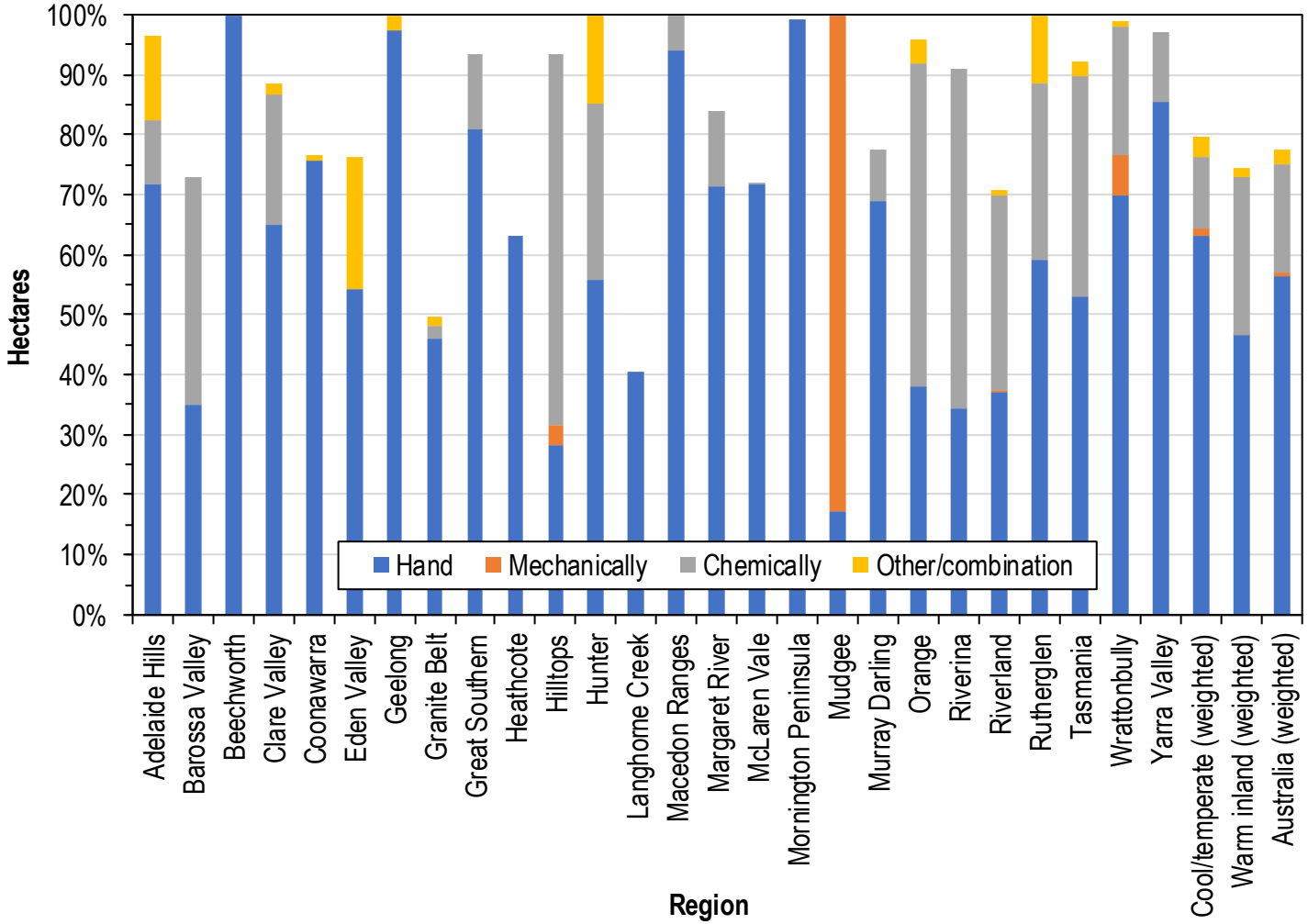
Canopy sprays in Australia

40% Sulfur
15% Copper

- Active constituent data was not collected by the survey.
- Summary data has been extracted from Grapeweb spray diaries.
- Sulfur and copper were the most commonly applied active constituents.
- Several respondents mentioned that sulfur and copper are effective multi-site fungicides and that sulfur is cheap.
- Fungicides like Revus were listed by some respondents as having had a positive impact on their business in the last five years. In contrast, others reported that adoption of organic practices (not necessarily certified) had a positive impact (see page 70).

*Data from the Grapeweb spray diary system (Agsmart) for the 2016 vintage growing season across all Australian vineyards in that system.

Desuckering



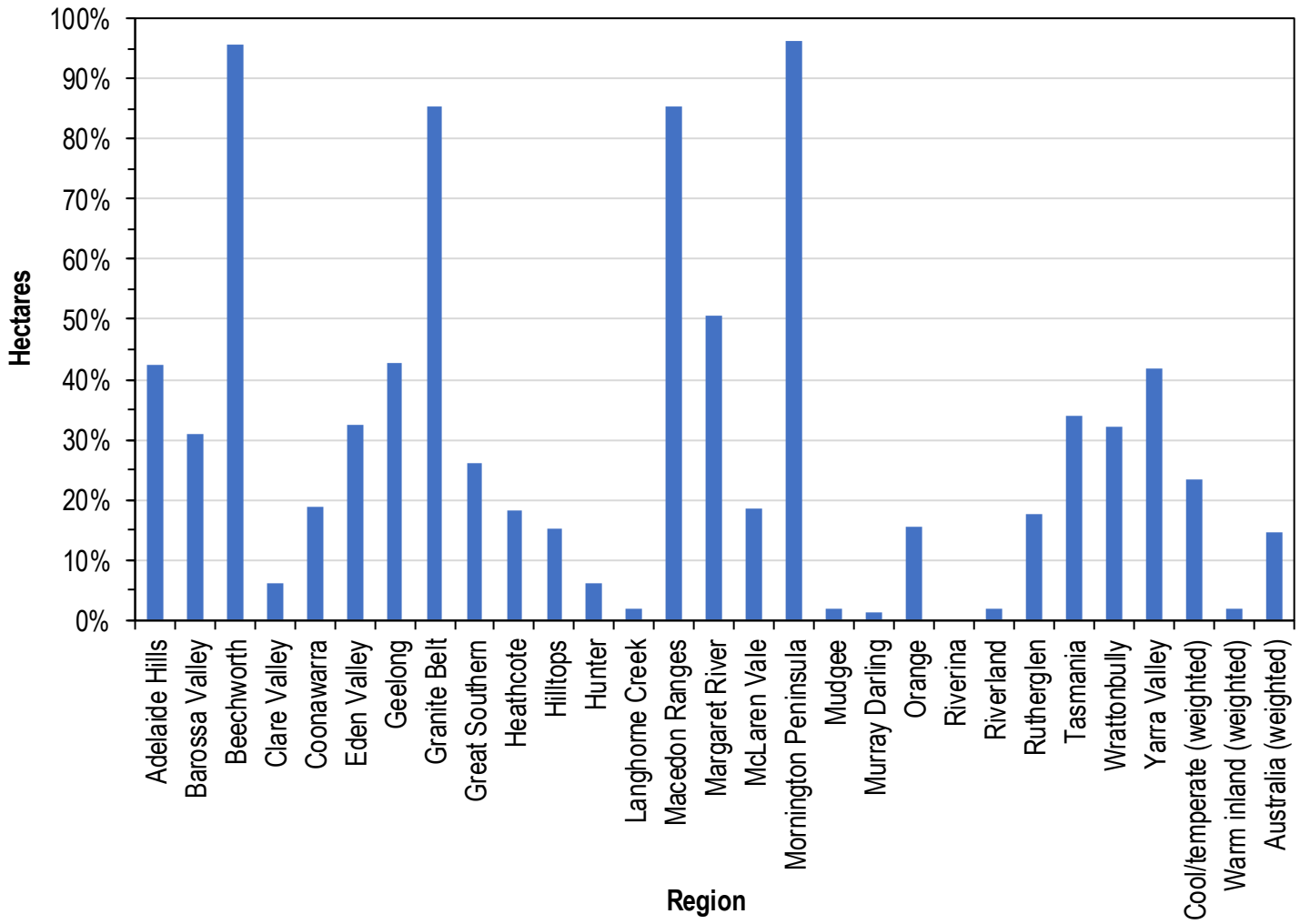
In Australia

78% of vineyard area was desuckered (>2/3 of it by hand)

- Hand desuckering was much more common than chemical desuckering and mechanical desuckering was rare.
- Respondents mentioned that chemical desuckering can work but that the timing is critical and if not done early enough it might need to be done by hand again anyway.
- Some respondents suggested that mechanical desuckering could be hard on infrastructure (e.g. drippers).

*The question asked first if any desuckering was performed and if they answered yes, they were asked to specify what area was not desuckered, hand desuckered, mechanically desuckered, chemically desuckered, desuckered by another or combination of methods.

Shoot thinning



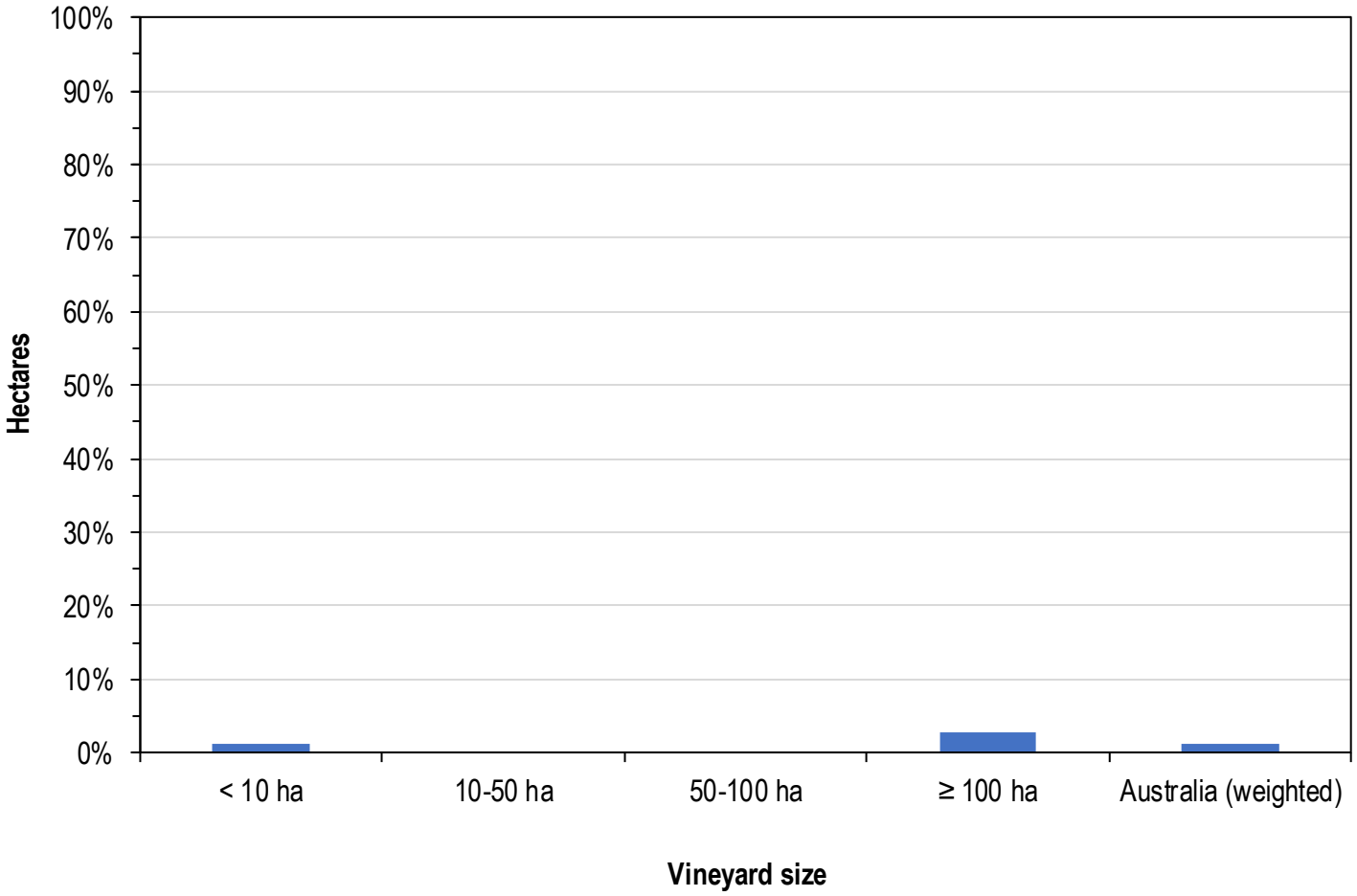
In Australia

14% of vineyard area was shoot thinned

- Shoot thinning was performed in some regions more than others.
- 85% of respondents said that the amount of shoot thinning conducted in 2015/2016 was fairly typical of the last five years.

*The question asked whether any shoot thinning was performed in the growing season and if respondents answered yes, they were asked to specify the areas that were not shoot thinned, hand shoot thinned, mechanically shoot thinned or other. All types of shoot thinning have been aggregated. Respondents were also asked to select how typical the amount of shoot thinning was of the last five years (a lot less, slightly less, fairly typical, slightly more, a lot more).

Shoot thinning – mechanisation (e.g. rotary paddles)



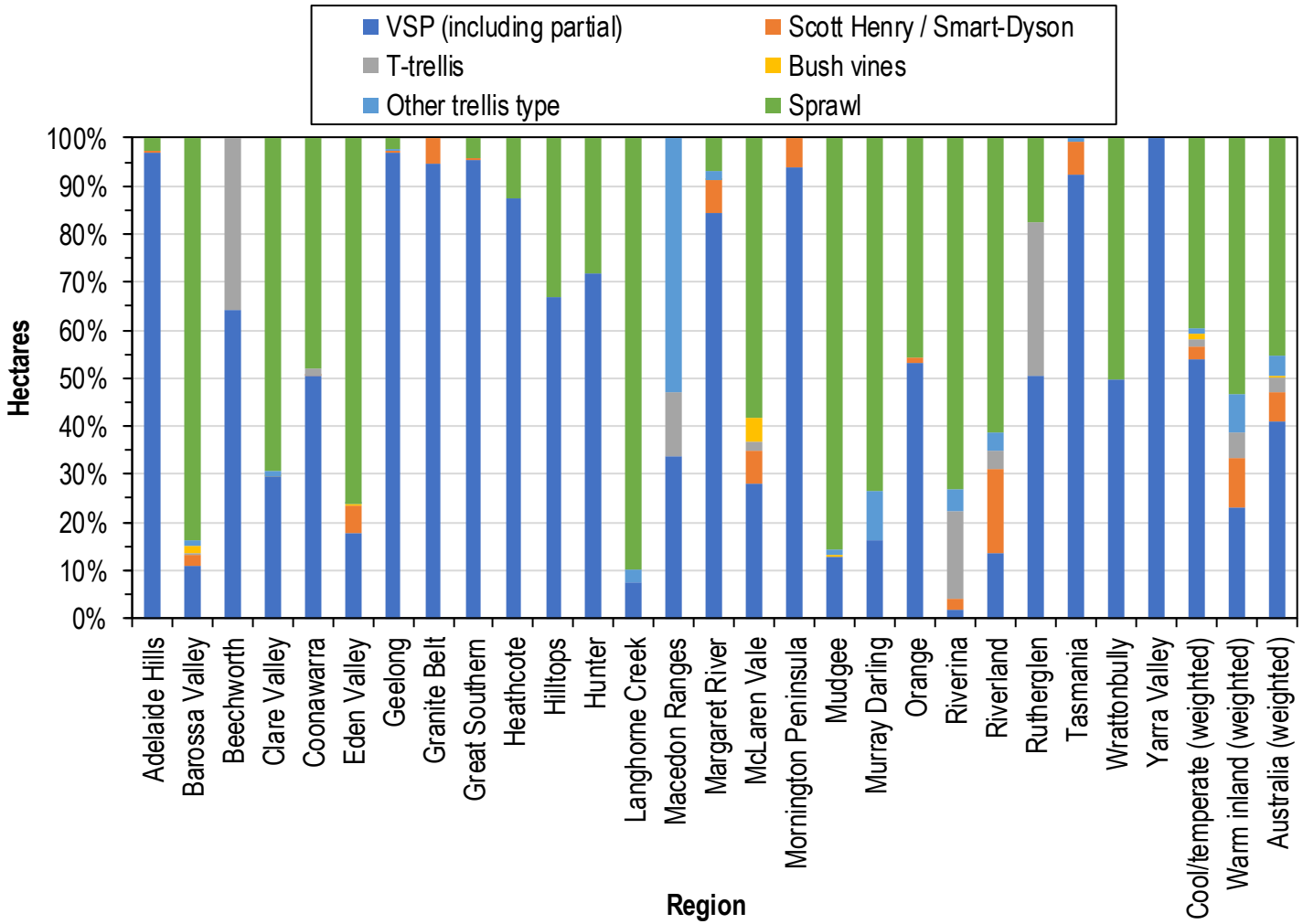
Shoot thinning in Australia

1% mechanised

- Very little mechanised shoot thinning was performed.

*Calculated based on the area mechanically shoot thinned divided by the total area shoot thinned.

Generalised training/trellis system



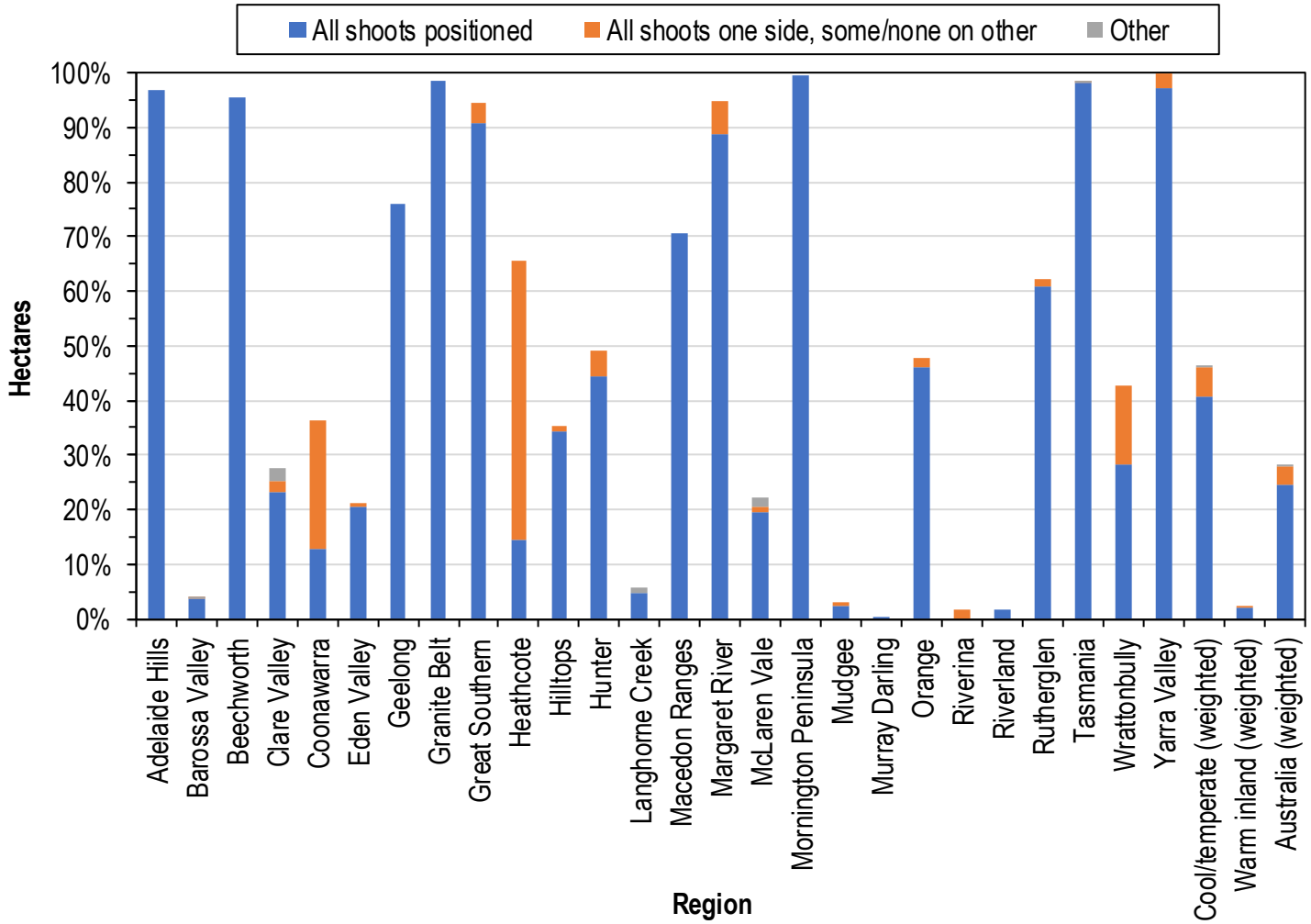
Trellising in Australia

41% VSP (incl. partial)
45% sprawl

- The question asked the respondent to still select a system that allows for shoot positioning even if only some shoots were positioned (e.g. VSP with shoots positioned only on one side). Respondents were advised that there would be an opportunity to elaborate on shoot positioning practices later in the survey (see next page).
- Some large warm inland vineyards reported a Scott Henry or VSP training/trellis system but performed no shoot positioning/wire lifting.

*The question asked respondents to specify the area that used each of the trellis systems.

Shoot positioning/wire lifting



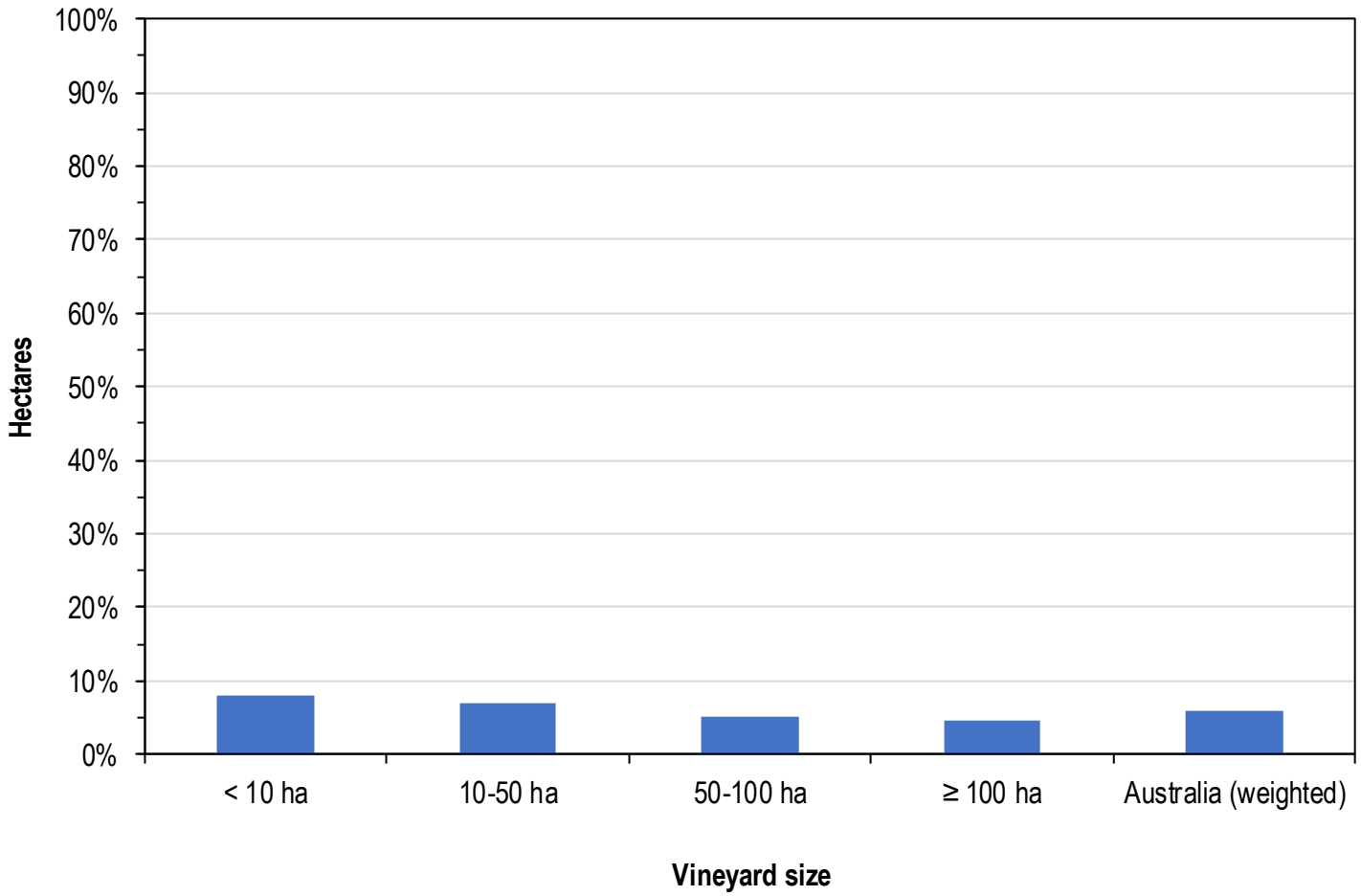
Shoot positioning in Australia

28% shoot positioned

- When shoot positioning was performed, all shoots were usually positioned.

*The question asked whether any shoots were positioned/wires lifted in the growing season and if respondents answered yes, they were asked to specify the areas where there were no shoots positioned/wires lifted, all, all on one side but some/none on the other, or another arrangement. There was an instruction on the question to select 'no' if the vineyard was 100% sprawl.

Shoot positioning/wire lifting – mechanisation



Mechanisation of shoot positioning in Australia

6% mechanised

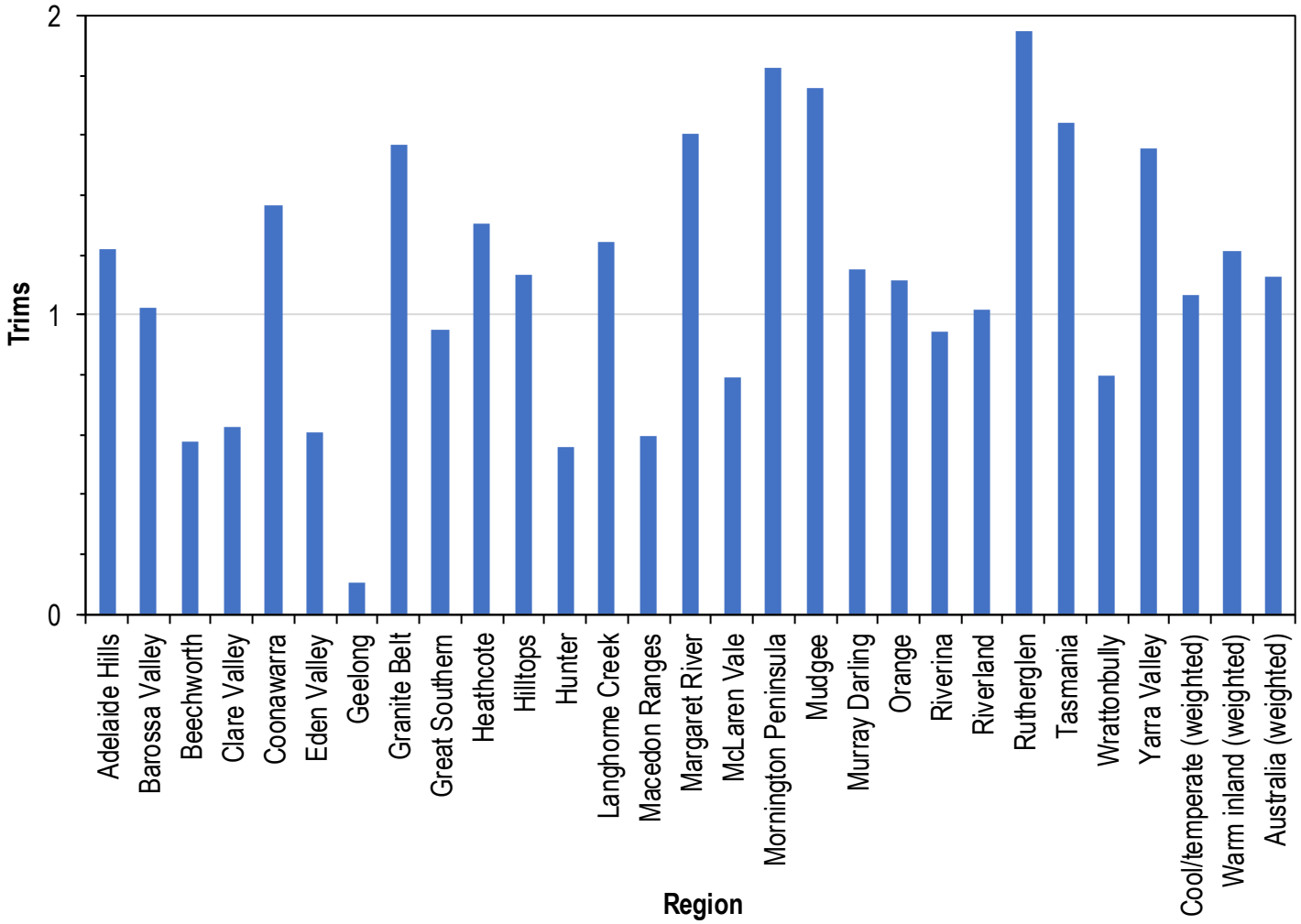
- There was a low level of mechanisation for shoot positioning/wire lifting.
- Some respondents noted that they had previously used or considered mechanical wire lifters, but the equipment was not satisfactory.

Reasons mentioned for not using:

- Not incremental, can only be used when foliage is more developed, and can't handle different length shoots
- Some shoots will snap or get tangled depending on variety
- High use of disposable plastic clips/line
- Not that fast when compared against a team of people.

*For respondents that had answered that some shoots were positioned/wires lifted in the growing season, they were asked to select from a menu to the nearest 10% what % of shoot positioning/wire lifting was performed by machine versus by hand. The hectares of shoot positioning by machine relative to the total was then calculated.

Average number of trims



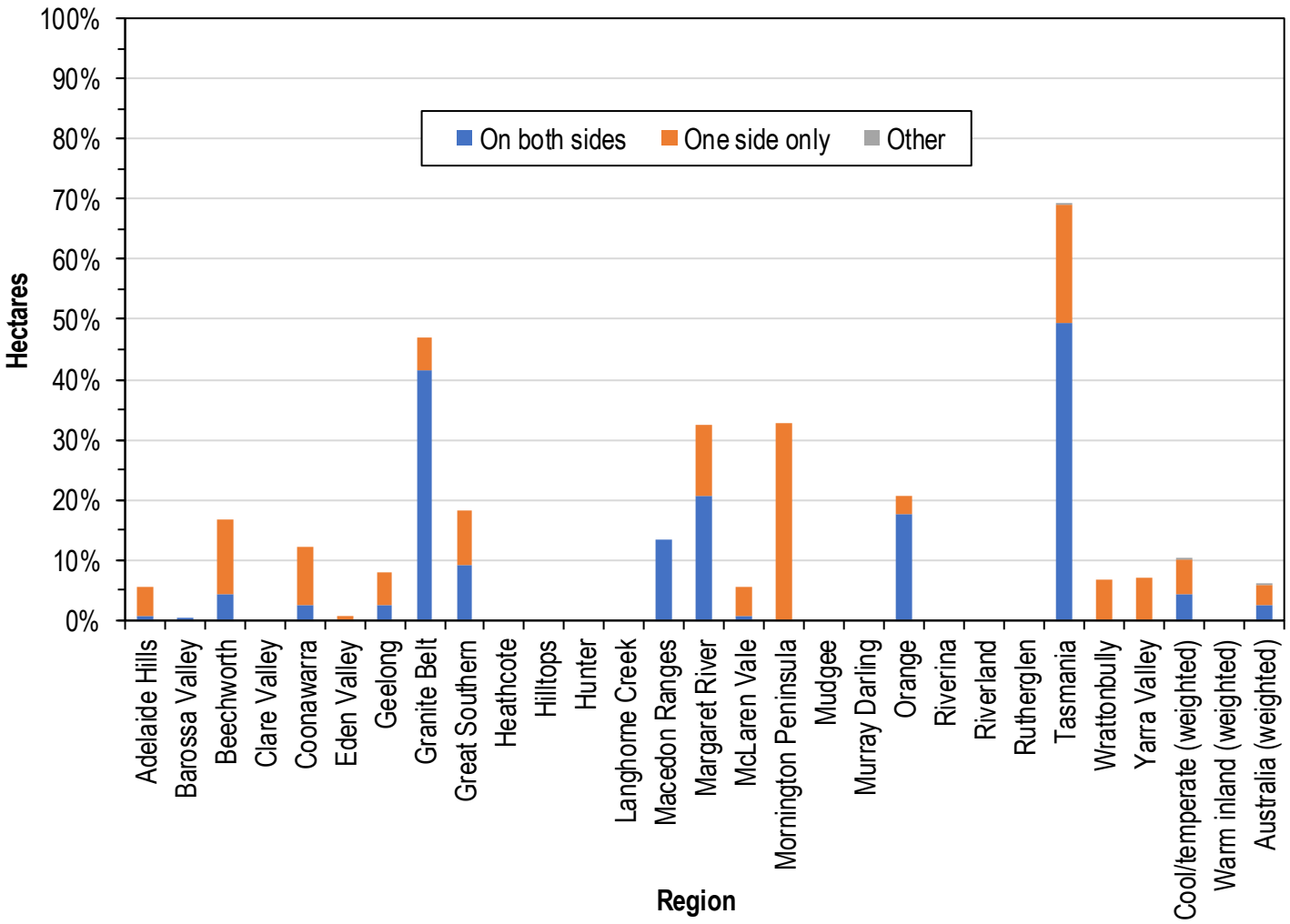
Trimming in Australia

1.1 trims per season

- 80% of respondents said that the number of trims performed in 2015/2016 was fairly typical of the last five years.

*The question asked whether any trimming was performed in the growing season and if respondents answered yes, they were asked to specify the area that was trimmed 0, 1, 2, 3 or 4 or more times. An average number for each region was calculated by weighting the trims according to the relative areas. Users were also asked to select how typical the number of trims was of the last five years (a lot less, slightly less, fairly typical, slightly more, a lot more).

Leaf plucking



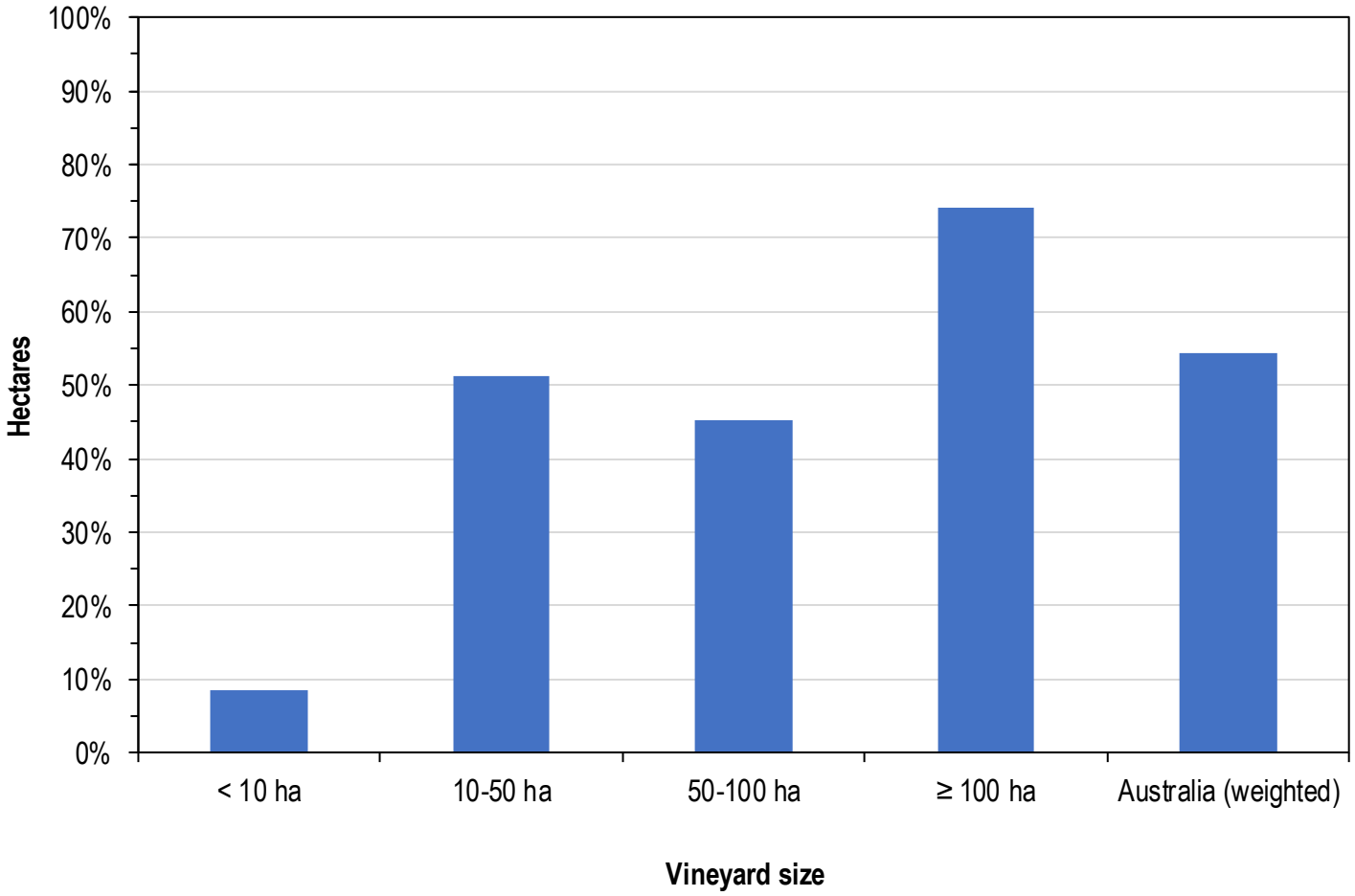
Leaf plucking in Australia

6% of vineyard area (about half plucked on one side only)

- One respondent noted that mechanical leaf plucking is an under-used technique.
- For hand-picked blocks one respondent noted that they often used mechanical leaf plucking the day before harvest, as this allows pickers to pick faster.
- One reason offered for the low use of leaf plucking in Australian vineyards is the Australian sprawl canopy; however, an adaptation that allows leaf plucking in sprawl canopies was developed by one wine company (a finalist in the Wine Grape Council of SA's 2016 Vinnovation awards)

*The question asked whether any leaf plucking/removal was performed in the growing season and if respondents answered yes, they were asked to specify the areas that were not leaf plucked, leaves plucked on both sides, leaves plucked on one side only, or another leaf plucking strategy. There was an instruction on the question not to count trimming as leaf removal.

Leaf plucking – mechanisation



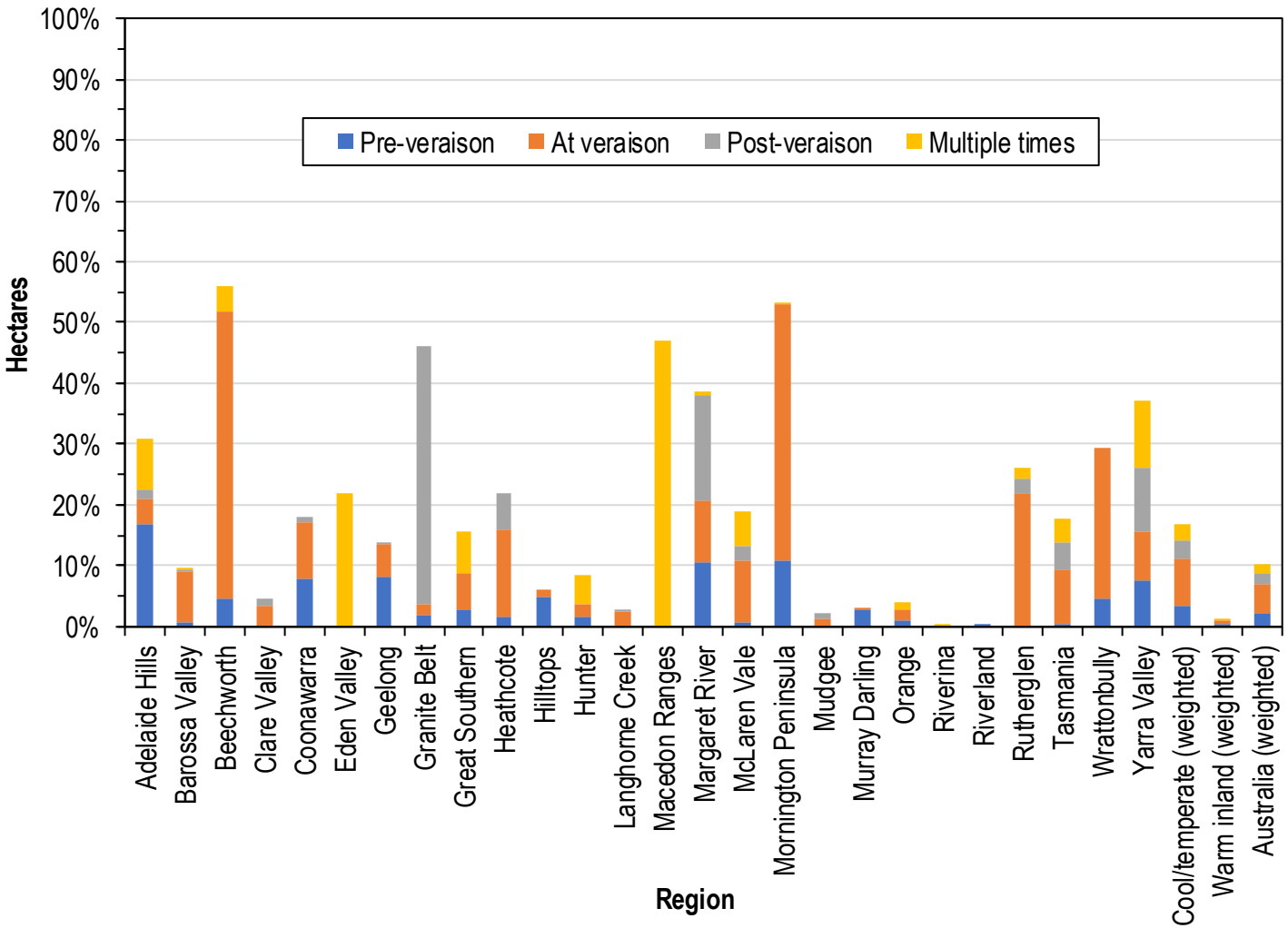
Leaf plucking in Australia

54% mechanised

- Leaf plucking was often mechanised when it was performed.
- One respondent noted that for high value fruit leaf plucking was still performed by hand, but the rest was done mechanically.

*Users that had answered that some leaf plucking was performed were asked to select from a menu to the nearest 10% what % of leaf plucking was performed by machine vs by hand. The hectares of mechanised leaf plucking relative to the total was then calculated.

Crop thinning



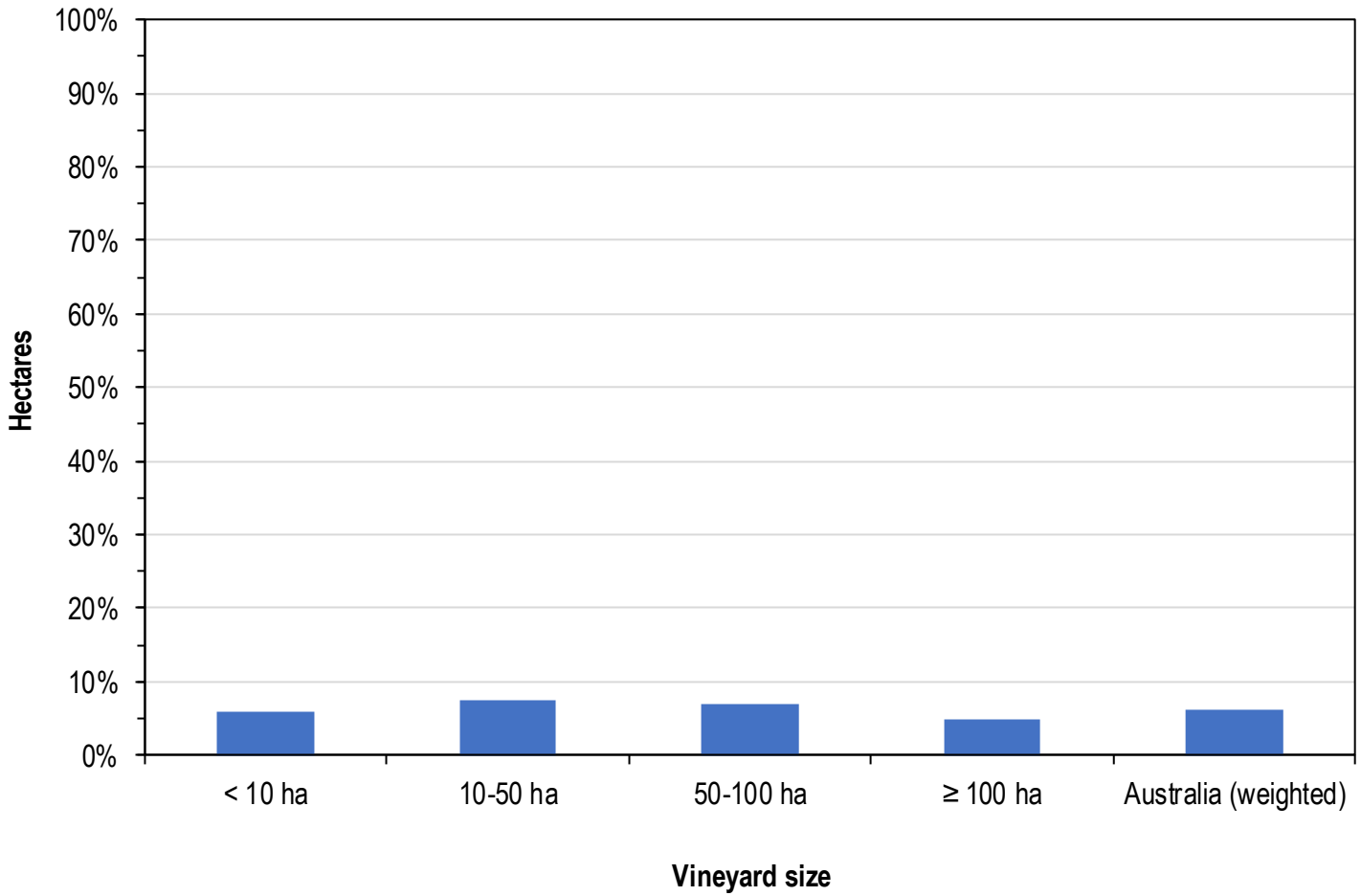
Crop thinning in Australia

10% crop thinned

- Crop thinning was performed reasonably often in some regions.
- Timings varied, with at veraison being the most common.

*The question asked whether any crop/bunch thinning was performed in the growing season and if respondents answered yes, they were asked to specify the areas that were not crop-thinned, crop-thinned pre-veraison only, at veraison only, post-veraison only, or at multiple times. There was an instruction on the question not to count hand-removal of diseased/damaged grapes prior to harvest as crop thinning.

Crop thinning – mechanisation (e.g. harvester or other beaters)



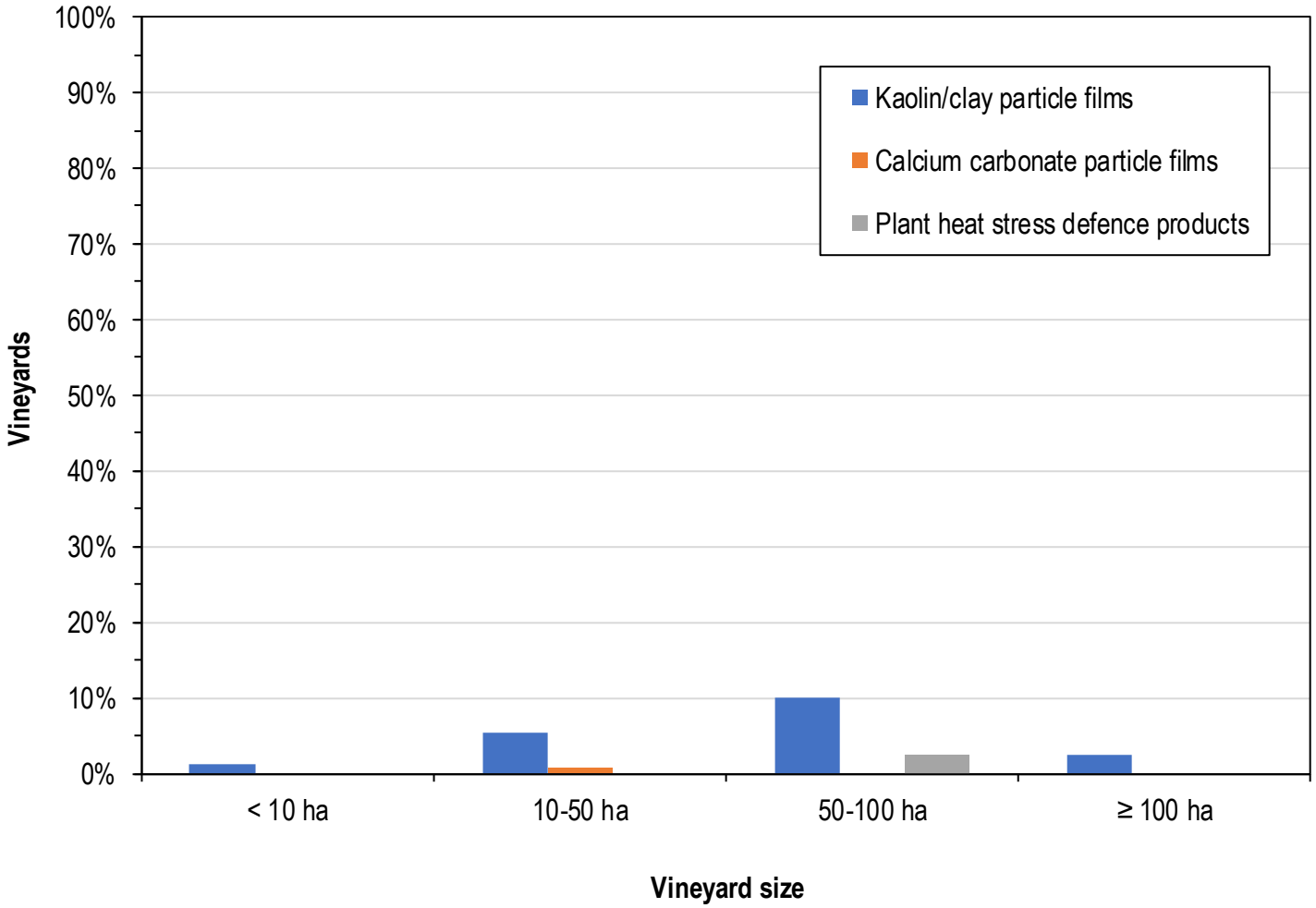
Crop thinning in Australia

6% mechanised

- Crop thinning was rarely performed mechanically.

*Users that had answered that some crop thinning was performed were asked to select from a menu to the nearest 10% what % of crop thinning was performed by machine (e.g. harvester or other beaters) vs by hand. The hectares of mechanised crop thinning relative to the total was then calculated.

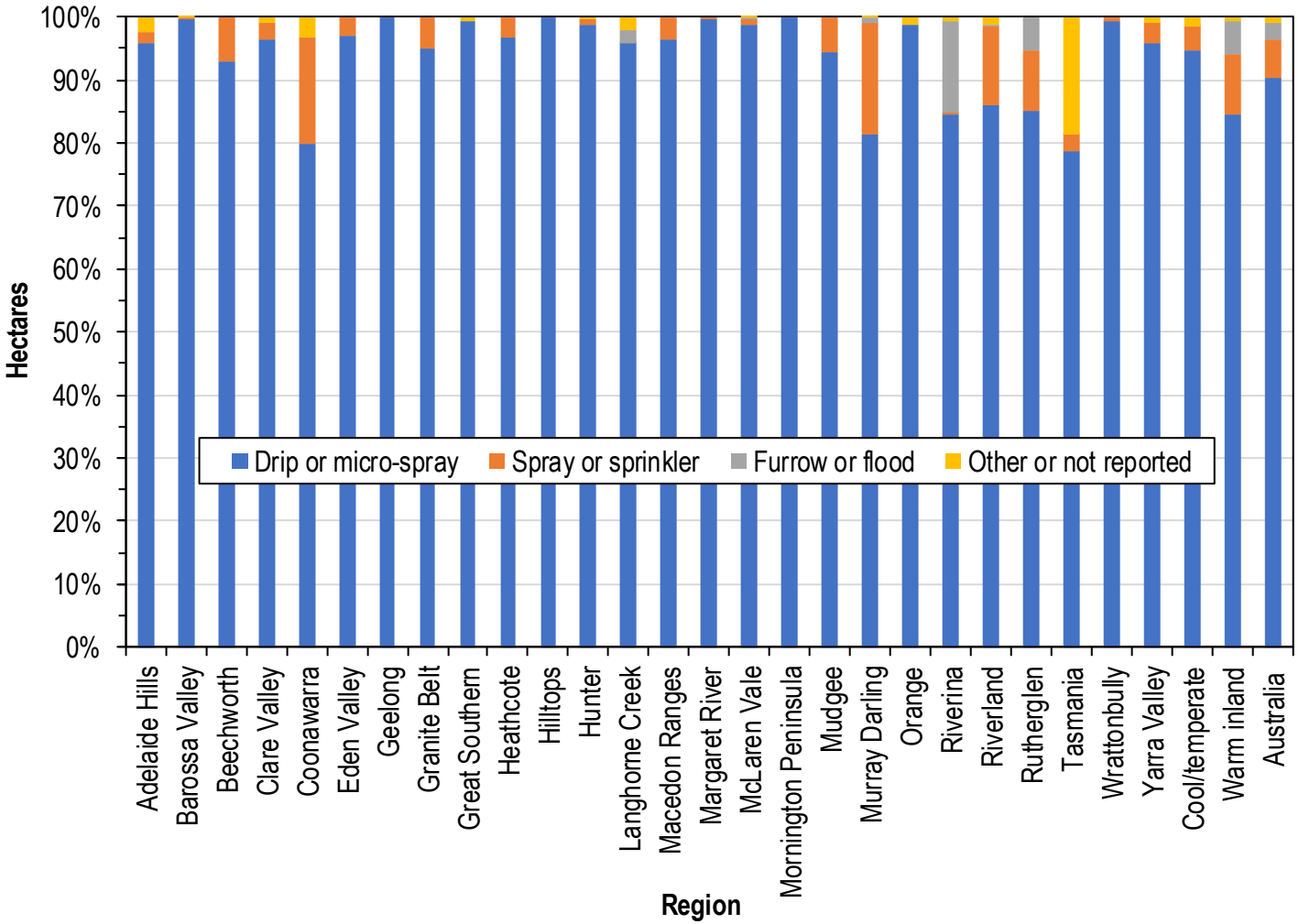
Grape sunscreens (used at all)



- A small number of vineyards reported using grape sunscreens during 2015/2016.
- Kaolin/clay particle films were the most common.
- One respondent indicated that they didn't need sunscreens because they managed the canopy instead.

*The question asked whether any grape sunscreens were used in the growing season (an instruction listed types), and if respondents answered yes, they were asked to select the types used from a list.

Irrigation method for irrigated vineyards - data from ABS



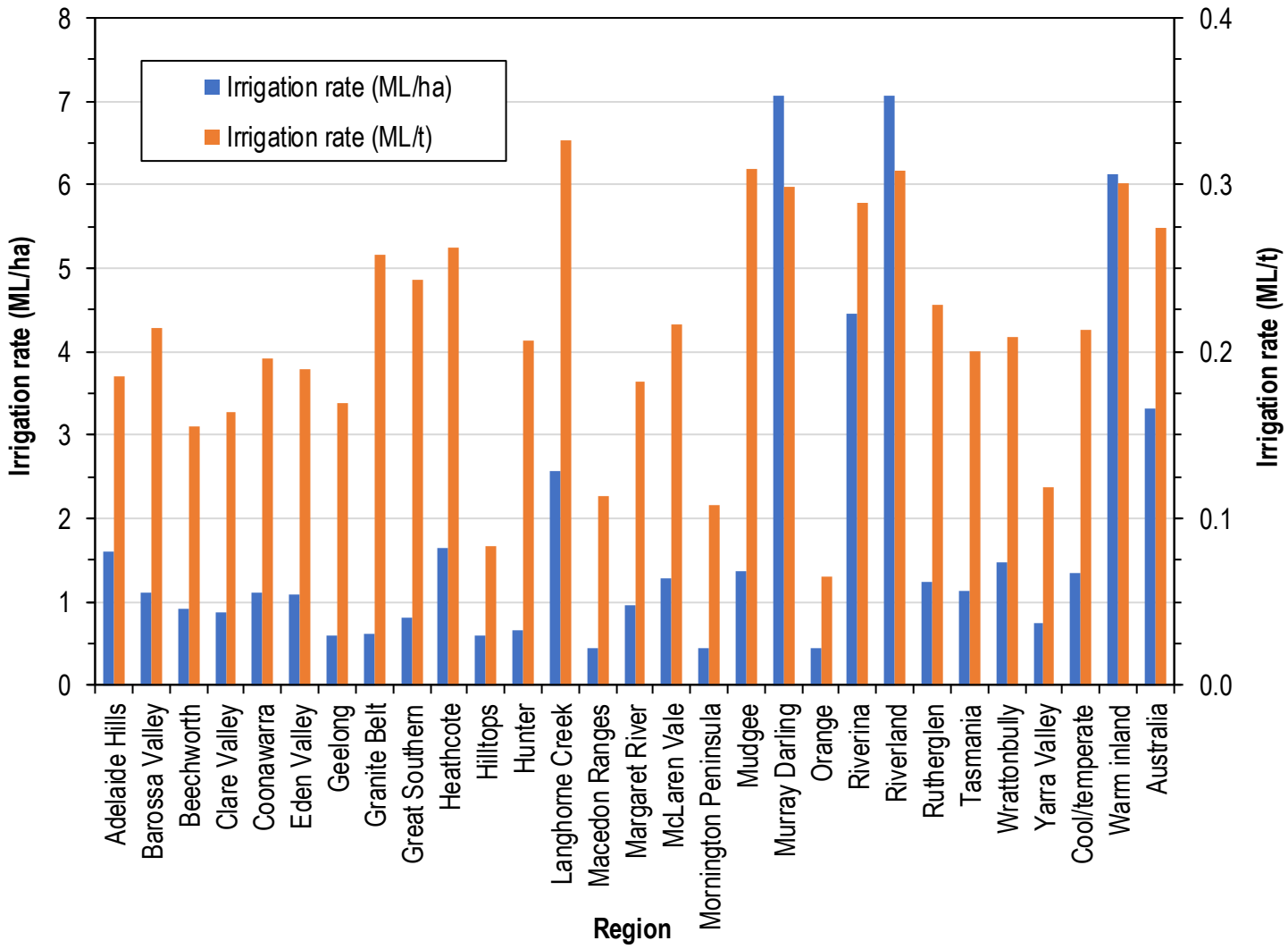
Irrigation in Australian vineyards

90% drip/micro-spray

- Data on irrigation methods was not collected in the survey because it was already reported by the ABS in 2015 (reproduced here).
- Drip/micro-spray was the dominant irrigation technique used in all regions.
- One respondent suggested that in future surveys they would be interested in the types of drippers used as that can be important with regards to puddling/run-off/clogging.

*ABS data from 1329.0.55.002, 2014-2015.

Irrigation rates – data from ABS



Irrigation rates in Australia

3.3 ML/ha
0.27 ML/t

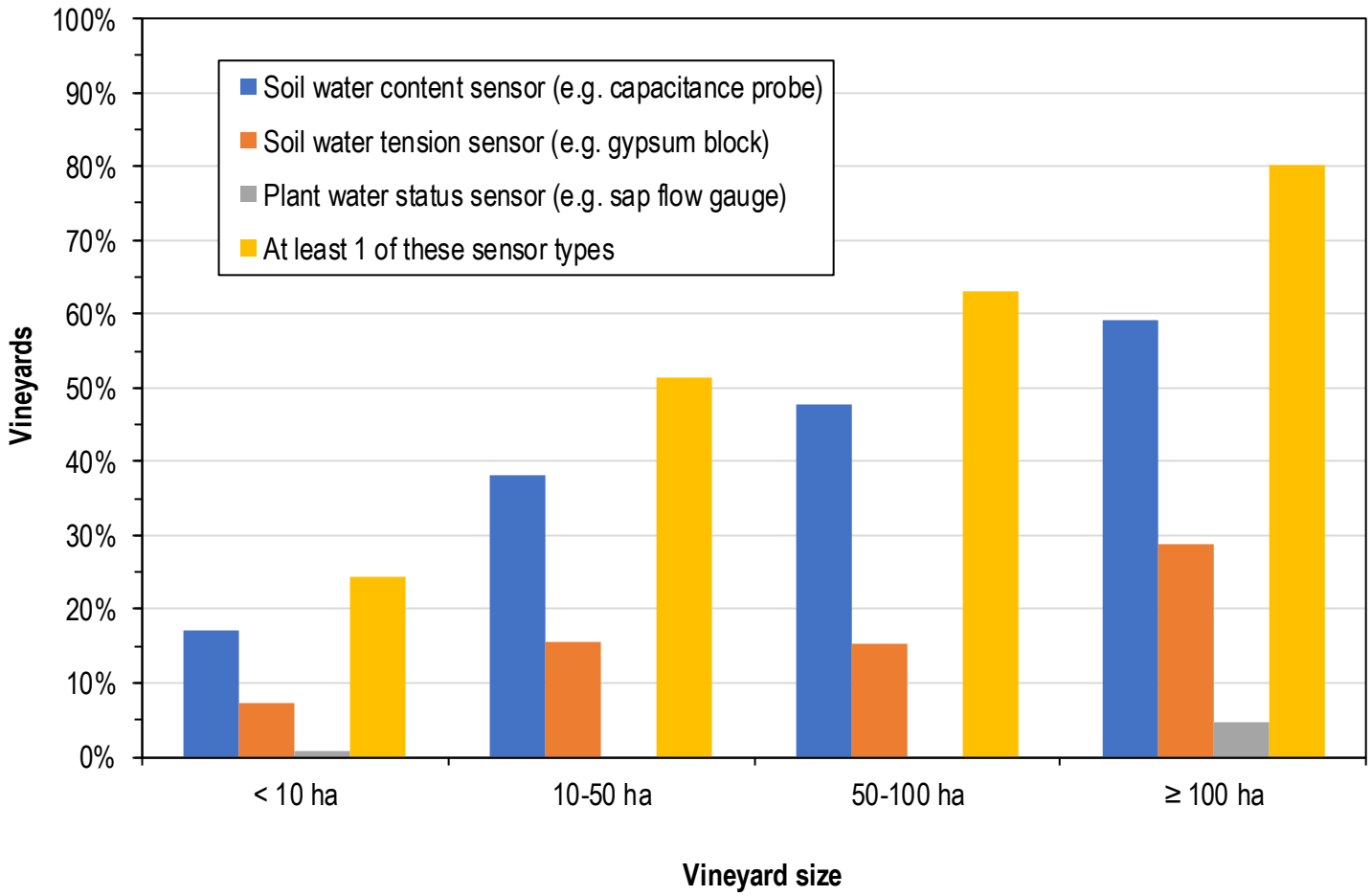
- **Vineyard irrigation sources:**

Irrigation channels or pipelines	47%
Rivers, creeks or lakes	36%
Groundwater	9%
On-farm dams or tanks	4%
Town or country mains	2%
Recycled from off-farm	1%
Other	1%

- Irrigation rates on hectarage and tonnage bases show very different patterns. For example, irrigation rates in warm inland regions were 350% higher than cool/temperate regions per hectare, but only 40% higher per tonne of grapes.

*ABS data from 1329.0.55.002, 2014-2015. Irrigation rates are based on water used, bearing hectares and tonnes harvested. The summary of vineyard irrigation sources is an aggregate Australian result.

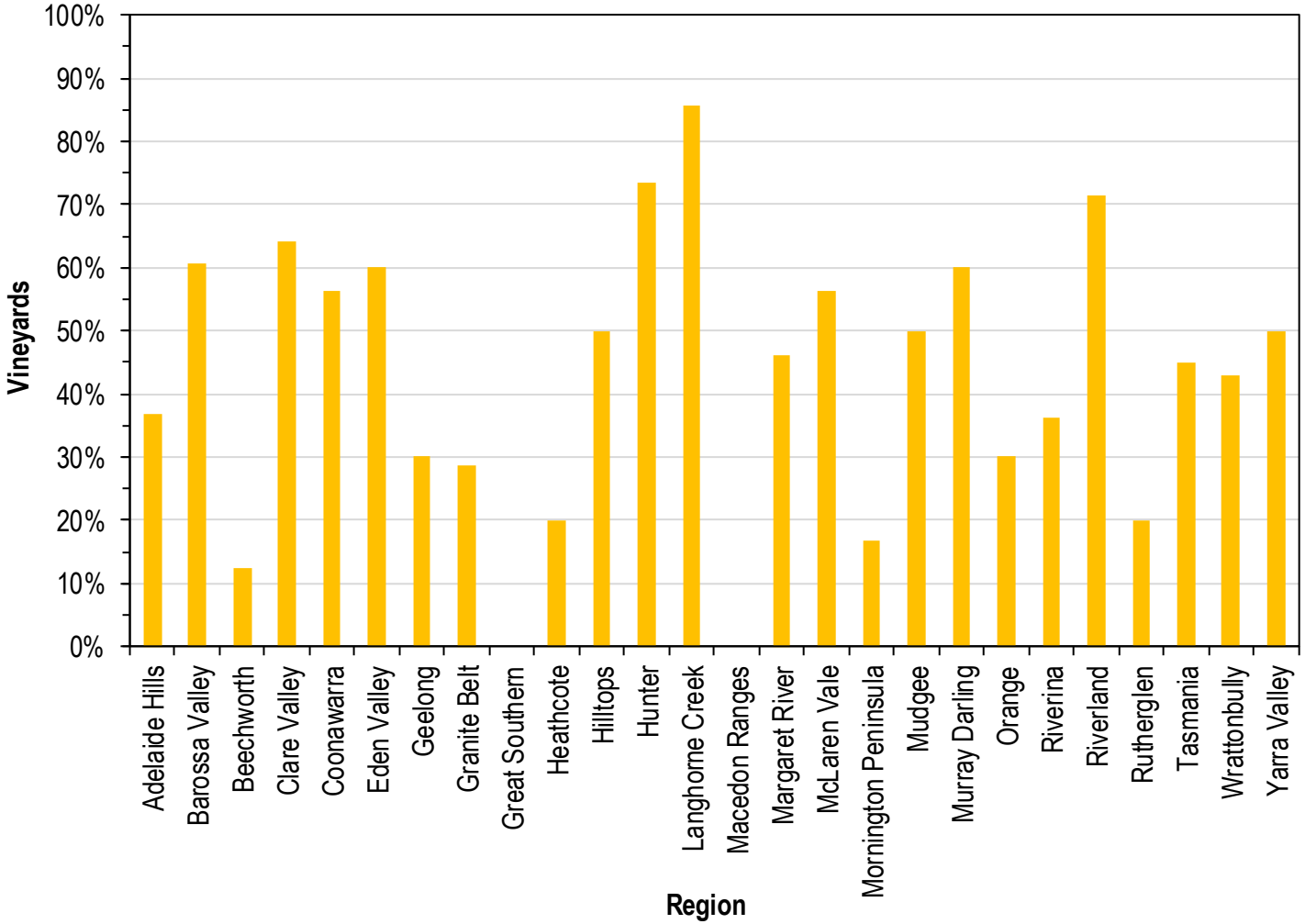
Water sensors in irrigating vineyards (used at all)



- Larger vineyards were more likely to use sensors and water content sensors were more common than water tension sensors.
- One respondent noted that they would buy capacitance probes because they might last 15 years, while a gypsum block needs to be replaced every four years.
- A couple of respondents noted that they do not use sensors because they are expensive to manage.
- Some other respondents noted that they had installed cloud-based irrigation software that allows them to view and activate irrigation remotely from their phone.
- **New soil moisture probes and irrigation controls were the second most common technology nominated by vineyards as having had a positive impact on their operation in the last five years (see page 70).**

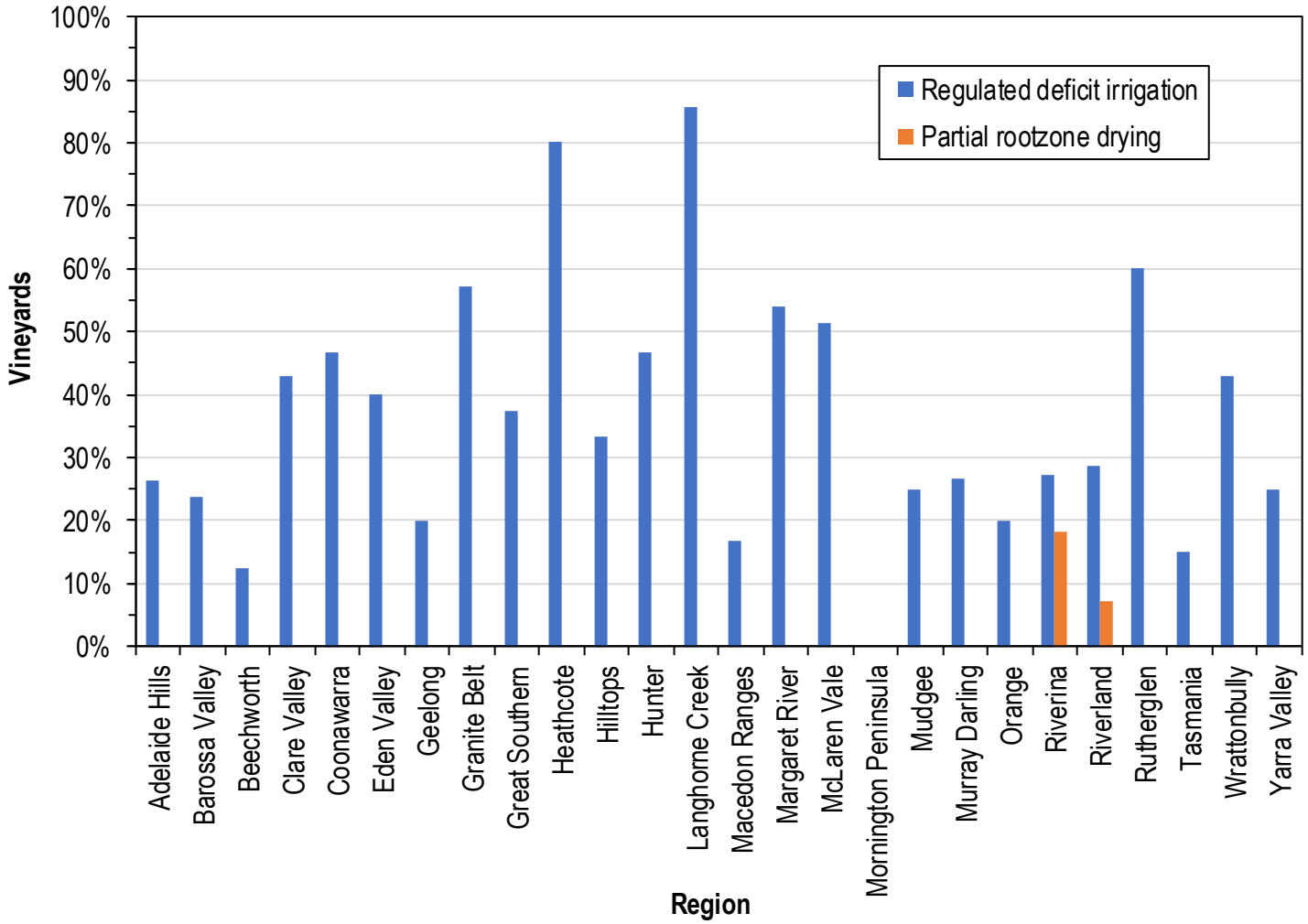
*The question asked whether any irrigation was performed in the growing season, and if respondents answered yes, they were asked to select whether different scheduling tools were used.

Water content/tension sensors in irrigating vineyards (used at all)



- The fraction of irrigating vineyards that used at least one water sensor type varied by region.

Regulated deficit irrigation and partial rootzone drying in irrigating vineyards (used at all)



- The following definitions were provided in the question:

  Regulated deficit irrigation: use of a regulated mild water stress at key stages of fruit development to reduce vegetative growth and improve berry ripening and thus improve grape quality.

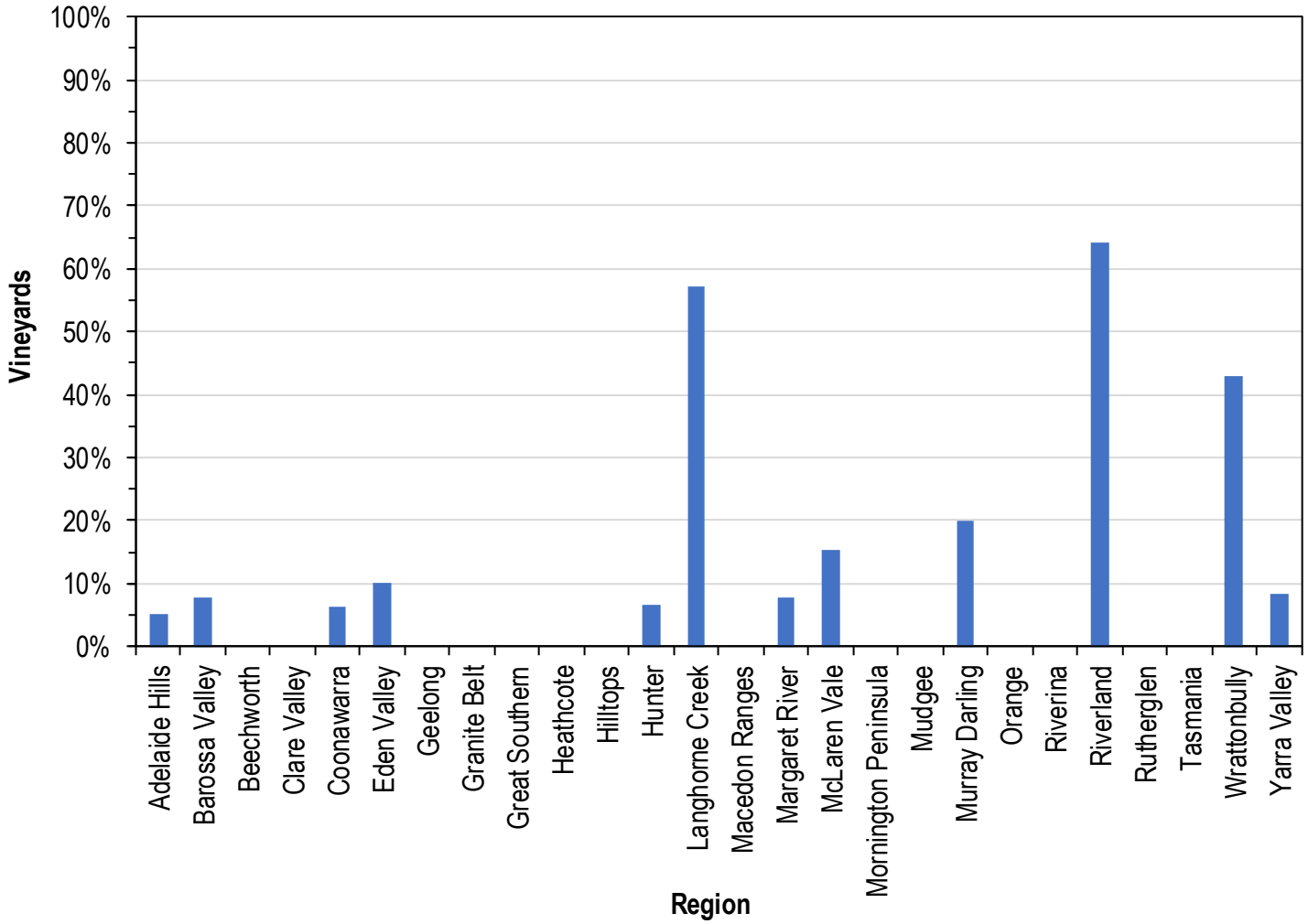
  Partial rootzone drying: alternatively wetting and drying two parts of the vine root system in order to control vegetative growth while maintaining yield and quality – performed using two irrigation lines per row.

- 40% of respondents using one of these techniques did not report using an irrigation sensor in their vineyard.

- Follow-up discussions were held with three growers that reported using partial rootzone drying. One had used the technique with cherries and had continued after switching the block to grapes, and two growers were using furrow irrigation and had always alternated between furrows on either side of the vine.

*Respondents who had selected that they irrigate were asked to select if these irrigation strategies were used.

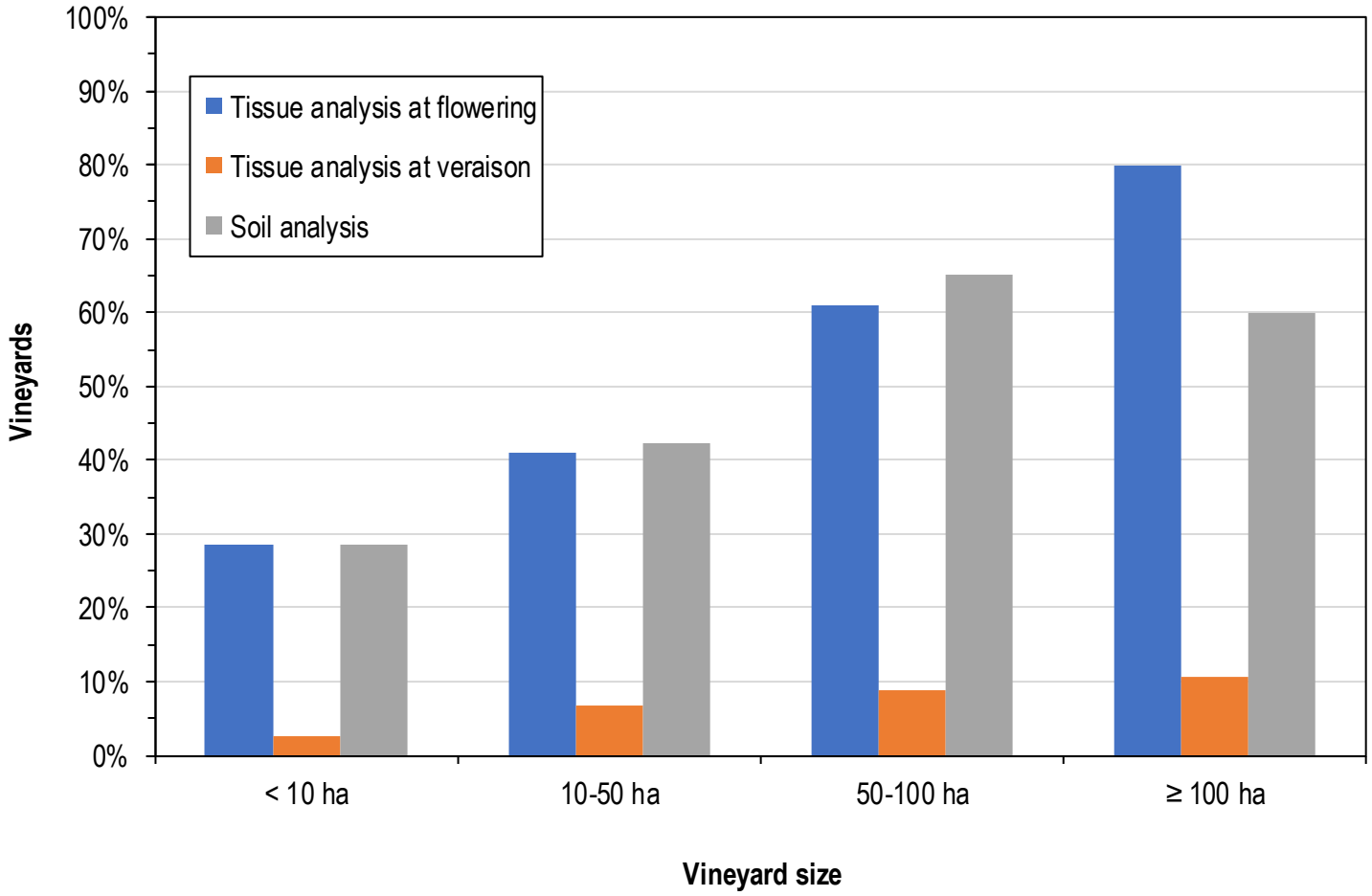
Leaching irrigations in irrigating vineyards (performed at all in 2015)



- Leaching irrigations were performed in some regions, but not in others.

*Respondents who had selected that they irrigate were asked if they performed any leaching irrigations in 2015.

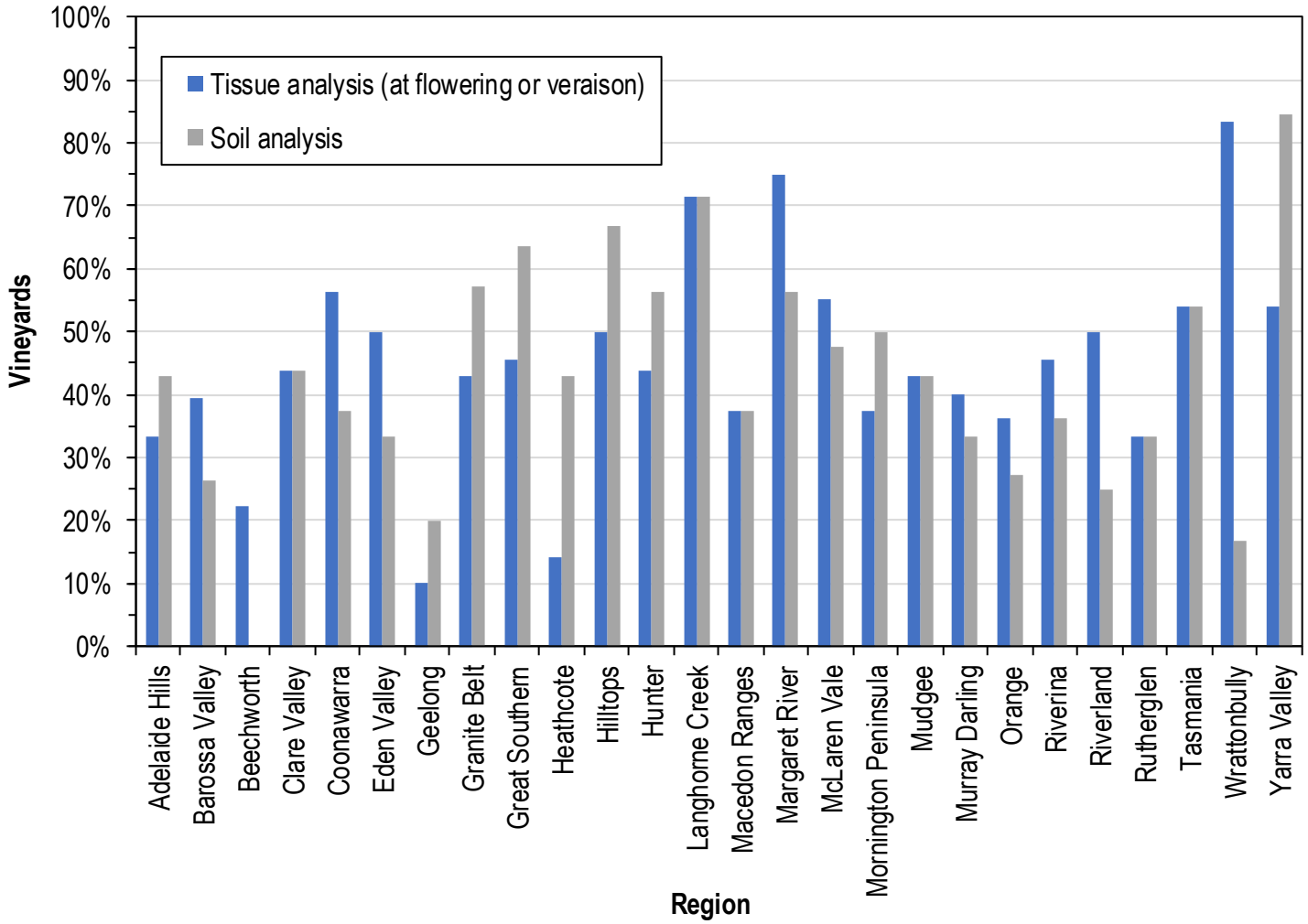
Nutrition testing (used at all)



- Tissue and soil analysis were more common in larger vineyards.
- Tissue analysis at flowering was much more common than at veraison.
- Many other respondents also mentioned visual observations for assessing vine nutrition and a couple mentioned YAN analysis of juice after harvest.

*Respondents were asked to select which nutrition testing methods were used during the growing season.

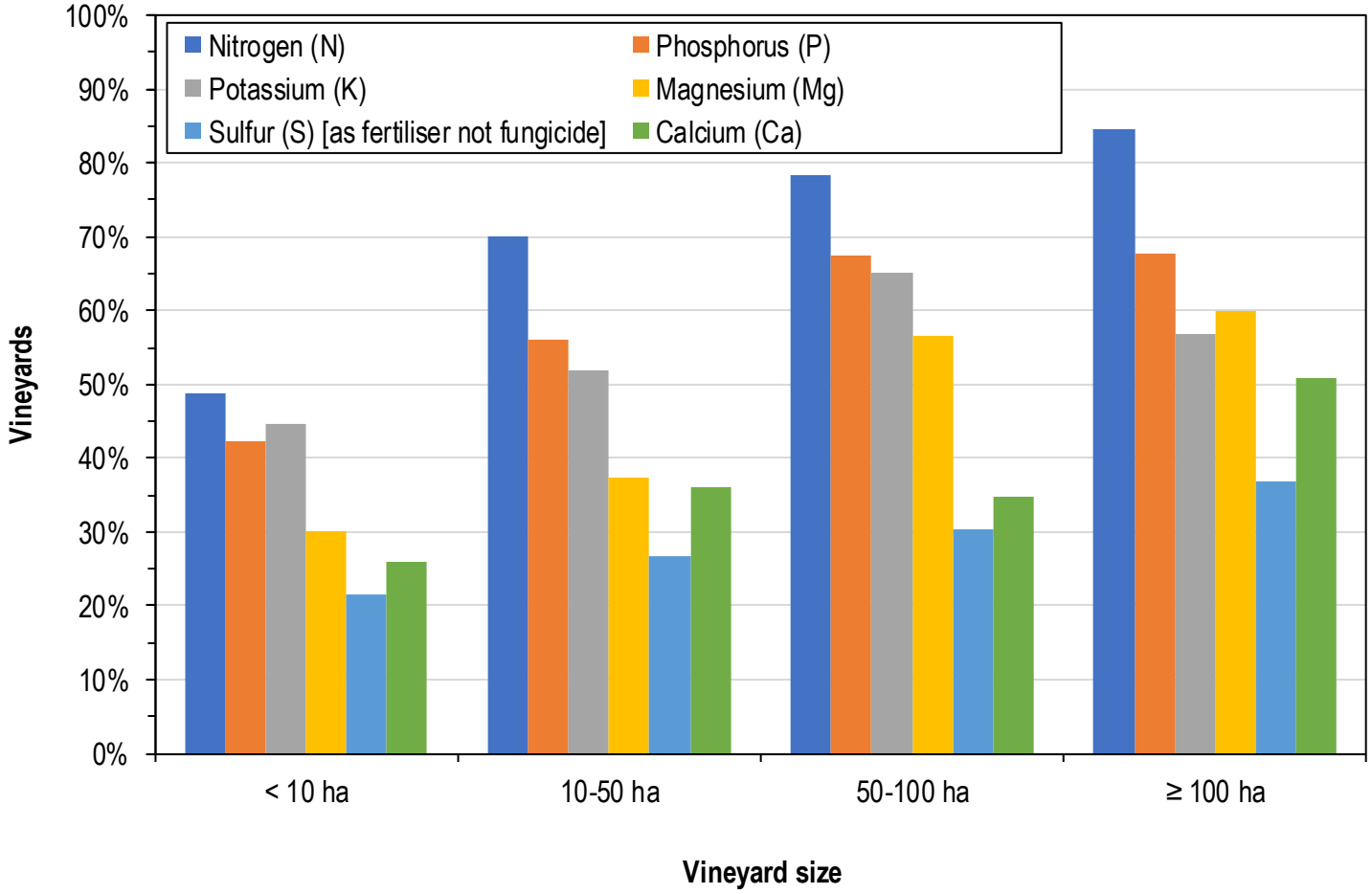
Nutrition testing (used at all)



- Tissue and soil analysis use shows some regional variability - this may be partly related to vineyard size.

*Responses for tissue analysis at flowering and veraison have been aggregated.

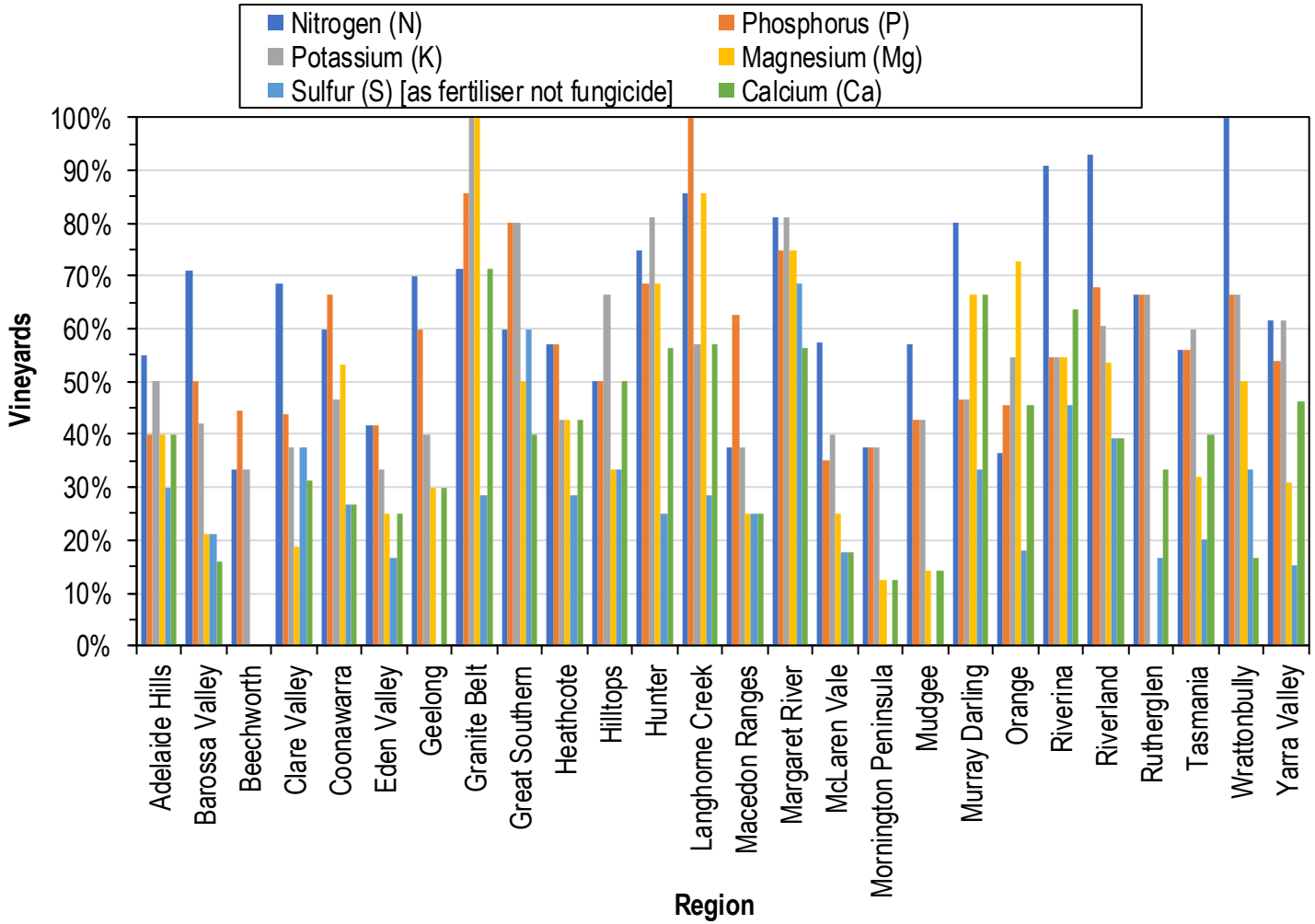
Macronutrients (applied at all)



- Nitrogen, phosphorus, potassium and magnesium were the most commonly applied macronutrients.
- Larger vineyards were more likely to have applied macronutrients in at least one of their blocks.
- The survey does not consider application rate. One respondent noted that while they apply a comprehensive set of macronutrients and micronutrients, the quantities that they apply are small and that fertiliser quantities are much smaller in viticulture than in broadacre farming.

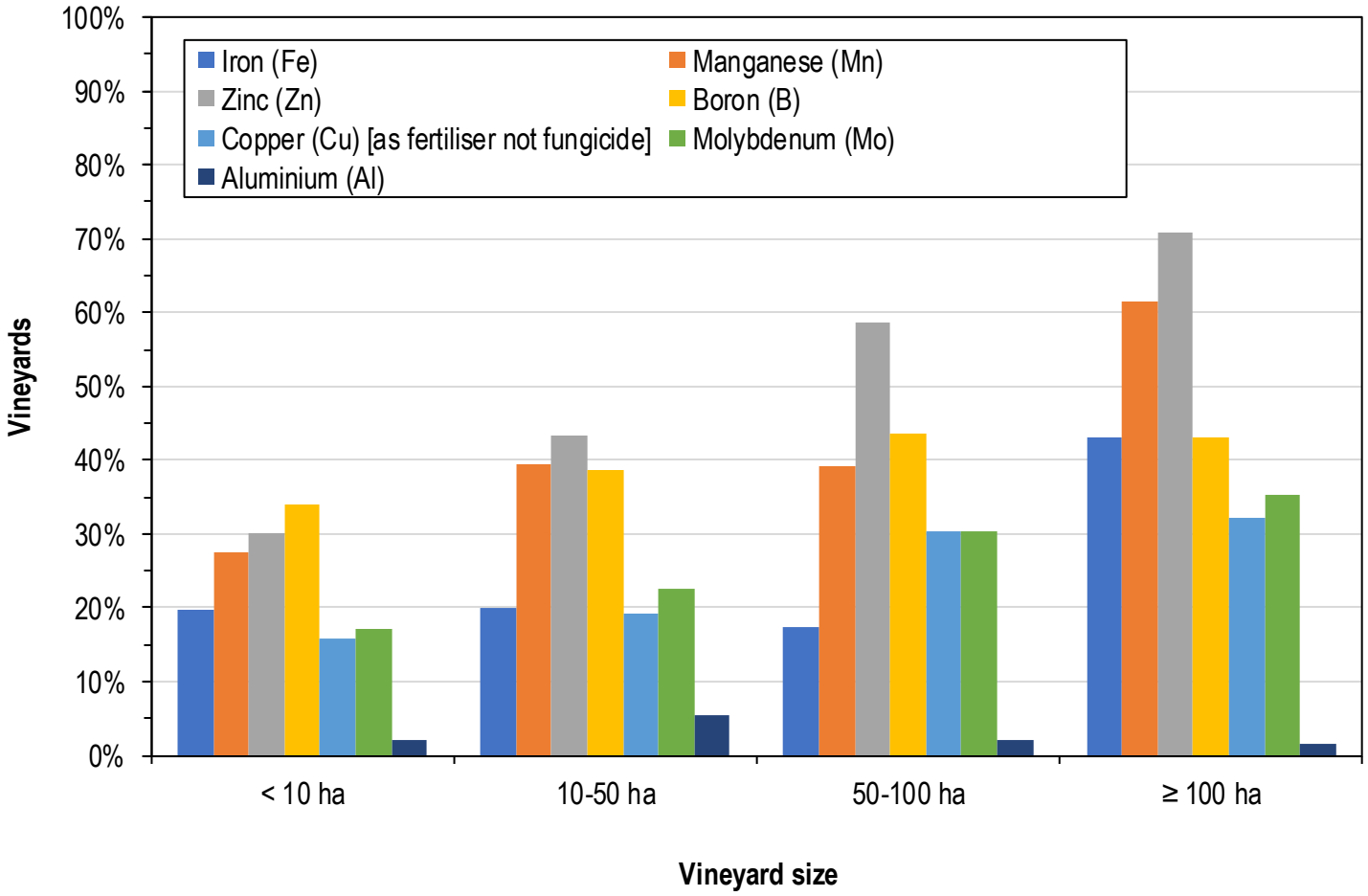
*Respondents were asked to select which nutrients were applied during the growing season.

Macronutrients (applied at all)



- There was some regional variability in macronutrient application.

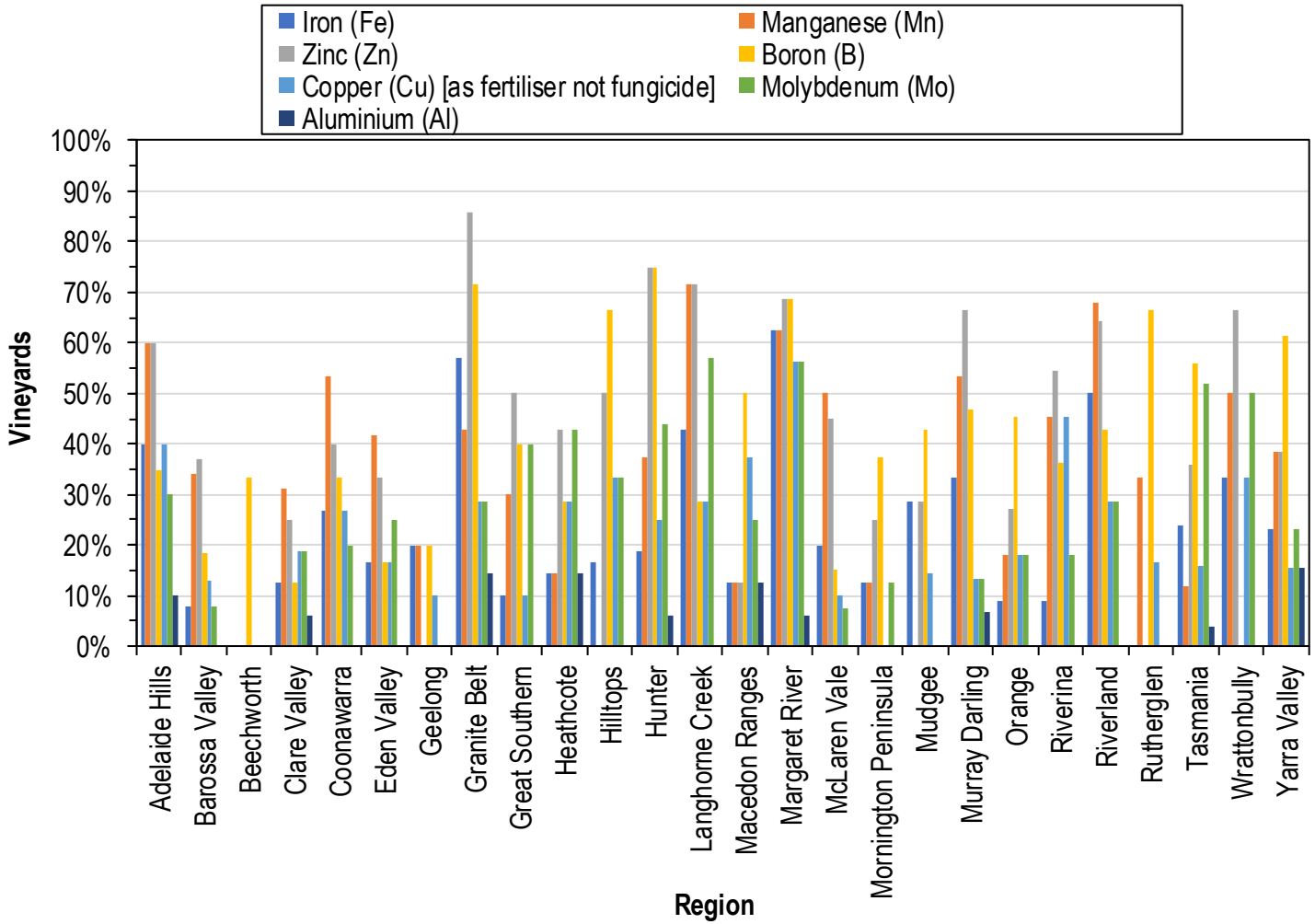
Micronutrients (applied at all)



- Zinc, manganese and boron were the most commonly applied micronutrients.

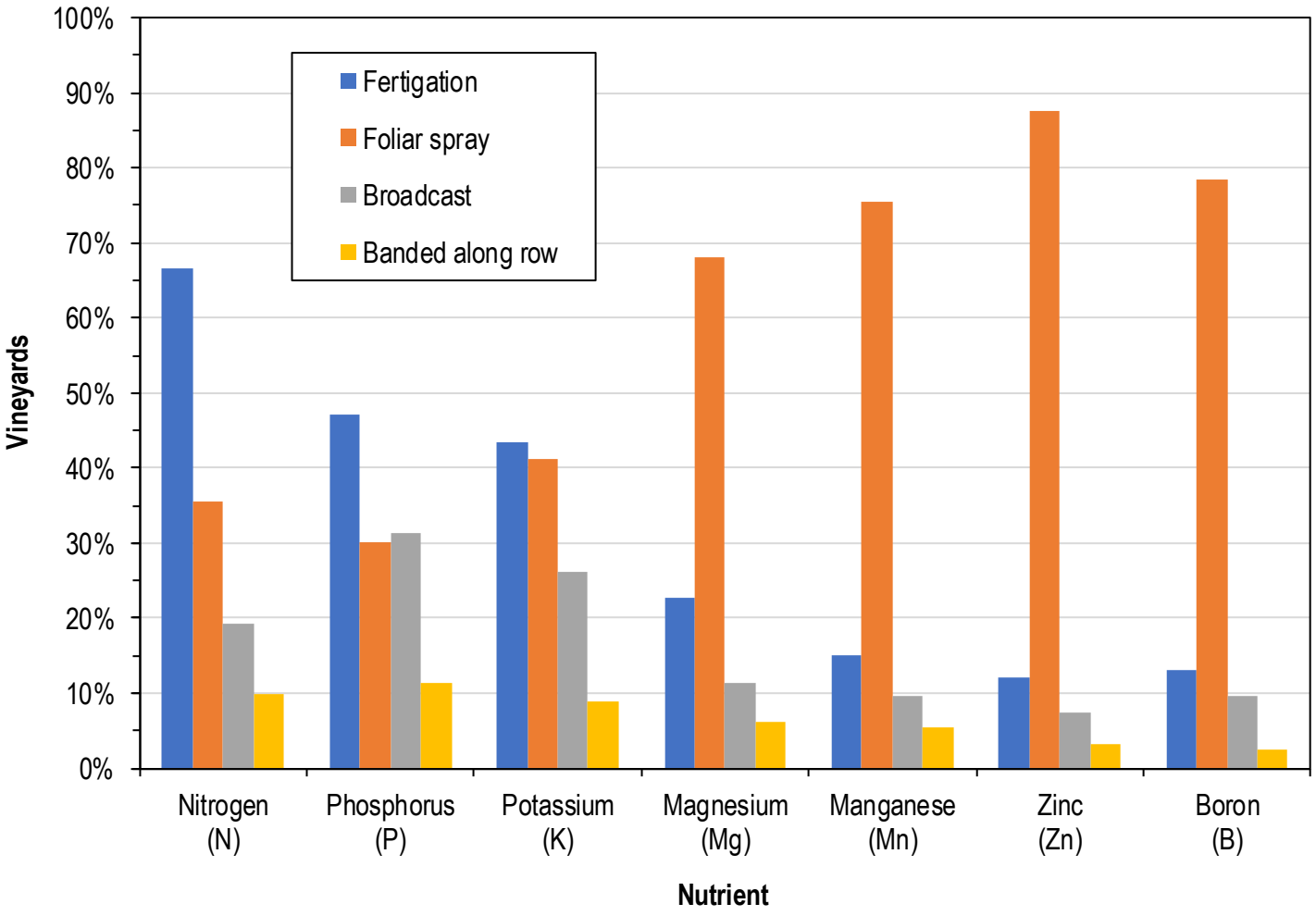
*Respondents were asked to select which nutrients were applied during the growing season.

Micronutrients (applied at all)



- There was some regional variability in micronutrient application.

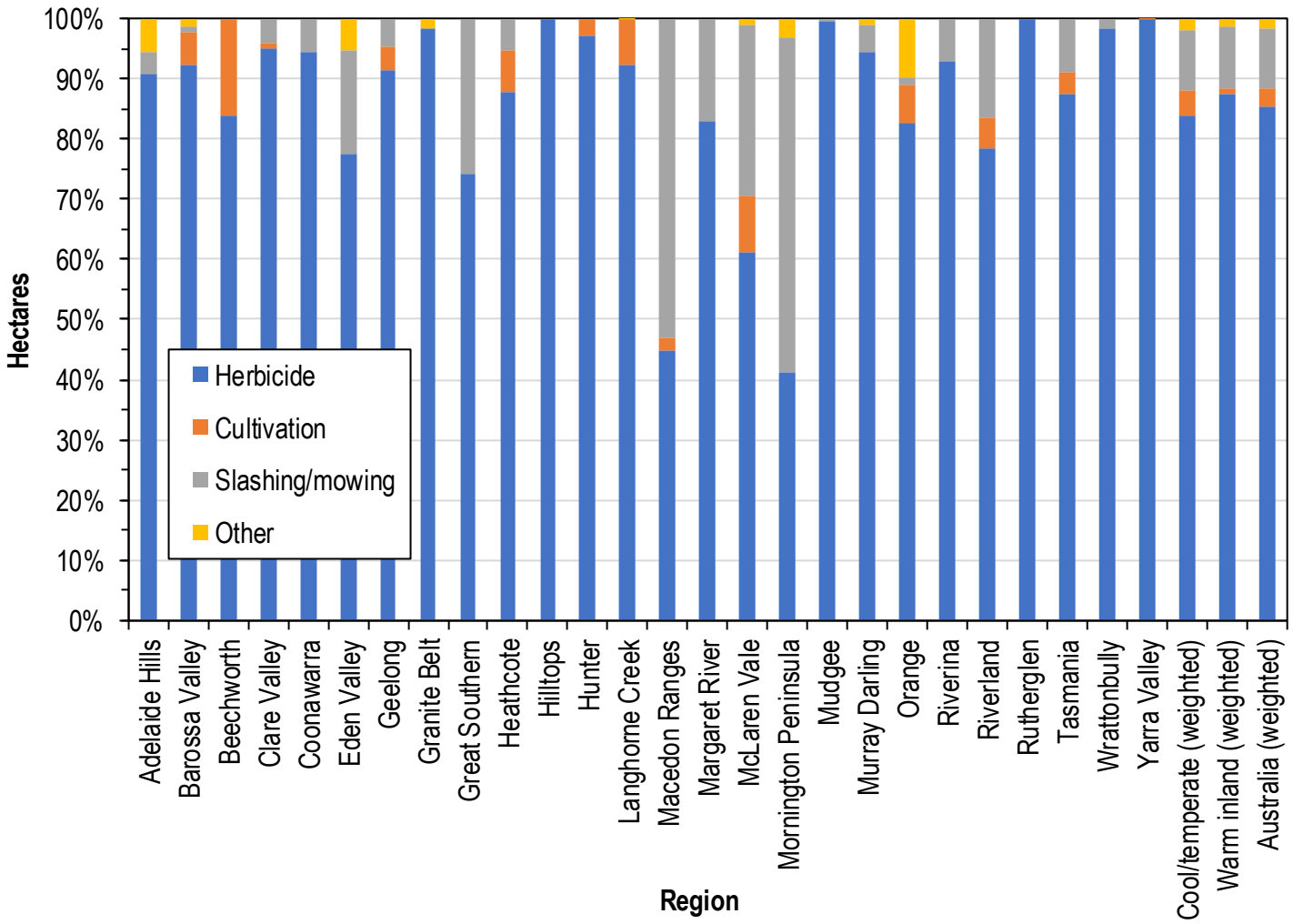
Nutrient application methods (used at all)



- Magnesium and major micronutrients were most commonly applied via foliar sprays.
- Major macronutrients were most commonly applied by fertigation, but some vineyards also applied macronutrients via foliar sprays.
- One respondent that applied nitrogen both by fertigation and foliar sprays noted that the foliar application gave more of an instant response.
- Other producers applying nitrogen only by fertigation noted that foliar nitrogen additions were not very effective apart from making the leaves look good and that it would be difficult to get as much nitrogen in as needed without burning the vines.
- The survey did not collect information on application rates.
- One respondent that previously added just the micronutrients they needed based on testing was moving to a liquid multi-trace blend for health and safety reasons to avoid lifting bags of individual micronutrients.

*Respondents were asked to select which methods were used to apply each of the nutrients that they had indicated they used.

Under-vine strip management



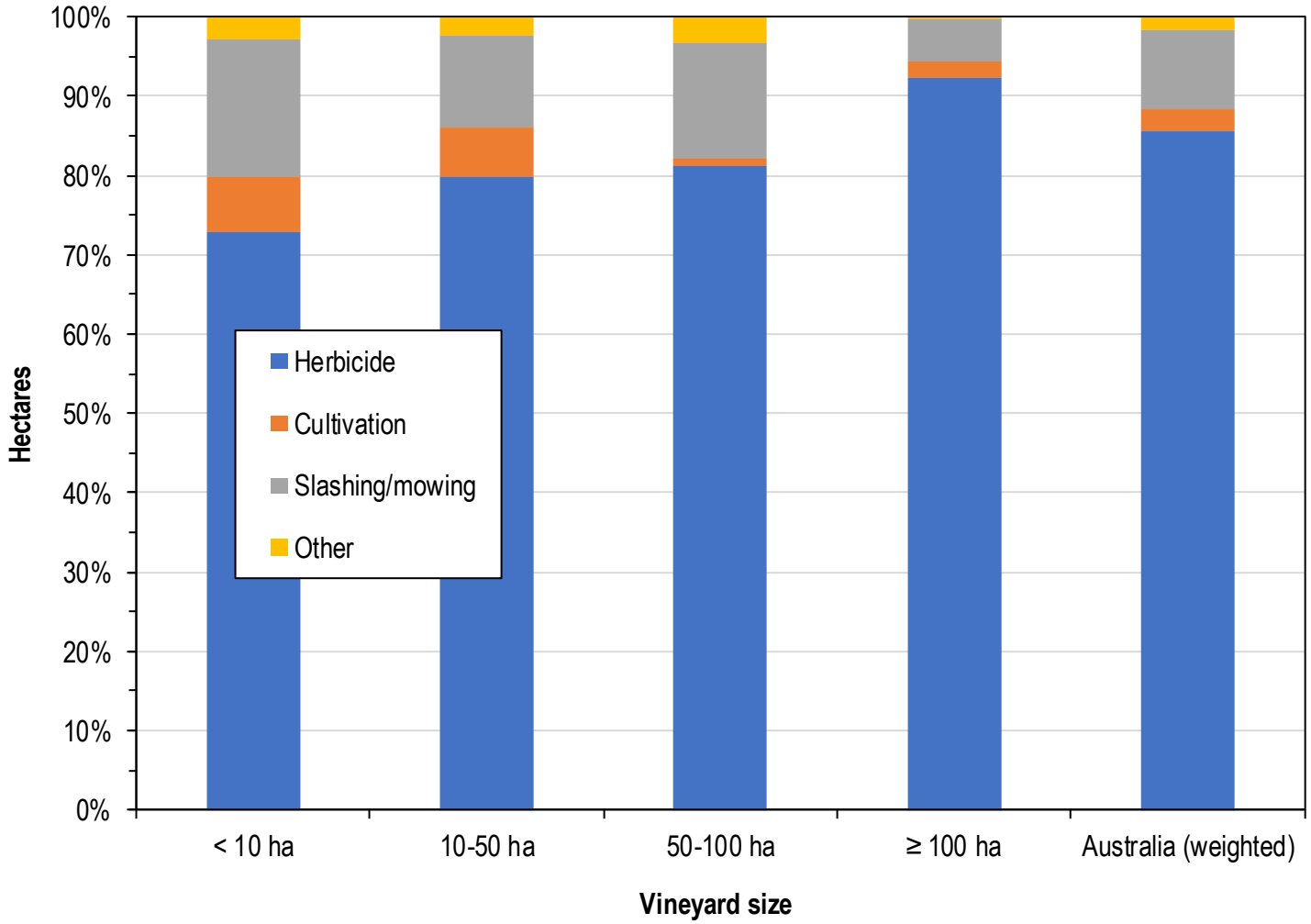
Under-vine strip management in Australia

85% herbicide

- Herbicide was the main method of under-vine strip management.
- In some regions, slashing/mowing and to a lesser extent cultivation were used.
- The question was a little simplistic and the techniques used are likely to be influenced by other factors such as the use of mulching (pages 54-55).

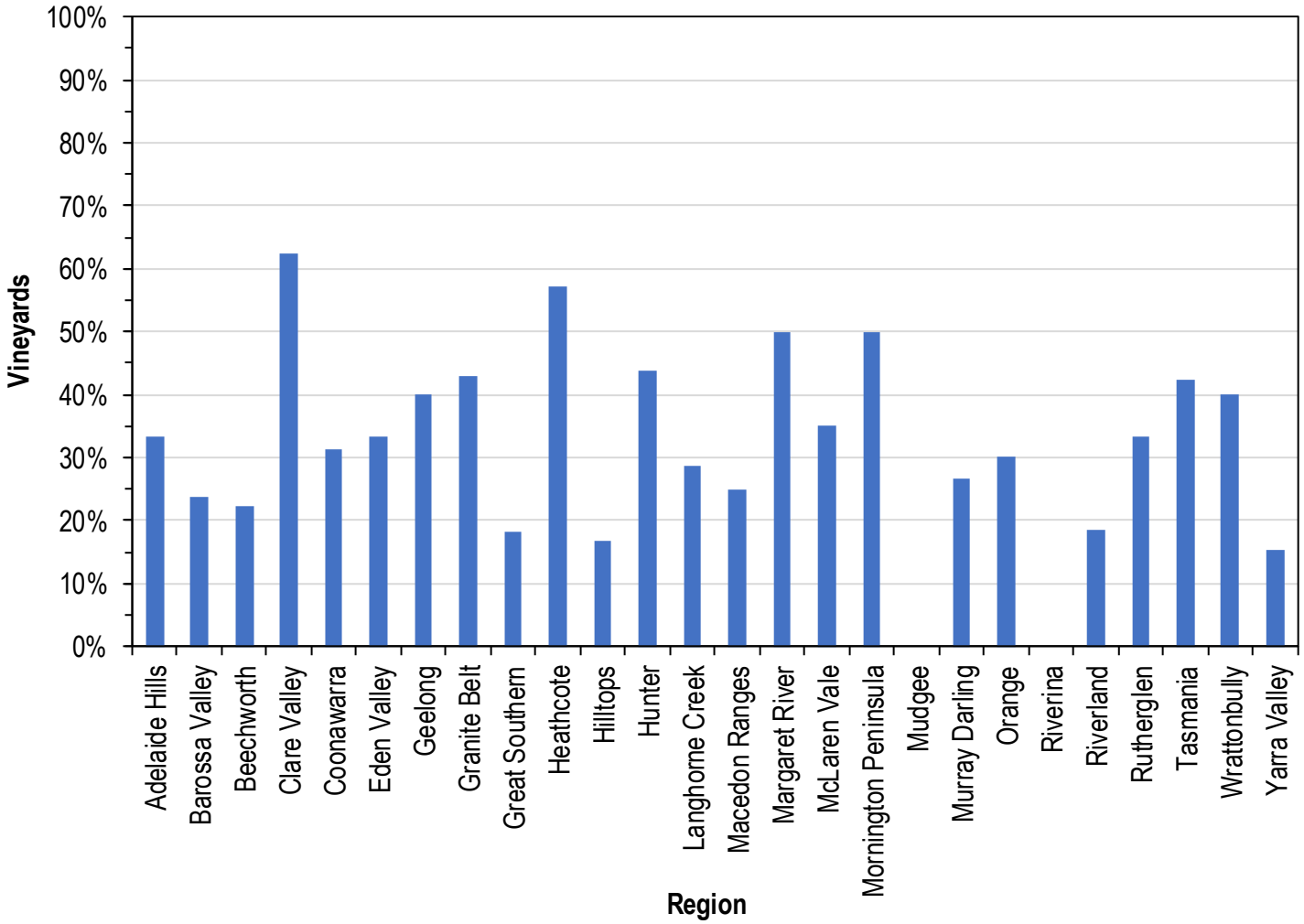
*Respondents were asked to select what under-vine management methods were used for the growing season and were able to select from herbicide for all blocks, cultivation for all blocks, slashing/mowing for all blocks or a combination of techniques. If they selected a combination of techniques, they were asked to record the areas managed with the different techniques.

Under-vine strip management



- Vineyard size had a small influence on under-vine management with smaller vineyards being slightly more likely to use slashing/mowing or cultivation.

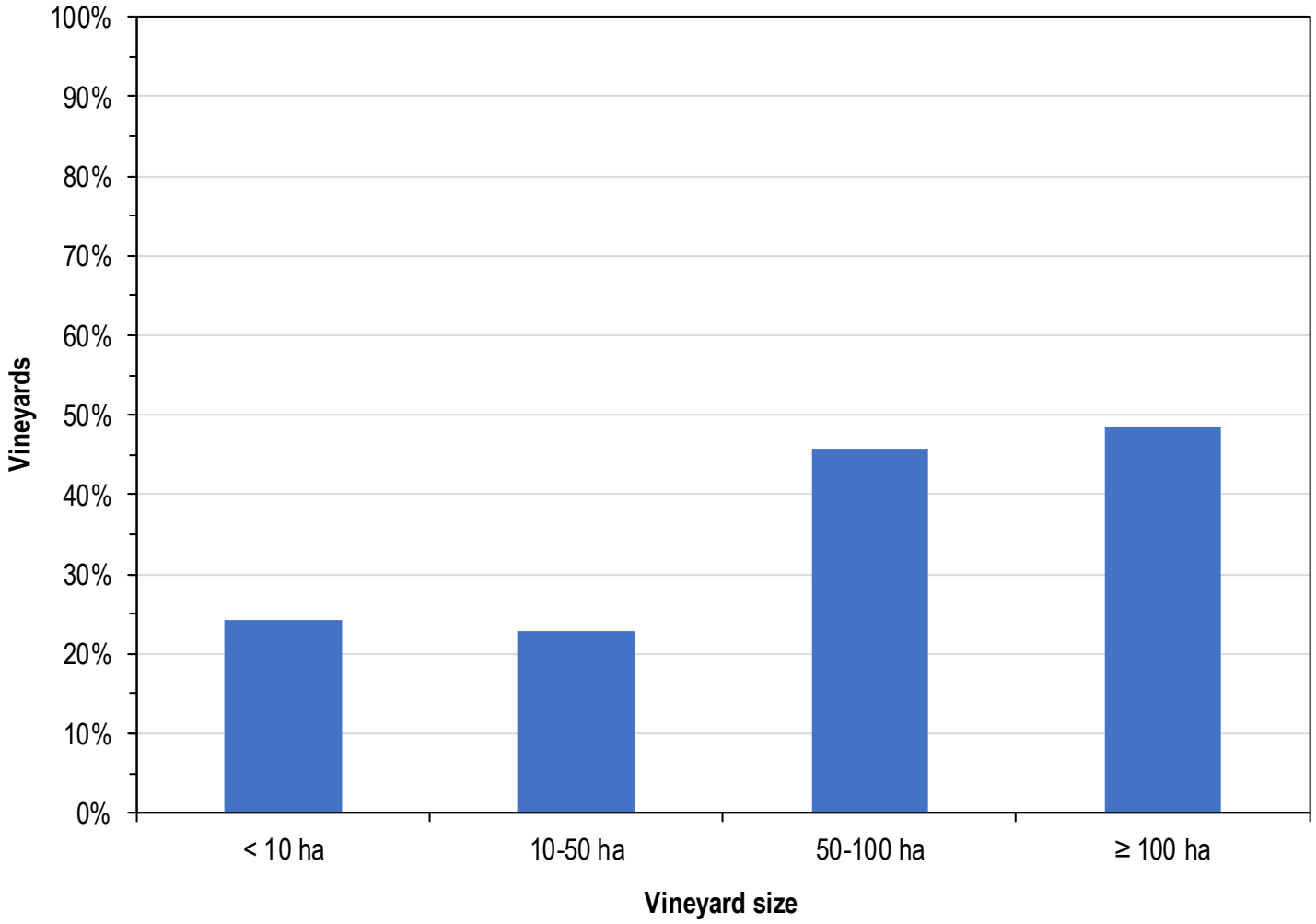
Under-vine strip mulching (used at all)



- Many producers added mulch under-vine to part of their vineyard.
- A range of different mulches were mentioned by producers in follow-ups, including straw mulch, wood chip mulch and prunings mulch.
- The under-vine area mulched each year is likely lower than the data suggests at first glance because many producers who indicated that they performed mulching at all were often only mulching part of their vineyard (and doing this each year such that after a certain number of years, all of it received some mulch).

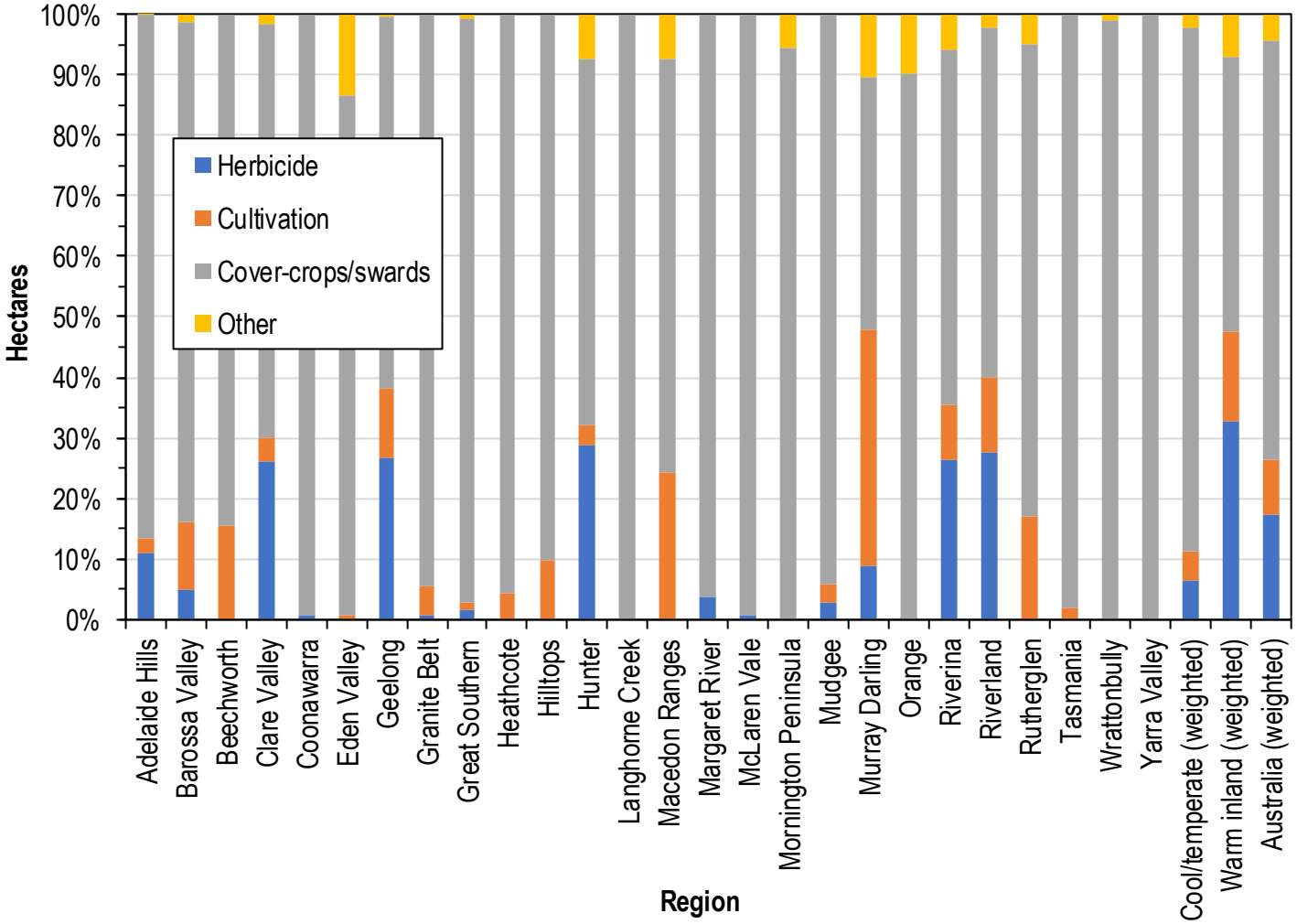
*Respondents were asked whether any mulch was applied to under-vine strips during the growing season.

Under-vine strip mulching (used at all)



- Whether mulching was performed at all was influenced by vineyard size.

Mid-row management



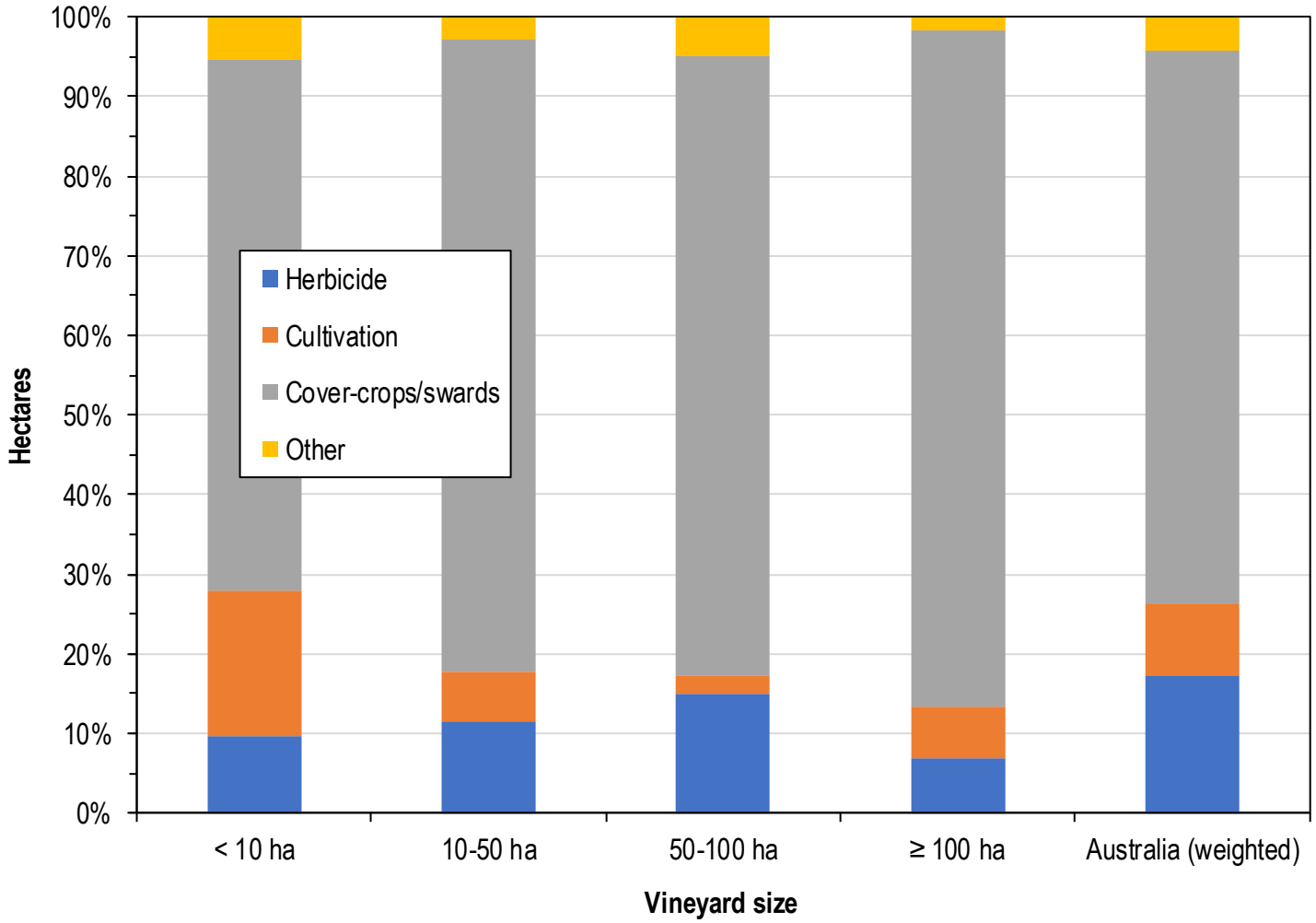
Mid-row management in Australia

69% crops/swards

- Cover-crops/swards were the most common mid-row management technique.
- Herbicide and cultivation were used to a lesser extent.
- How cover-crops/swards were managed was asked as a separate question if the respondent indicated some area was managed using cover-crops/swards (see page 58). There may be some overlap between these two questions.
- The questions relating to vineyard floor management may have been too simplistic and may not have captured the techniques cycled through at different times of the year.

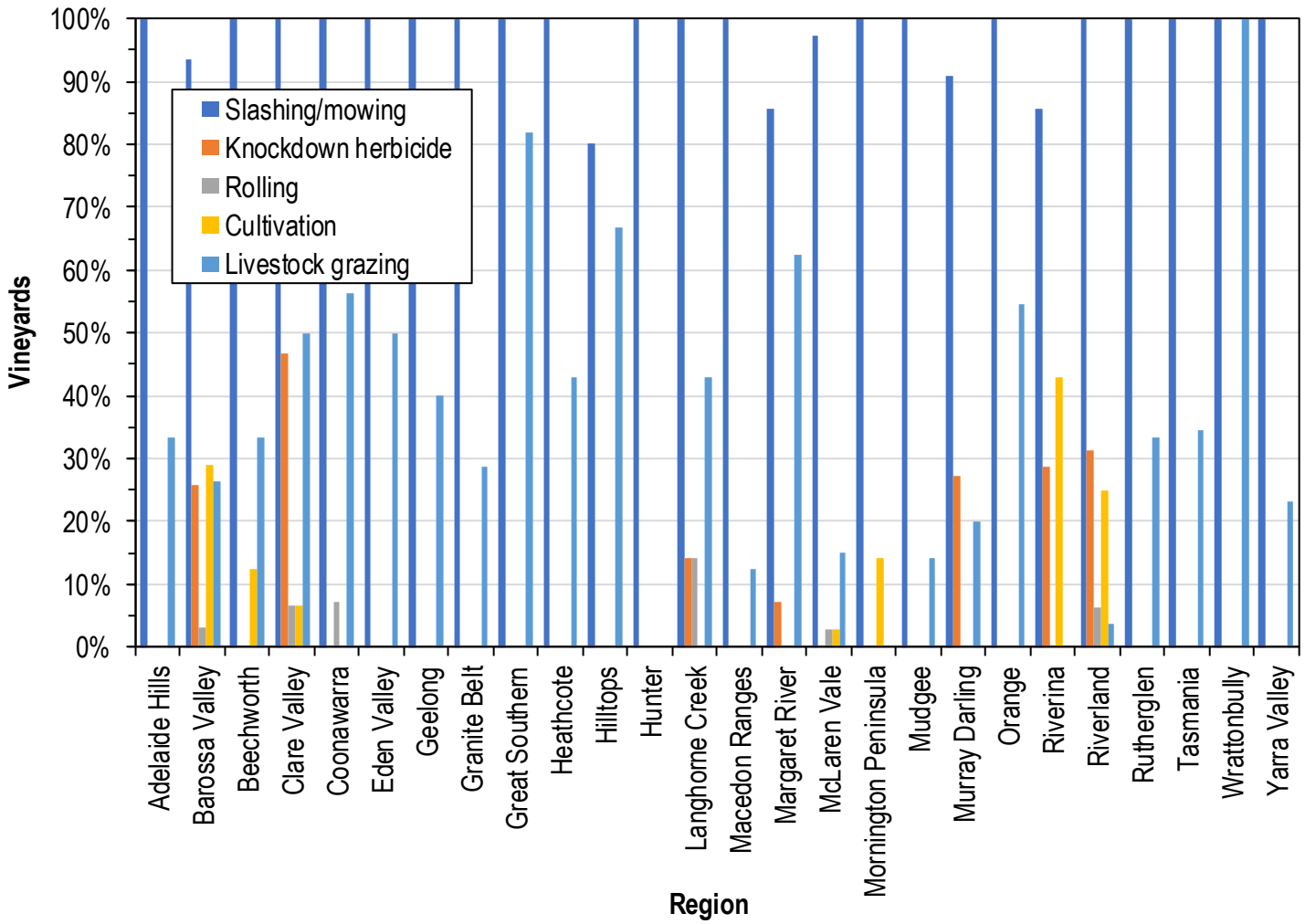
*Respondents were asked to select the mid-row management technique used for the growing season, choosing from the options herbicide for all blocks, cultivation for all blocks, cover-crop/swards for all blocks, or a combination of techniques. If they selected a combination of techniques, they were asked to record the area managed using the different techniques.

Mid-row management



- Use of cover-crops/swards dominated all vineyard sizes.
- Mid-row cultivation was more common in smaller vineyards.

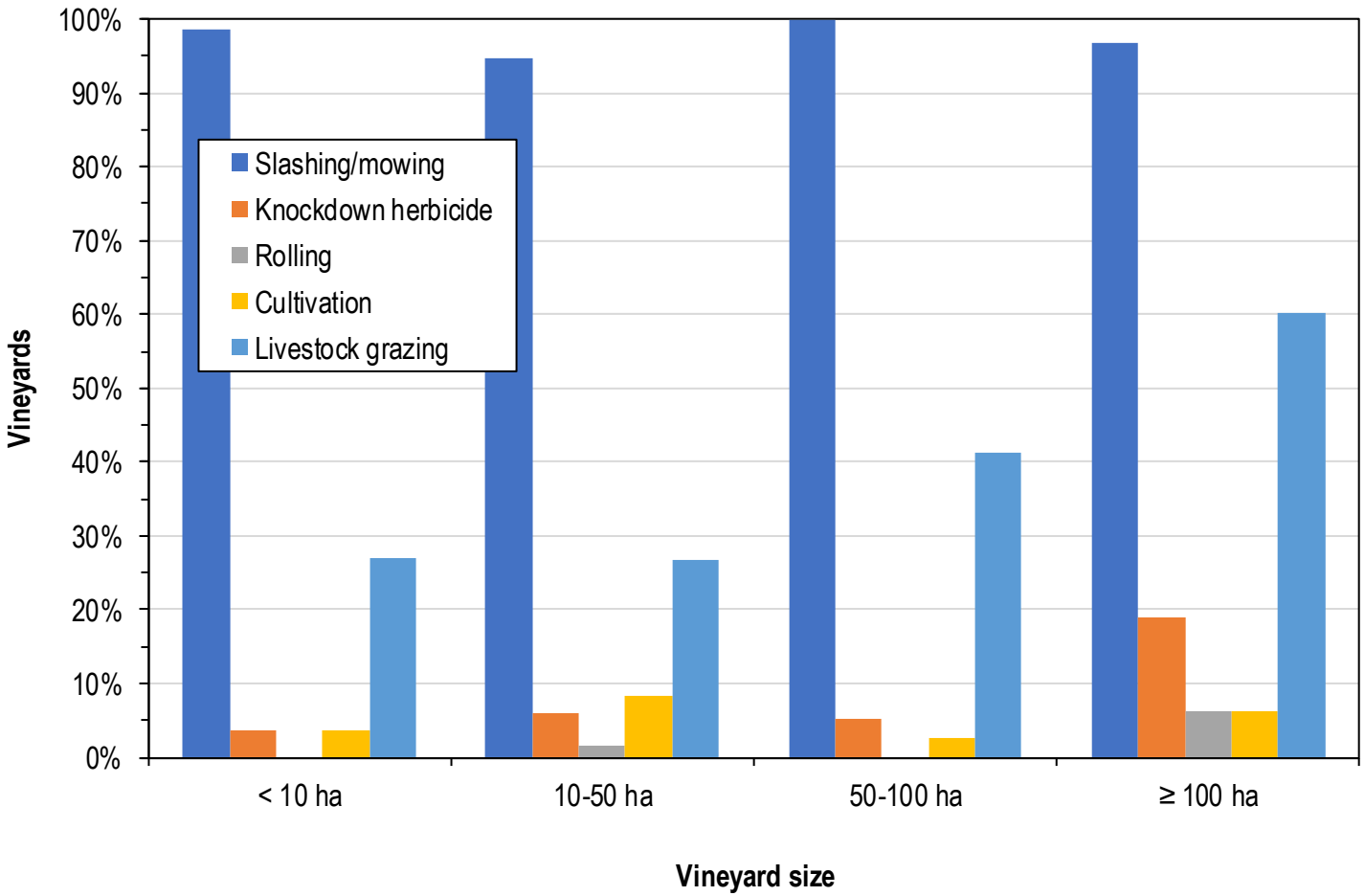
Management of grown mid-row cover-crops/swards (used at all)



- Slashing/mowing was the dominant technique for managing cover-crops/swards in all regions.
- Livestock grazing was the second most common technique.
- One respondent noted that livestock are good because they mean fewer tractor passes, and they remove some bulk material from under-vine, but that there can be some effort in getting livestock in, risks of them compacting the soil, damaging infrastructure and spreading weeds.
- Given the question on livestock mentioned the growing season, a small number of respondents may have selected no on the basis that grazing was conducted during dormancy.

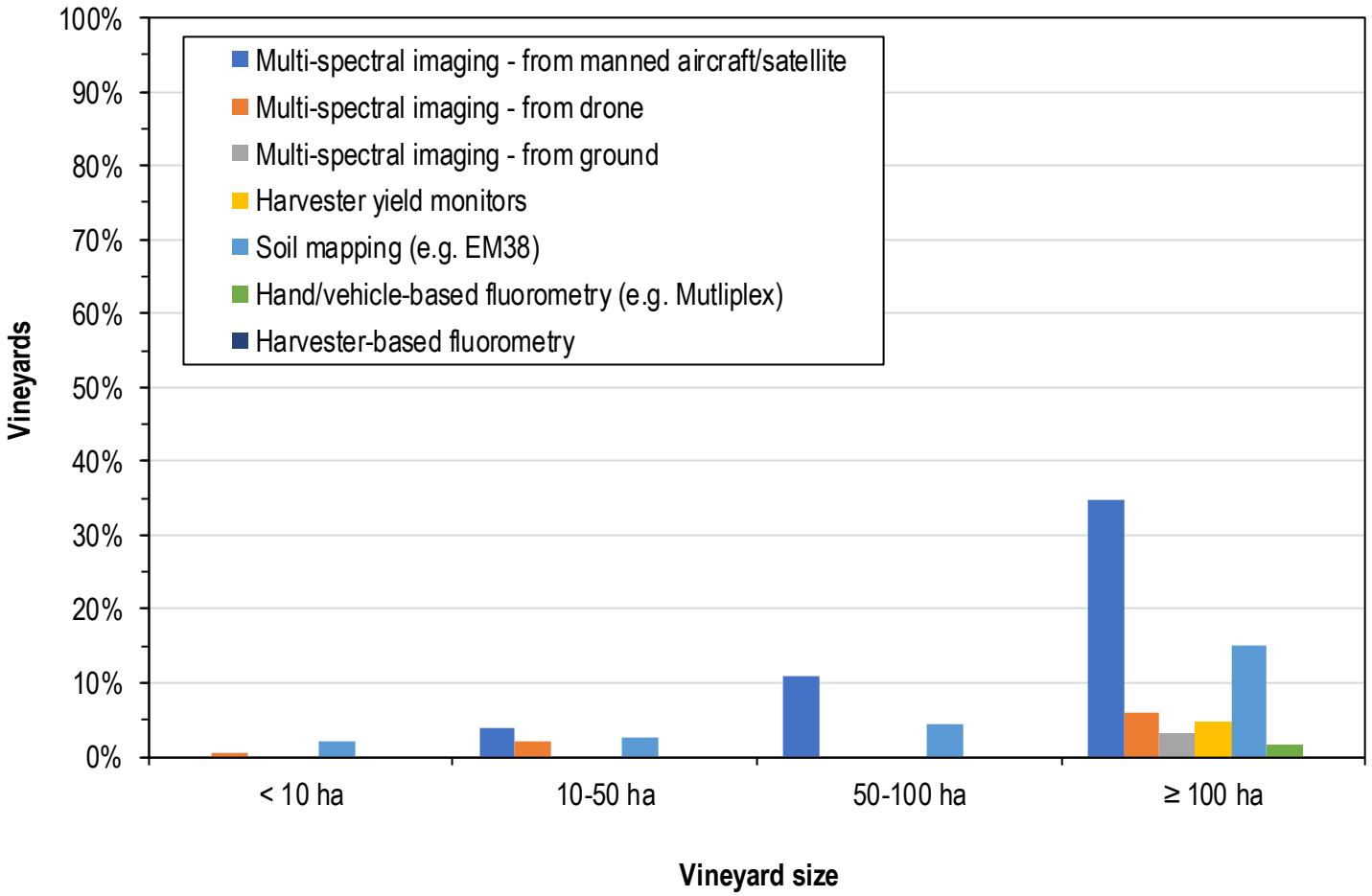
*Respondents that had indicated that they used some cover-crops swards were asked to select all the techniques that were used to deal with them once they had grown: slashing/mowing, knockdown herbicide, rolling, cultivation or other. A separate question asked whether any livestock were grazed in the vineyards during the growing season, but this has been aggregated into this analysis.

Management of grown mid-row cover-crops/swards (used at all)



- Slashing/mowing dominated all vineyard sizes.
- Livestock grazing was used most in the largest vineyards, perhaps partly because they have more blocks and a greater chance of the technique being applied.

Precision viticulture (used at all)

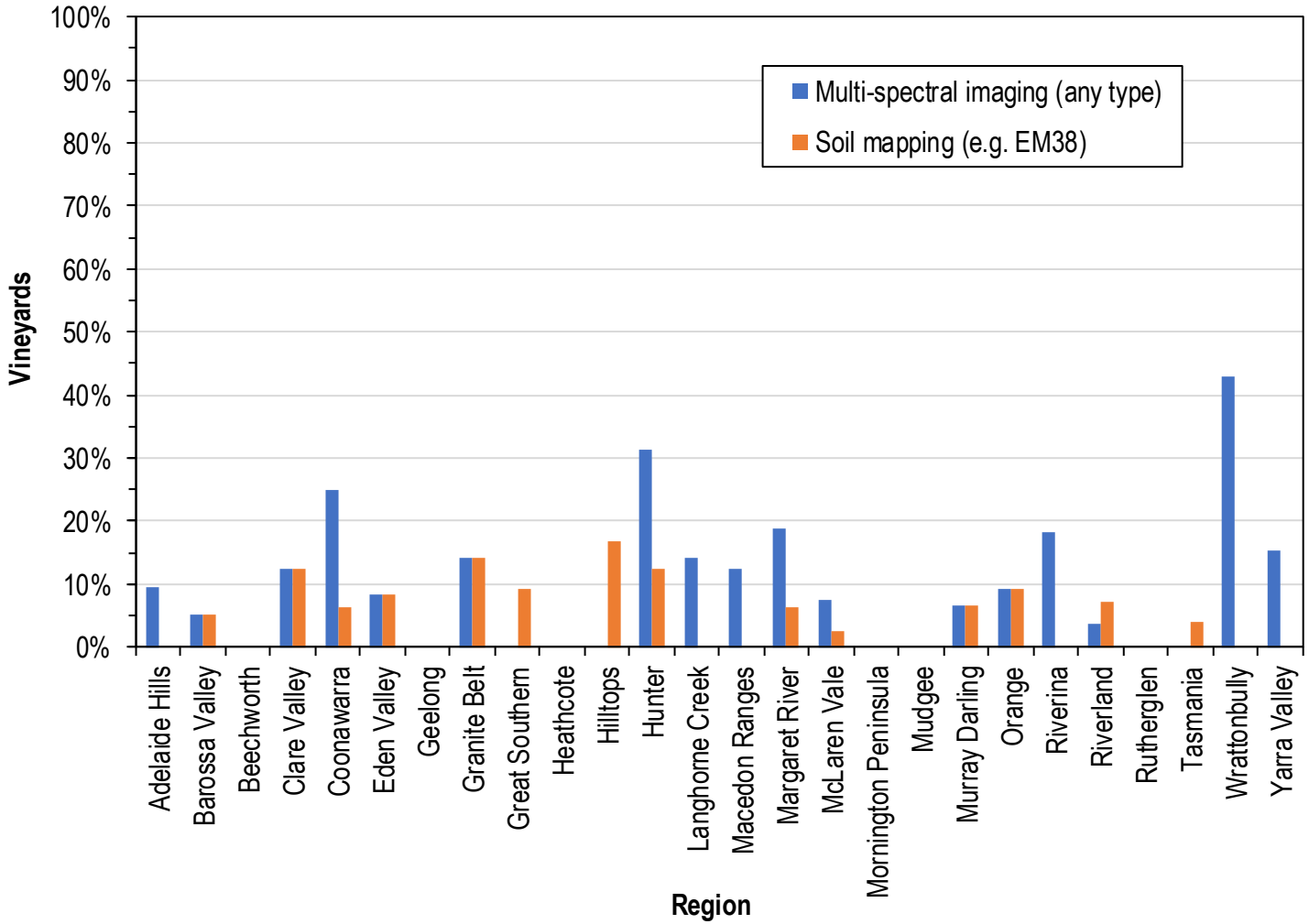


- Use of precision viticulture measurement techniques was low.
- Use was heavily dependent on vineyard size.
- Multi-spectral imaging from manned aircraft and soil mapping were the most common techniques used.
- End applications mentioned by respondents included split picking, split mulching and vineyard redevelopment.
- Use of harvester yield monitors was very low and some expressed sentiments that the available equipment is not robust enough for practical use.

(continued next page…)

*The question asked whether any precision viticulture techniques were used in the growing season and if respondents answered yes, they were asked to select which techniques were used.

Precision viticulture (used at all)



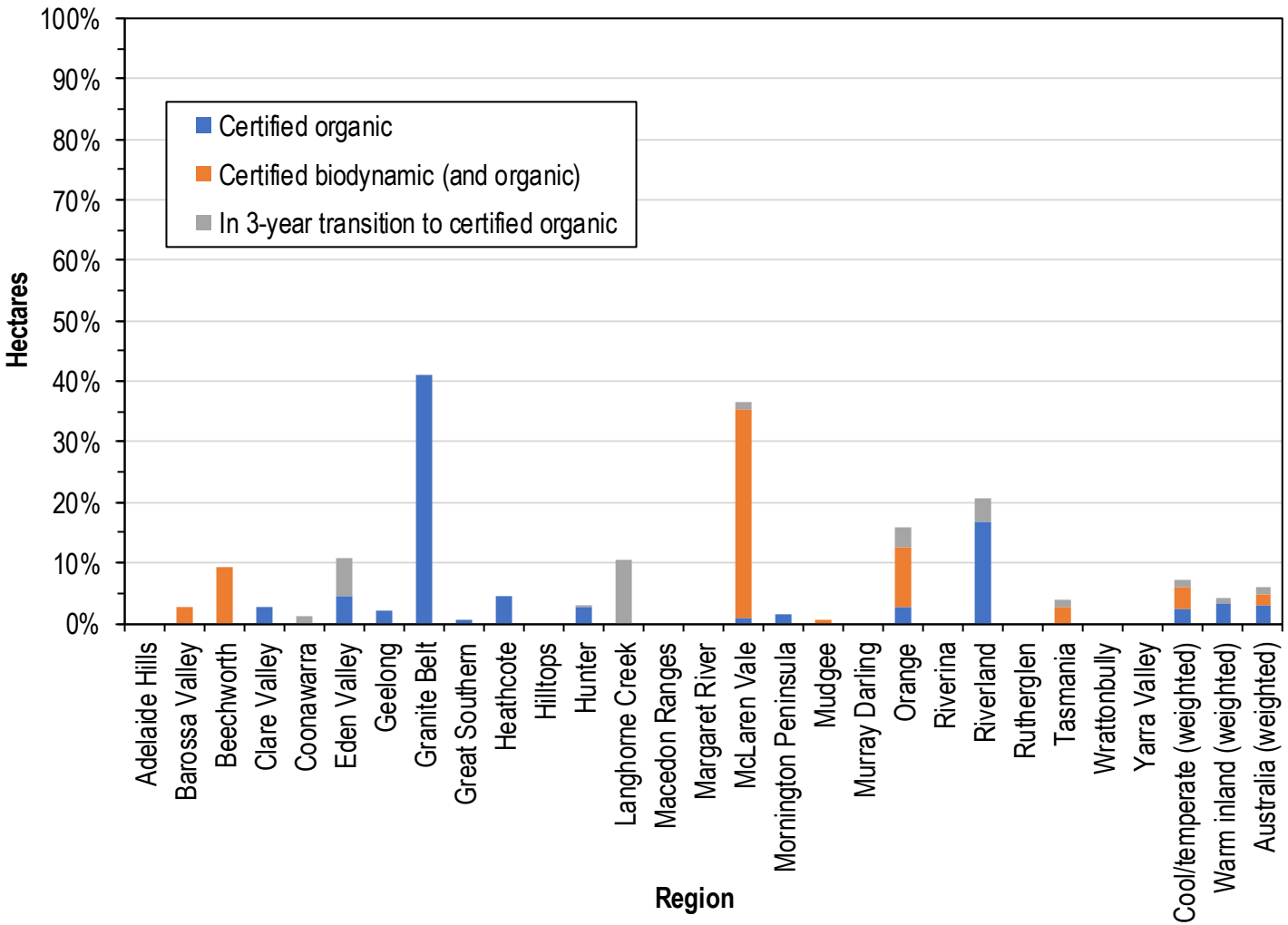
(…from previous page)

- Respondents that used multi-spectral imaging were generally positive about the value of the data that it provided.

Reasons given by those not using multi-spectral imaging:

- It is expensive.
- Long turnaround times mean it is too late to act on the results.
- It tells you where the areas of low vigour are, not what the yield is.
- Unless it is a very large vineyard, managers already have a good knowledge of the spatial variability.

Organic/biodynamic vineyard certification (vineyard)



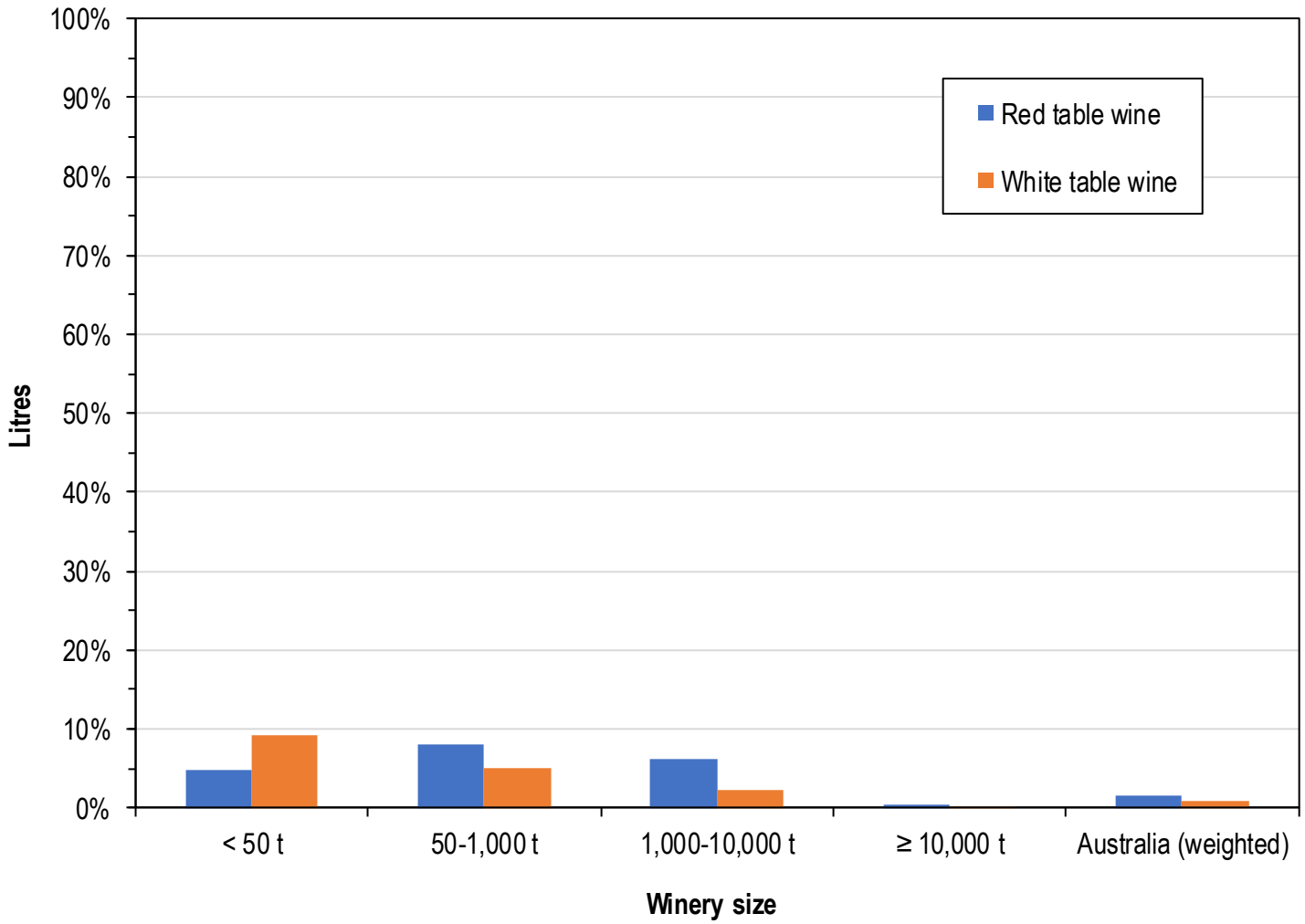
Australian vineyards

3% certified organic
2% biodynamic
1% in-transition

- While the area of certified organic vineyards was low, several respondents noted that they were generally using organic principles, just not seeking certification.

*The question first asked whether any of the vineyard area is certified as organic or biodynamic or in the transition process to certification. If respondents answered yes, they were prompted to specify the areas not certified, certified organic, certified biodynamic (and organic) and in the transition process.

Organic certified wine production



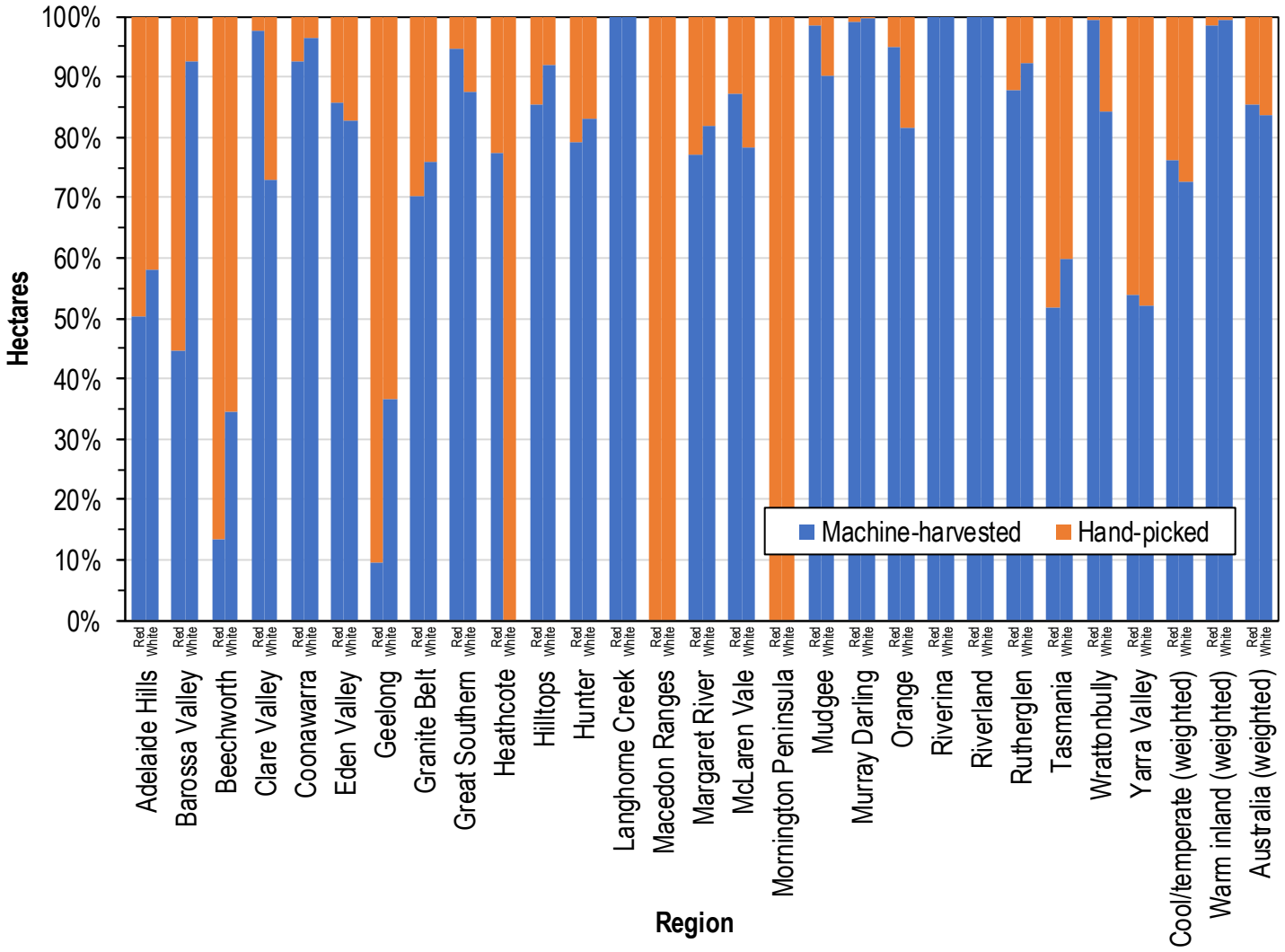
Certified organic wine in Australia

2% red table wine
1% white table wine

- Winery survey data confirmed that only a small volume of certified organic wine was produced.

*The question first asked whether any certified organic wine was made at the site in 2015. If the respondent answered yes, they were prompted to enter the % of red and white table wines that were organic from drop-down boxes to the nearest 10%. Quantities of wine were then estimated based on the winery intake of red and white grapes.

Mechanisation of harvesting



Machine harvesting in Australia by vineyard area

85% red grapes
84% white grapes

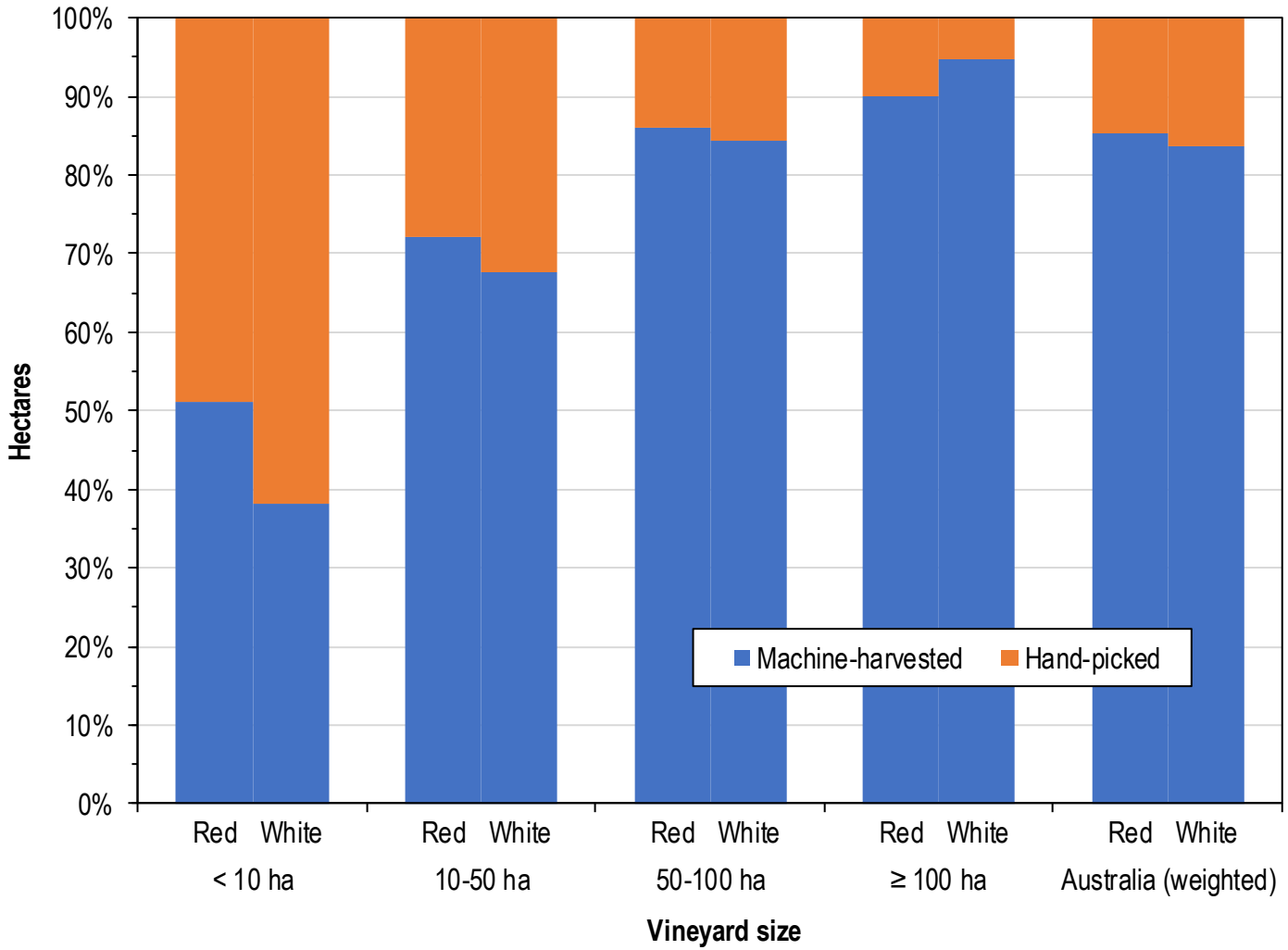
- Levels of machine harvesting varied regionally.

Reasons given for hand-picking:

- Higher-priced wines (although grapes for some higher-priced red wines were machine harvested)
- Whole bunch pressing for sparkling
- Whole bunch fermentation
- Very old vines.
- Very young vines
- Vines not set up for mechanisation
- Grapes needing sorting
- Carbonic maceration
- Small blocks.

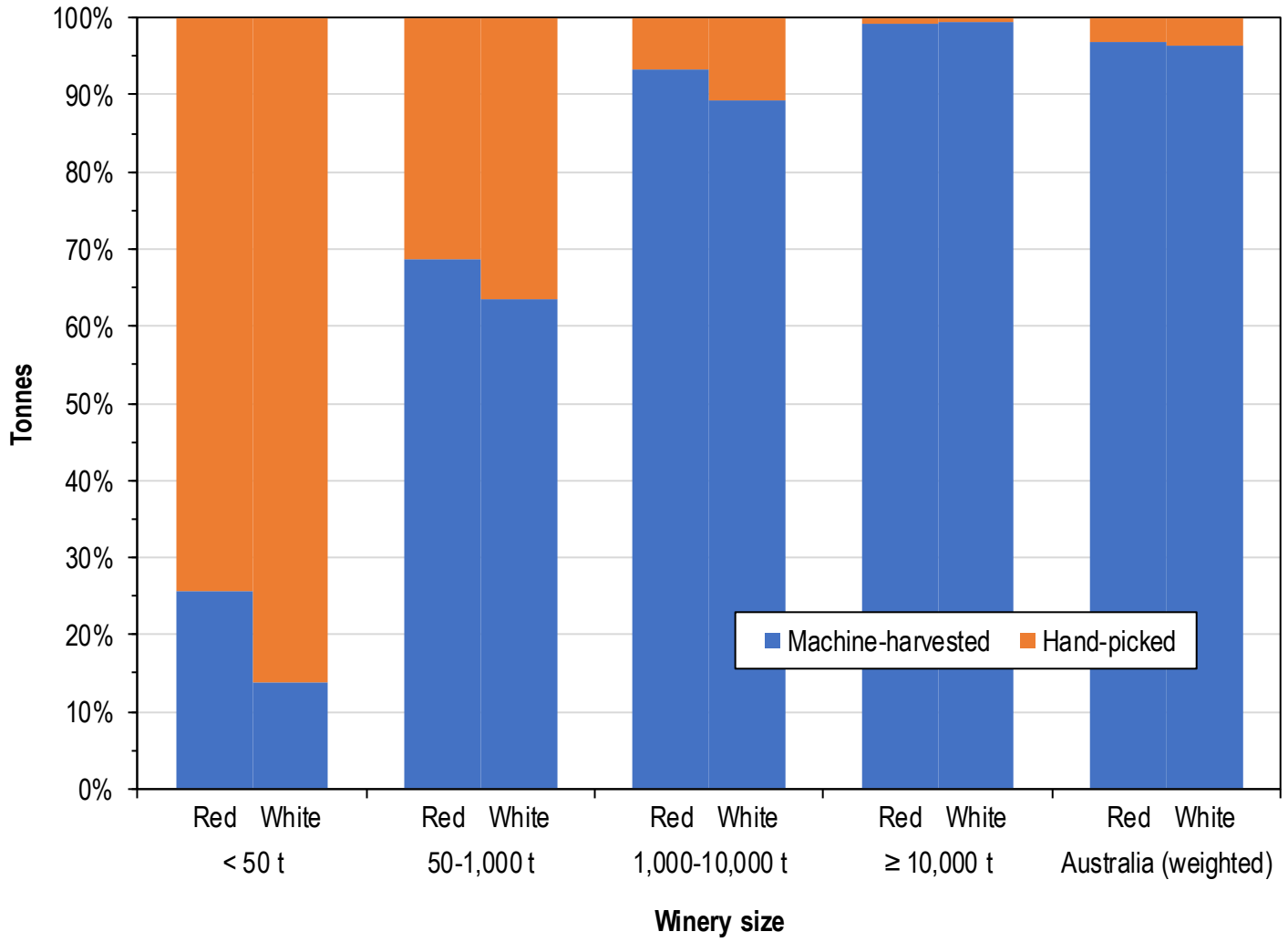
*The question first asked whether grapes were all machine-harvested, all hand-picked or a combination of both. If respondents selected a combination of both, they were prompted to select the % of red and white grapes that were machine-harvested from drop-down boxes to nearest 10%.

Mechanisation of harvesting



- Smaller vineyards hand-picked a larger proportion of their crop than larger vineyards.

Mechanisation of harvesting (winery intake tonnage data for comparison)



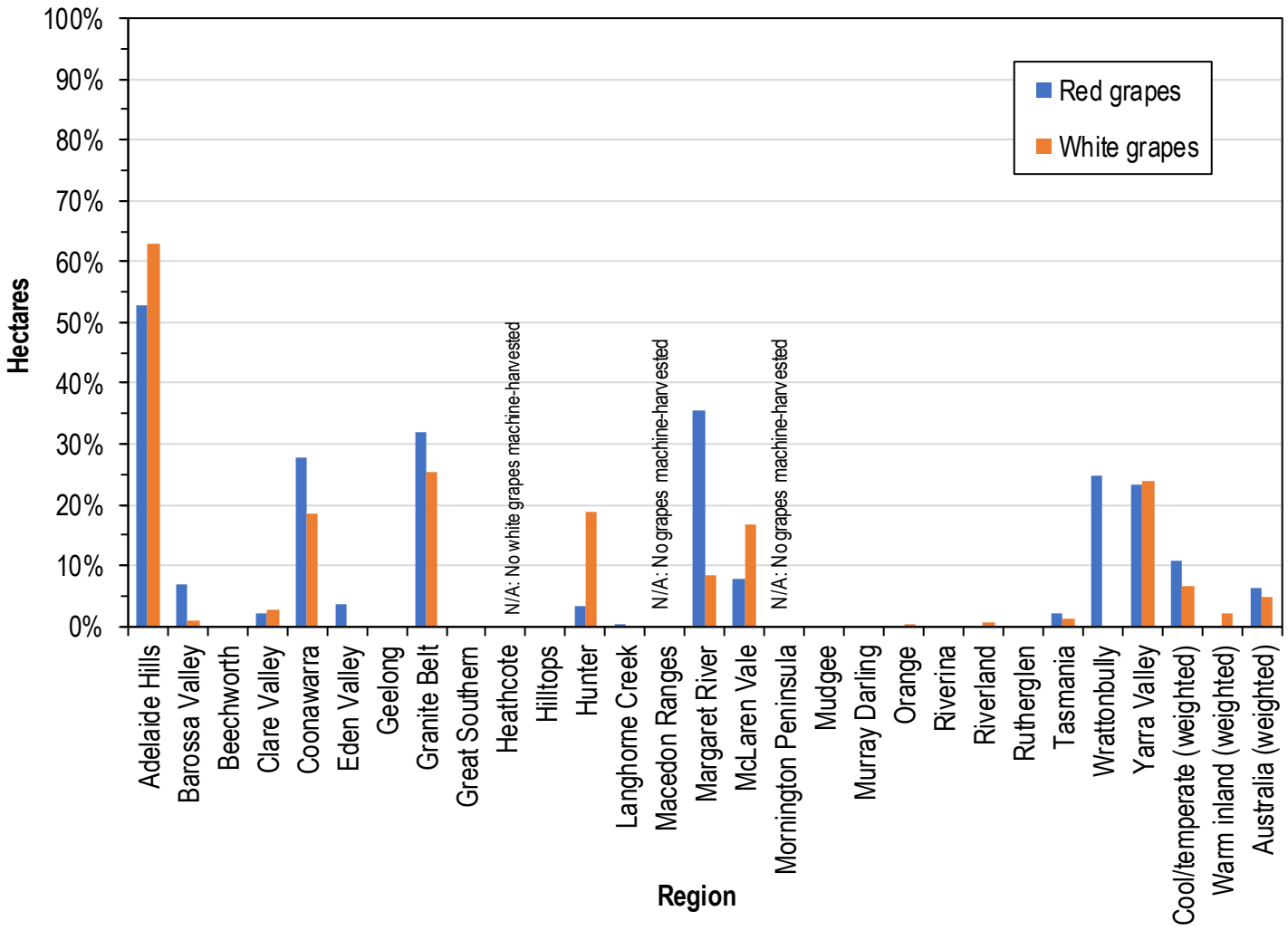
Machine-harvested grapes in Australia by winery intake (tonnes)

97% red grapes
96% white grapes

- Smaller wineries more commonly processed hand-picked grapes.
- On a winery intake tonnage basis more grapes were machine-harvested (96%) than on a vineyard area basis (84%), partly because on average the yield was higher in machine-harvested vineyards.

*The question first asked whether grape loads arriving at the site were all machine-harvested, all hand-picked or a combination of both. If respondents selected a combination of both they were prompted to select the % of red and white grapes that were machine-harvested from drop-down boxes to the nearest 10%.

On-harvester destemming used when machine harvesting



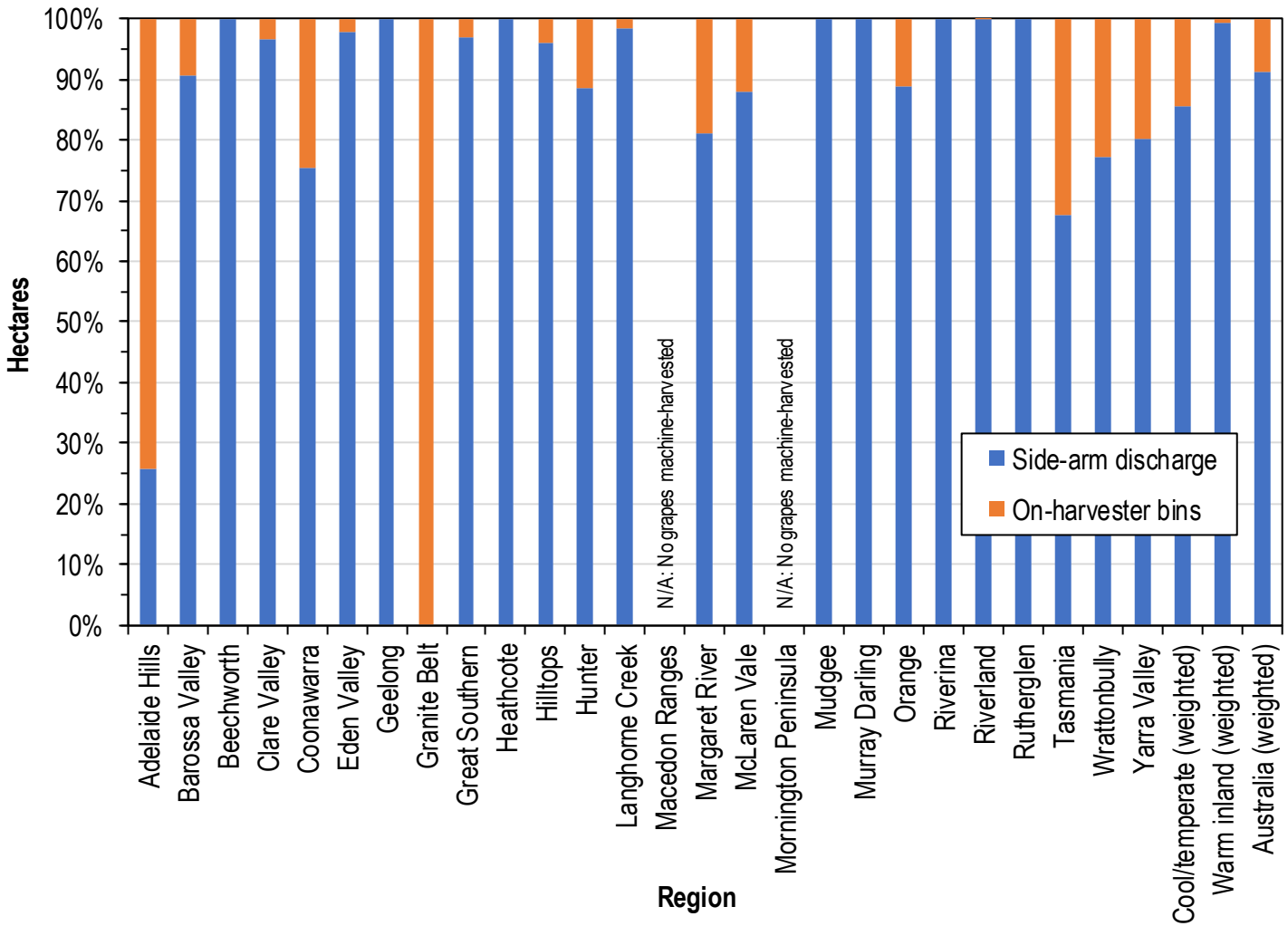
On-harvester destemming in Australia

6% red grapes
5% white grapes

- Low overall uptake, but quite high uptake in some regions.
- Winemakers were generally positive about the results from these machines and some wineries are now paying more for fruit harvested using them.
- One respondent raised concerns about higher juice levels and a contractor mentioned an issue with managing batch sizes during transport because of increased risks of juice spillage.
- Uptake was almost as high for white grapes as for red grapes.

*Vineyards that machine harvested were first asked whether any machine harvesting was performed using a harvester with a destemmer (e.g. Pellenc Selectiv', Braud with SOCMA or Optigrape, Gregoire Cleantech, ERO Vitiselect, etc.) and if they answered yes, they were asked to select the % of machine-harvested red and white grapes that were harvested with the destemmer running (from a drop-down menu, to the nearest 10%).

Side-arm discharge vs on-harvester bins only when machine harvesting



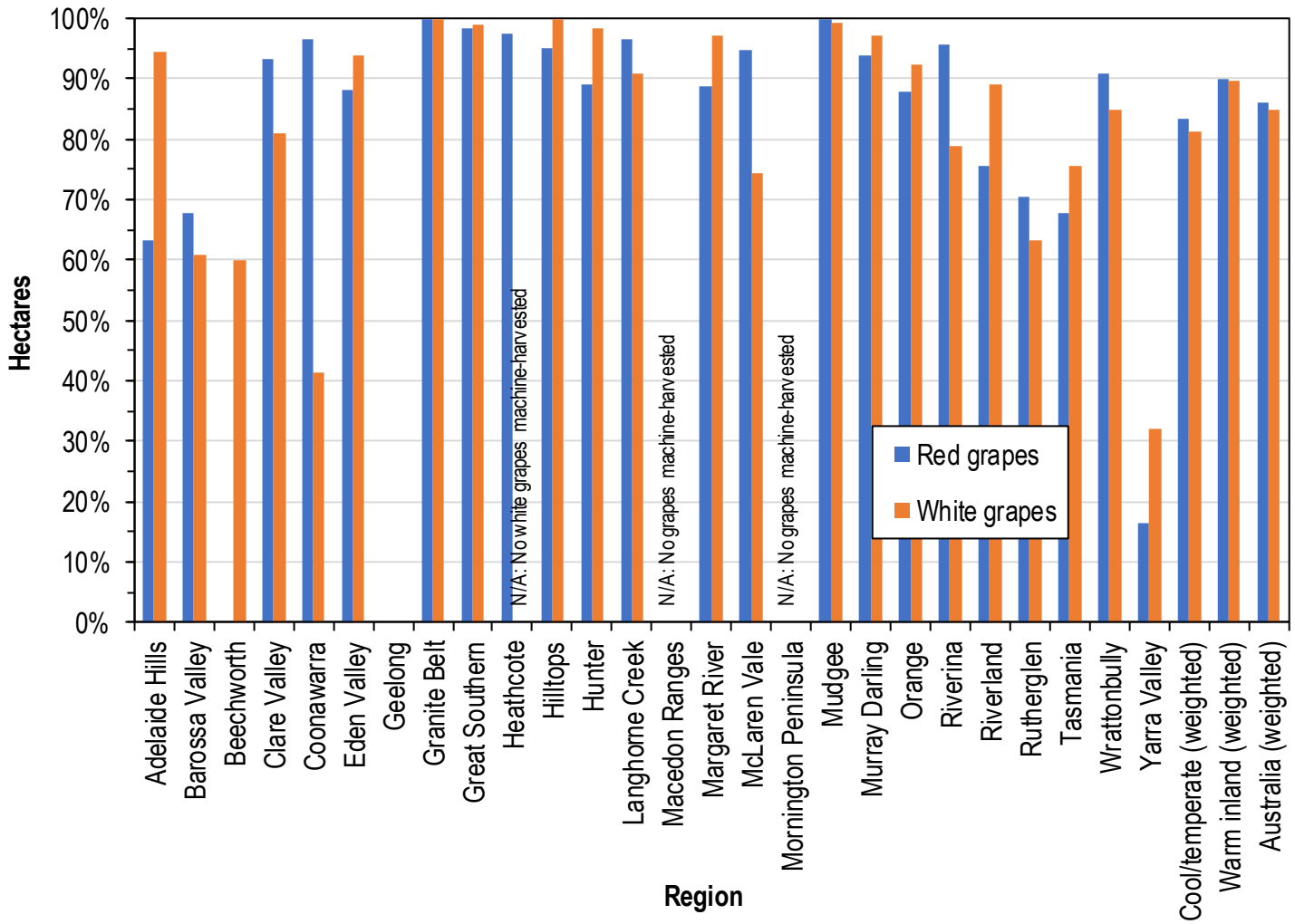
Machine harvesting in Australia

91% side-arm discharge

- Harvesters primarily using a side-arm discharge conveyor dominated machine harvesting in Australia.
- Many of the machines with only on-harvester bins were those fitted with a destemming system.
- Machines with only on-harvester bins can be a problem in long rows as the operator may fill bins part way along a row and then have to come back and empty the bins.

*Vineyards that machine harvested were first asked whether this was performed all using harvesters with side-arm discharge conveyors, all using harvesters with on-harvester bins or with some of each. If respondents selected some of each, they were then asked to select the % that was performed with each type of machine (from a drop-down menu, to the nearest 10%).

SO_2 addition to machine-harvested grapes



SO_2 addition to machine-harvested grapes in Australian vineyards

86% red grapes
85% white grapes

- SO_2 addition to machine-harvested grapes was common with a few apparent exceptions.
- Several wineries noted that it is mainly grapes for sparkling wine that do not receive SO_2 additions.
- Proximity of the vineyard to the winery was also offered as an explanation for machine-harvested grapes not receiving SO_2.

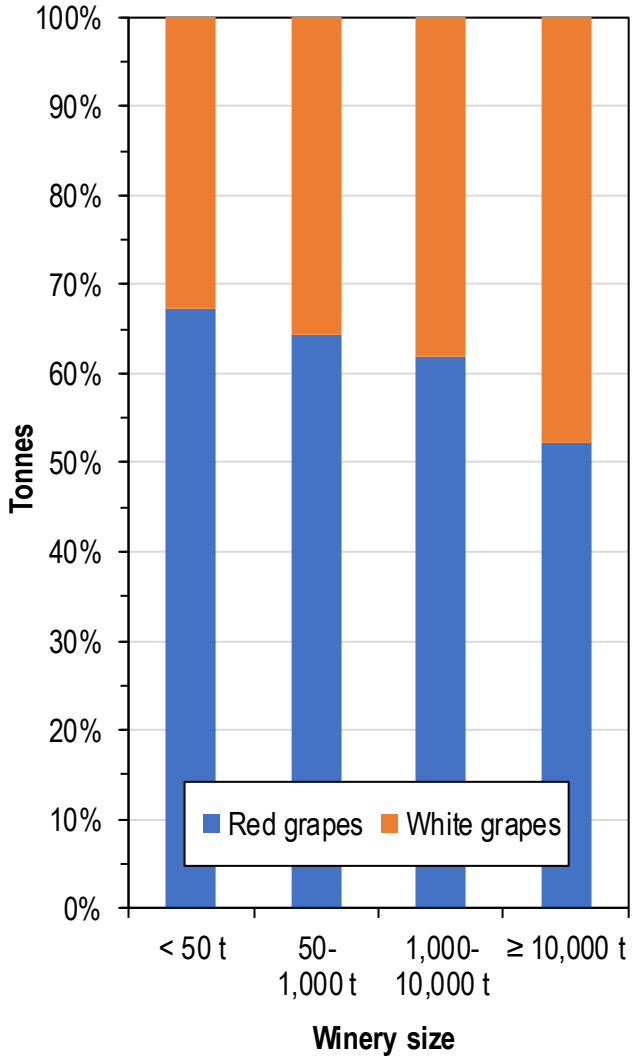
*Vineyards that machine-harvested were first asked whether potassium metabisulfite/sulfur dioxide was added to machine-harvested grapes in the vineyard, with options of yes-added to all loads, yes-added to some loads, no-never added. If respondents selected that it was added to some loads, they were then asked to select the % of machine-harvested red and white grapes to which it was added.

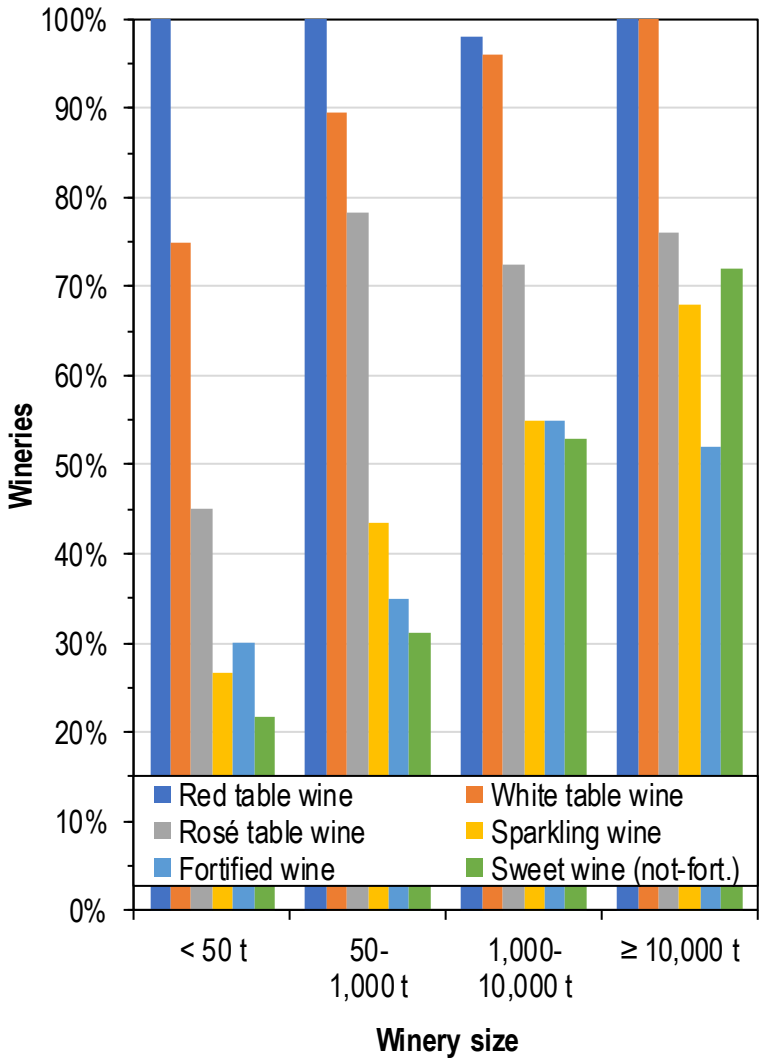
New vineyard products/techniques that had the biggest positive impact in the last five years

1. Multi-row equipment, particularly canopy sprayers
2. Soil moisture probes and irrigation controls
3. Mulching under-vine strips
4. Organic practices
5. Recycling sprayers
6. Klima mechanical cane pruning
7. Sheep grazing
8. Mechanical under-vine management - slashing and cultivation
9. Pruning wound fungicide sprays
10. Mechanical leaf plucking
11. More cane pruning
12. Various fungicides – Revus (most commonly listed), Vivando, Talendo, Flute, Switch
13. Improved spray equipment (some cross-over with multi-row equipment)
14. Destemming/sorting harvesters
15. Seaweed fertilisers
16. Shoot and bunch thinning

*Respondents were asked which new products or techniques had the biggest positive impact on their operations over the last five years. Themes are listed in decreasing order of responses – 45% of survey respondents provided at least one item for this optional free-text question.

Winery red-white grape intake mix and products (made at all on site)

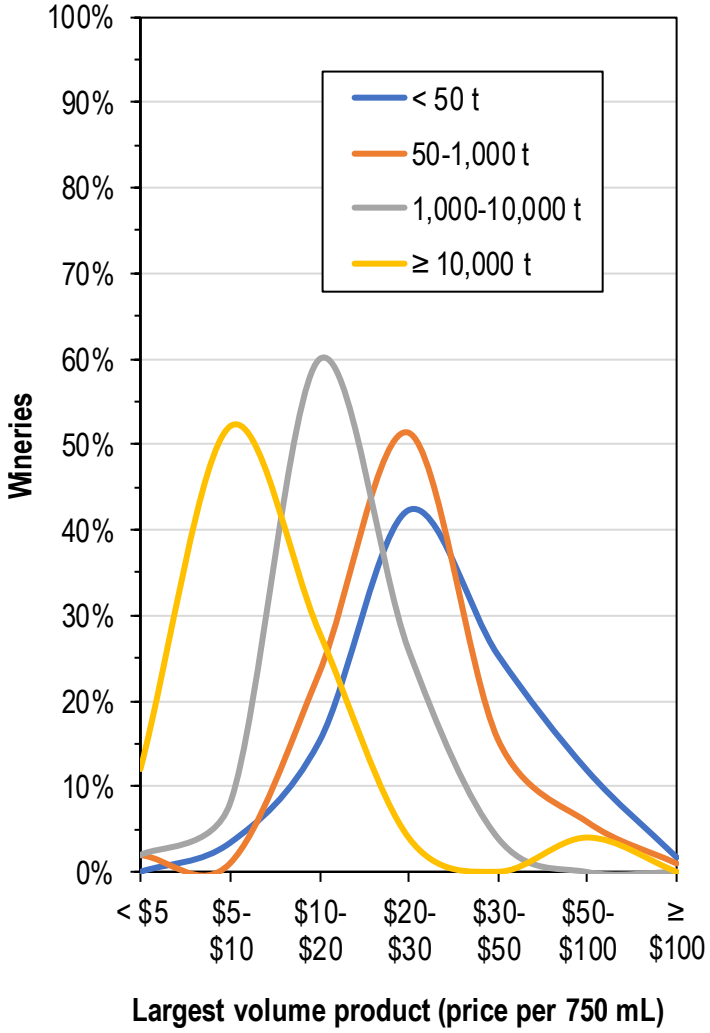


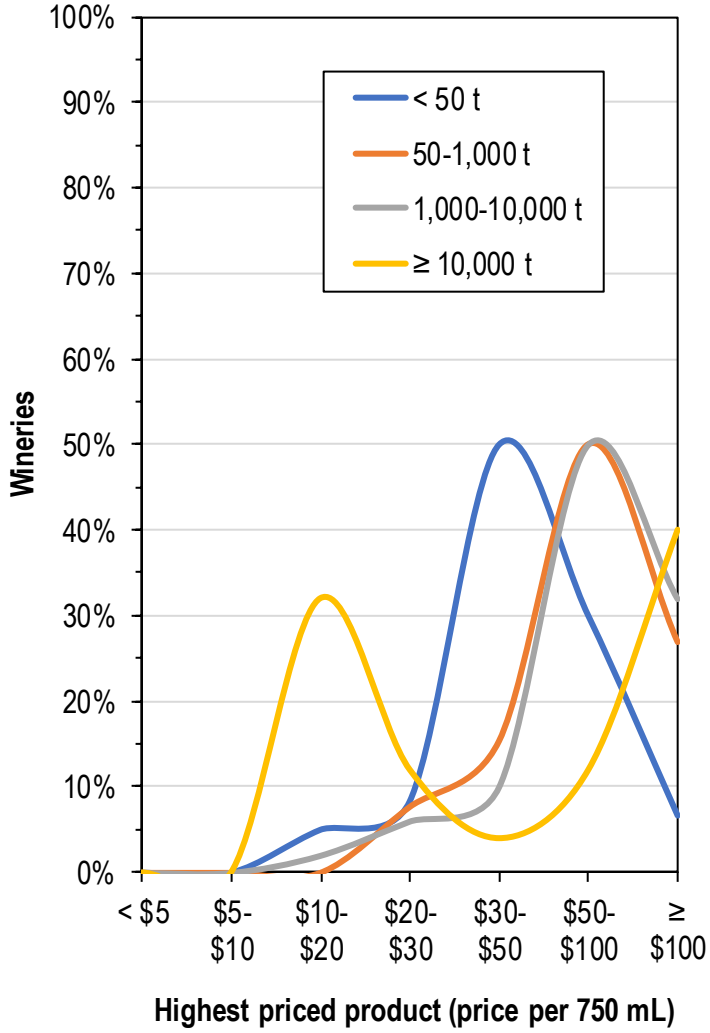


- A greater proportion of wine production in smaller wineries was red wine.
- The number of different types of products made at a winery generally increased with winery size.

*If the respondent processed grapes in 2016, they were asked to enter the tonnes processed and select the % of red vs white grapes from a drop-down menu in 10% increments. Respondents were also asked to select which products were made at the site, irrespective of whether they were for their own or someone else's brand.

Retail price of largest volume and highest priced products

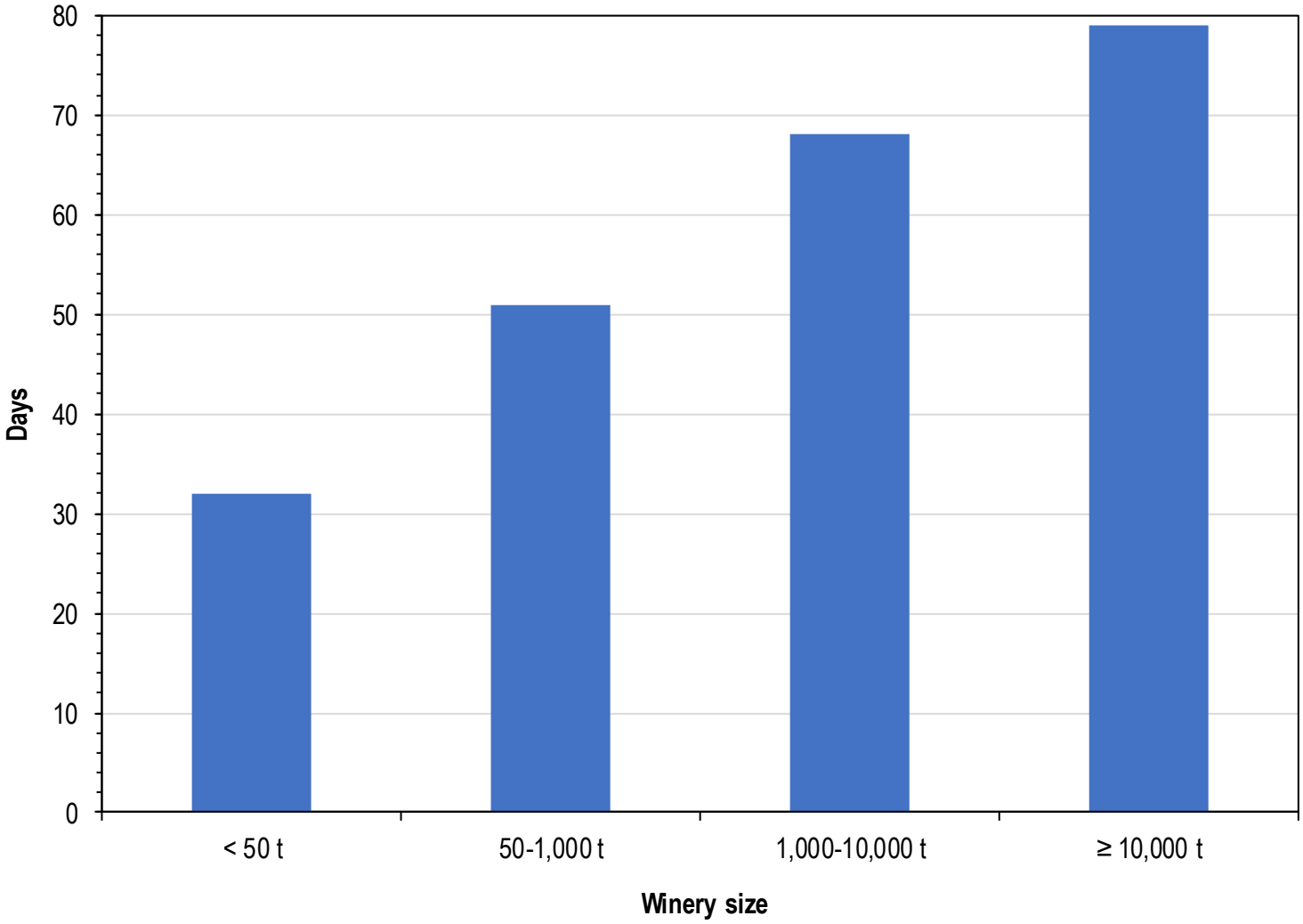




- The data for the retail price of the largest volume product at each winery suggests that on average smaller wineries produce higher priced wines.
- The bimodal distribution of highest priced product for ≥ 10,000 t wineries suggests that some larger wineries are focused on the production of modestly priced wines, while others make both these and higher priced wines.
- Practices data presented in % of production in this report are likely to better reflect practices used for the largest volume product at each winery, rather than for the highest priced product.
- The practices used in small wineries may sometimes be representative of the practices used in large wineries for their higher-priced wines.

*Respondents were asked to select the retail price bracket of their largest volume and highest priced products, from a drop-down menu with the options shown on the axes above.

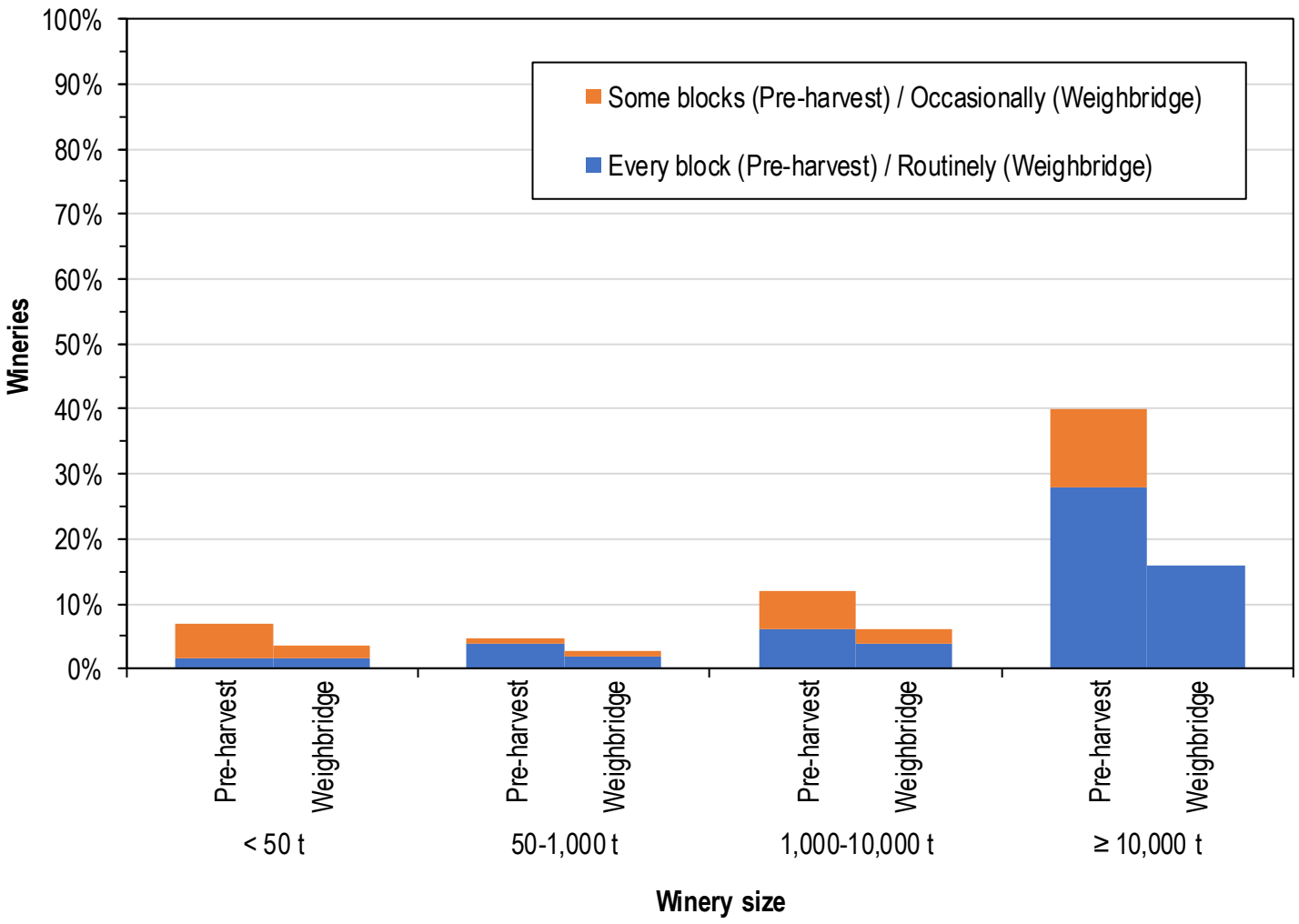
Median vintage length (first to last grape intake)



- Median vintage length ranged from one month in small wineries to almost three months in large wineries.
- As wineries increase in size, they are more likely to process more grape batches from more climatic regions for more product types, extending the length of the vintage period.

*Respondents were asked to enter what dates they first and last received grapes in 2016.

Pre-harvest and weighbridge measurements of red grape colour, phenolics, or tannin



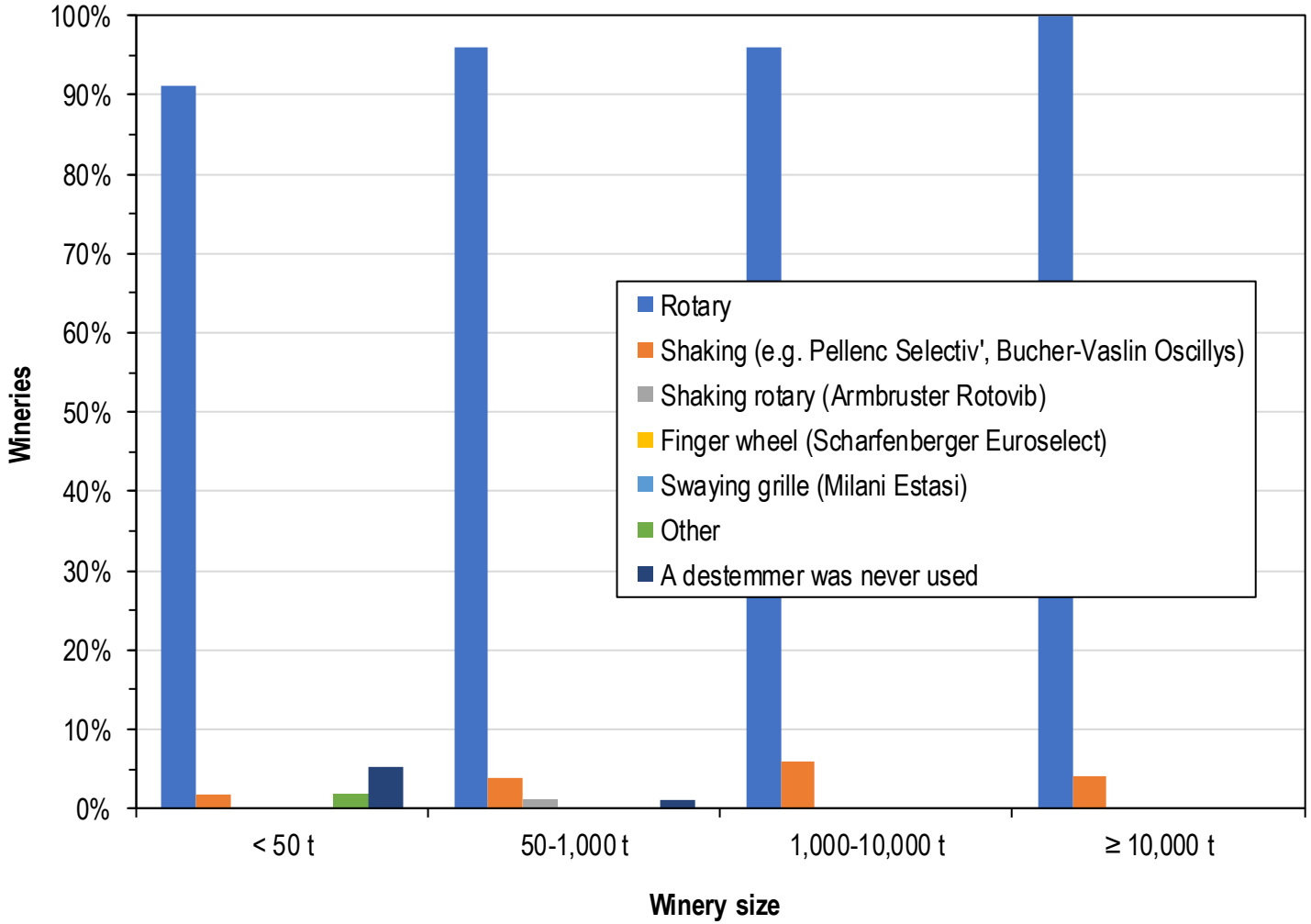
- Colour measurements were most commonly adopted by large wineries on an every block/batch basis.
- A few wineries measured tannin and colour on selected high-end blocks.
- These analyses were more commonly performed on grapes pre-harvest than on arrival at the winery.
- Some large wineries adjusted grape payments based on colour measurements and/or used the data to assist with streaming.
- Many large wineries not using colour measurements said that this was something that they had considered or used in the past and stopped, while a few were considering doing more.

Reasons given by those not using:

- No problems with colour
- Visit and grade vineyards anyway
- Not convinced that grape colour is always a great marker for wine colour
- Cost and effort
- Didn't use the results for streaming or payments so have stopped.

*Respondents that received red grapes were asked if measurements of red grape phenolics, colour or tannin were performed pre-harvest at least once for each block, for some blocks or not at all. They were also asked whether red grape loads arriving at the site were analysed for phenolics, colour or tannin routinely, occasionally or not at all.

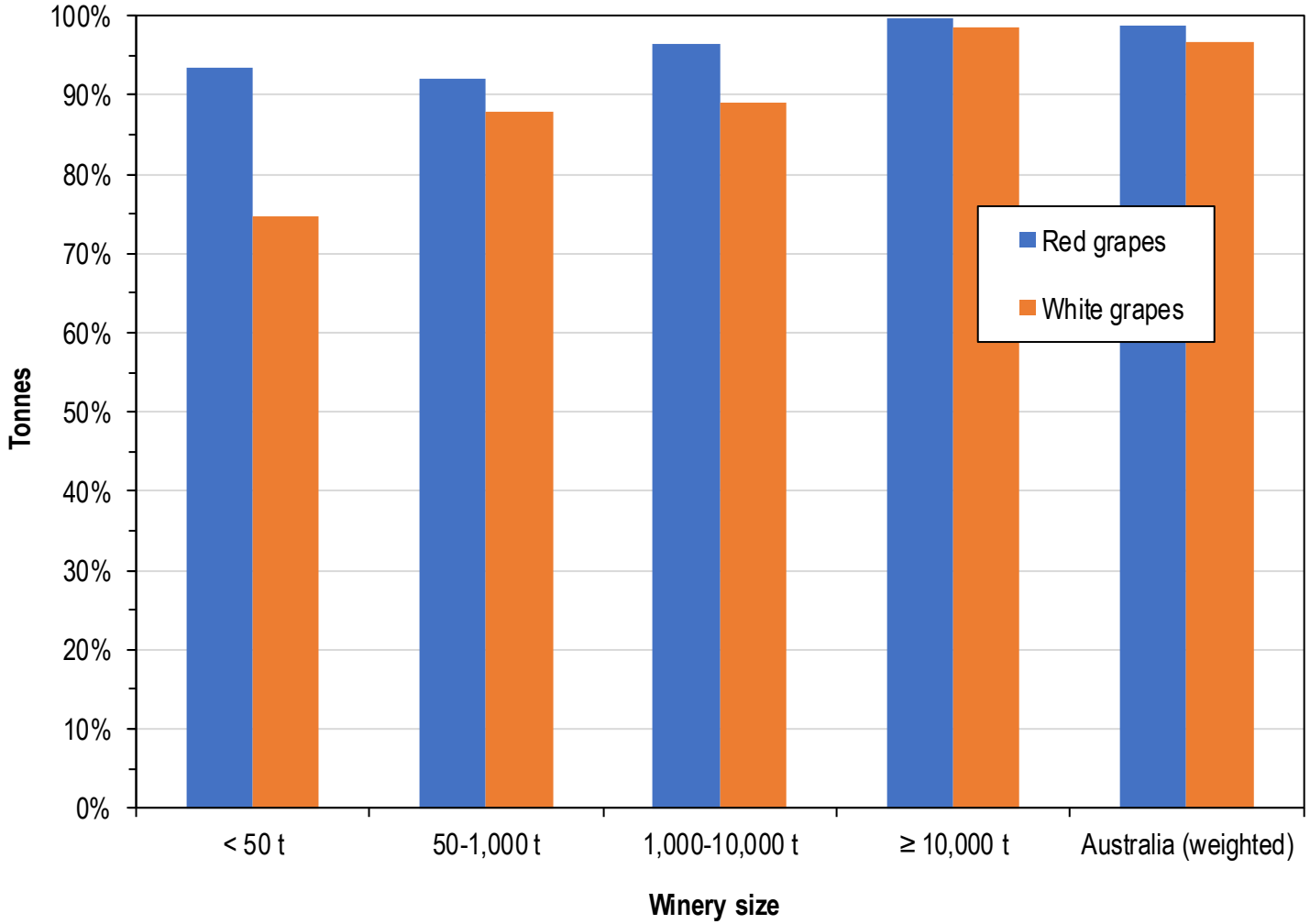
Winery destemming equipment (used at all)



- Rotary destemmers were the primary destemmer type used by wineries.
- Only a limited number of very small wineries used no destemmer at all.
- Shaking destemmers were the next most common type of destemmer being used by ~5% of wineries ≥ 50 t.
- Additional installations of shaking destemmers have been made since 2016 (e.g. they were used in at least 12% of wineries ≥ 10,000 t in the 2019 vintage – typically for more premium batches).

*Respondents were asked to select from a list all types of destemmers that were used.

Destemmed at the winery



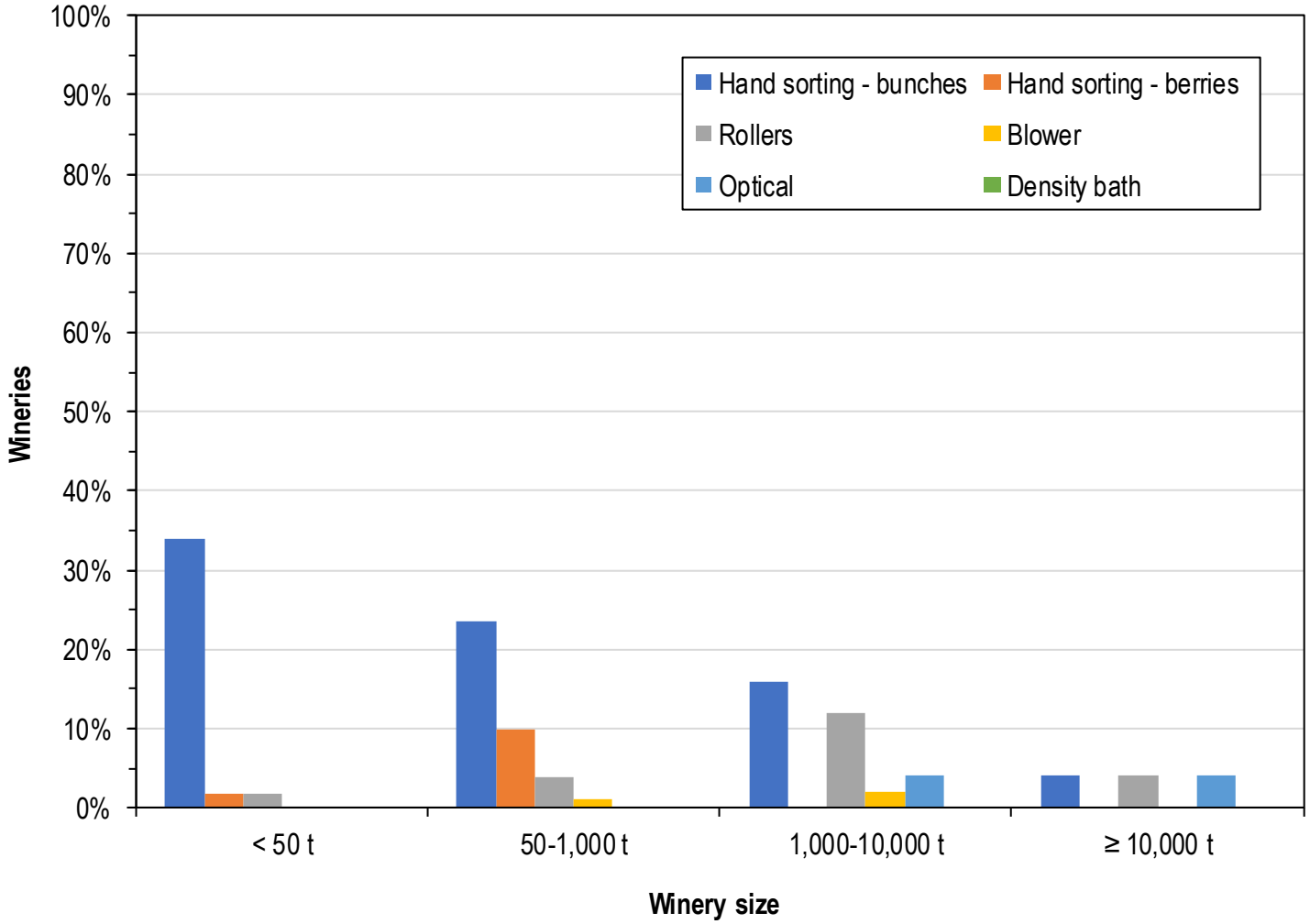
Grapes destemmed at the winery in Australia

99% red
97% white

- Most grapes were destemmed.
- Smaller wineries were slightly less likely to destem than larger wineries and white grapes were slightly less likely to be destemmed than red grapes.
- It should be noted that most grapes are machine-harvested and are therefore partially destemmed already. In addition, some grapes may have been harvested using a harvester with a destemmer (see page 67).

*Respondents were first asked to select whether excluding any whole bunch pressing, all grape loads arriving at the site were processed with both a destemmer and a crusher. If they answered yes, then their tonnage was assigned as all being destemmed. If they answered no, they were asked to select what % of red and white grapes were processed with a destemmer to the nearest 10%. Destemmed tonnage was calculated based on this, the winery intake tonnage and the fraction of red and white grapes. There was guidance at the first question to answer no, if the destemmer was sometimes bypassed.

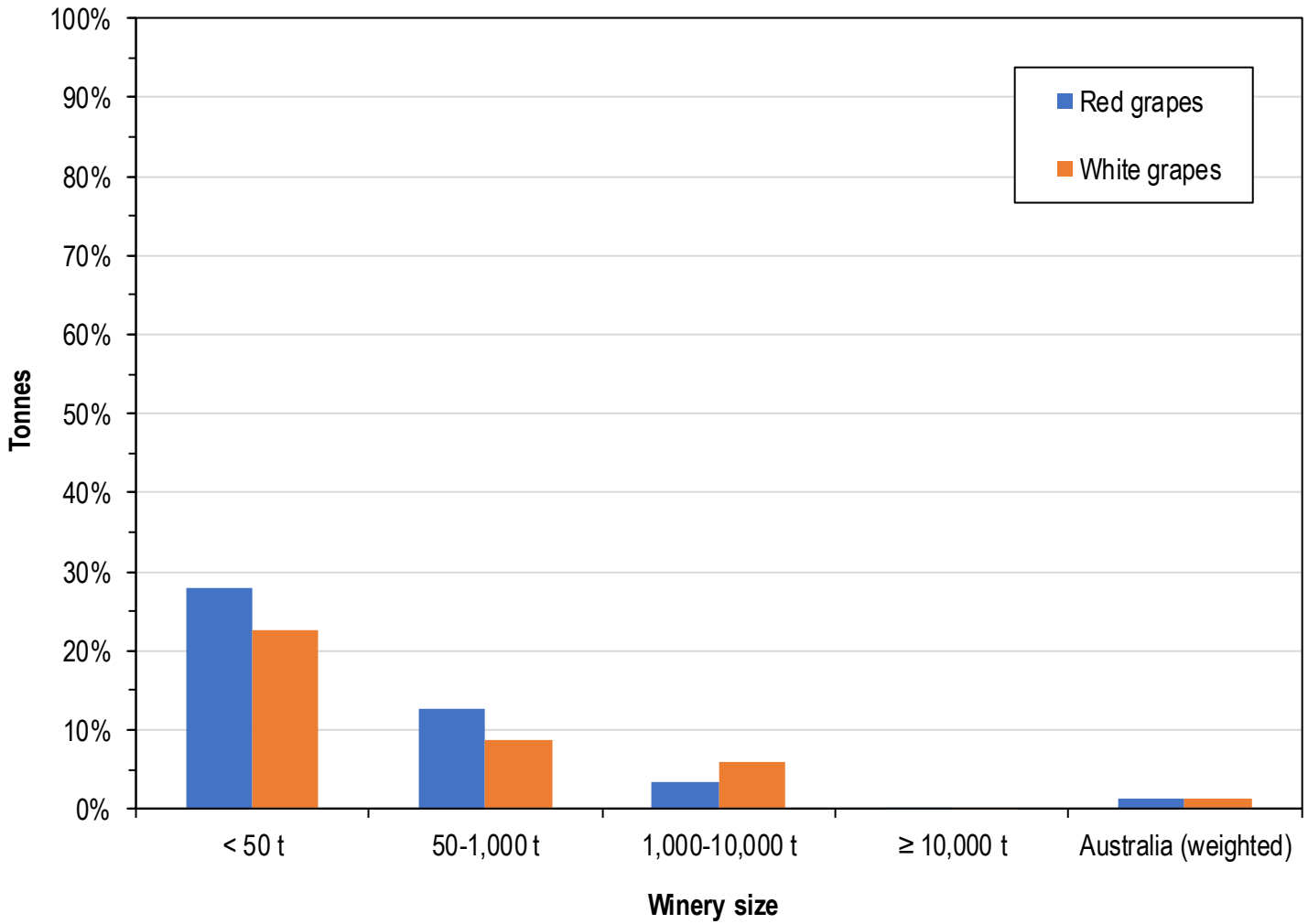
Winery sorting techniques/equipment (used at all)



- Hand sorting of bunches was the most widely used technique.
- Sorting was more commonly performed at all in smaller wineries.
- Roller sorting was the most common form of mechanical sorting, with ~6% of wineries ≥ 50 t using them.
- Since 2016 there have been some further installations of roller sorters (e.g. at least 16% of wineries ≥ 10,000 t used roller sorting in the 2019 vintage).
- It was not clearly captured in the survey, but some wineries achieve mechanical sorting by slots in vibrating conveyors used for hand sorting and/or feeding other equipment – one supplier estimated that that there may be more than twice as many wineries using slotted vibrating conveyors as roller sorters.
- The use of optical sorters was low and no density sorters were in use; however, in 2019 there is at least one density sorting system in Australia.

*Respondents were first asked whether any sorting was performed. If they answered yes, they were then asked to select all the sorting techniques used.

Sorted at the winery



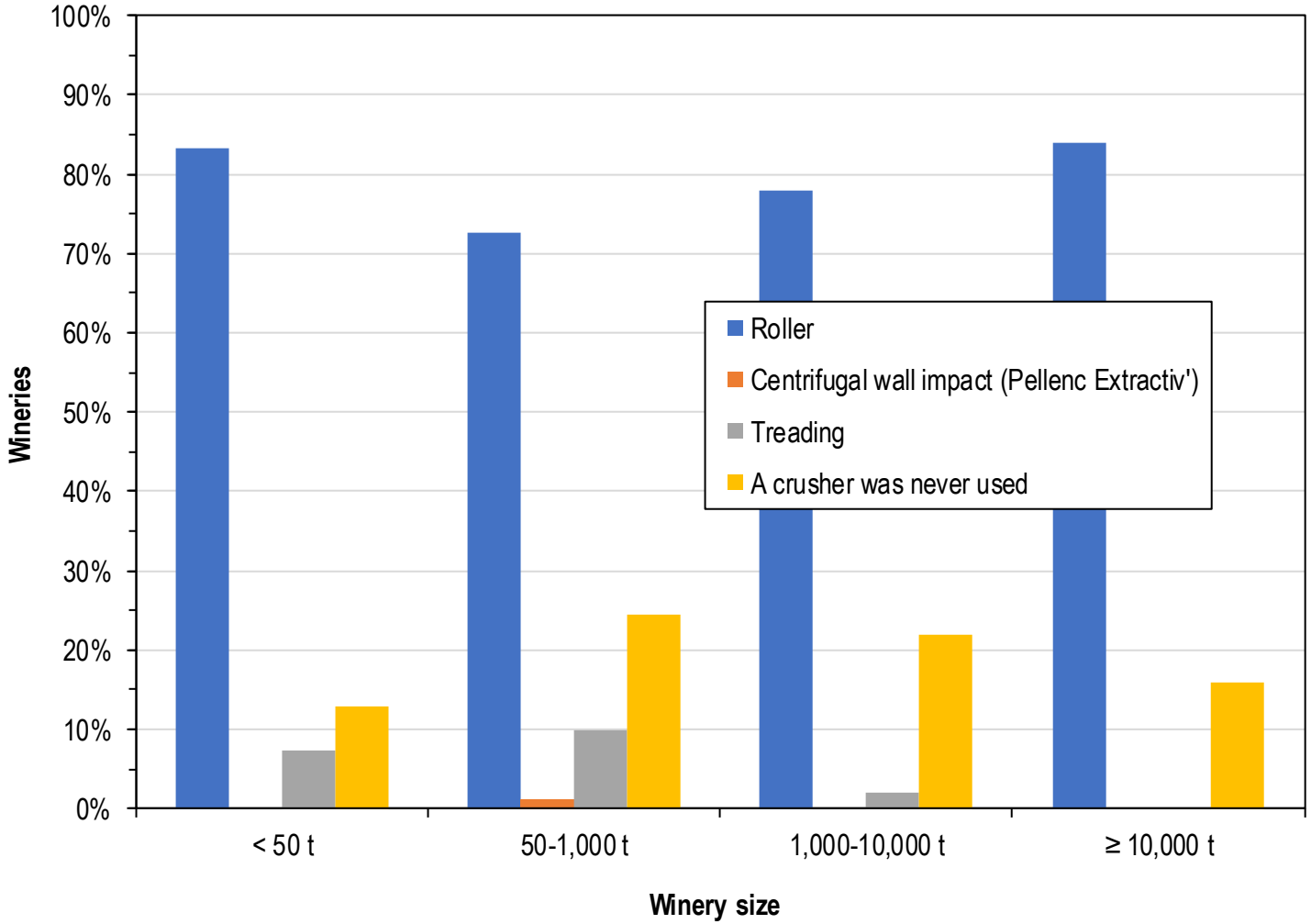
Grapes sorted at the winery in Australia

1% red
1% white

- Smaller wineries sorted a greater proportion of their intake than larger wineries.
- The data presented here includes all sorting systems, which means the type and quality of sorting would have varied (e.g. some was by hand, some was roller sorting, some was optical sorting, some was combinations of these).
- Apart from sorting in the winery, some sorting would have been performed in the vineyard during hand-picking and on some mechanical harvesters with a mechanical destemming and sorting system (e.g. by rollers or aircushion).

*If respondents answered that sorting was performed, they were then asked to select what % of red and white grapes were sorted to the nearest 10%. Sorted tonnage was calculated based on this, the winery intake tonnage and the fraction of red and white grapes.

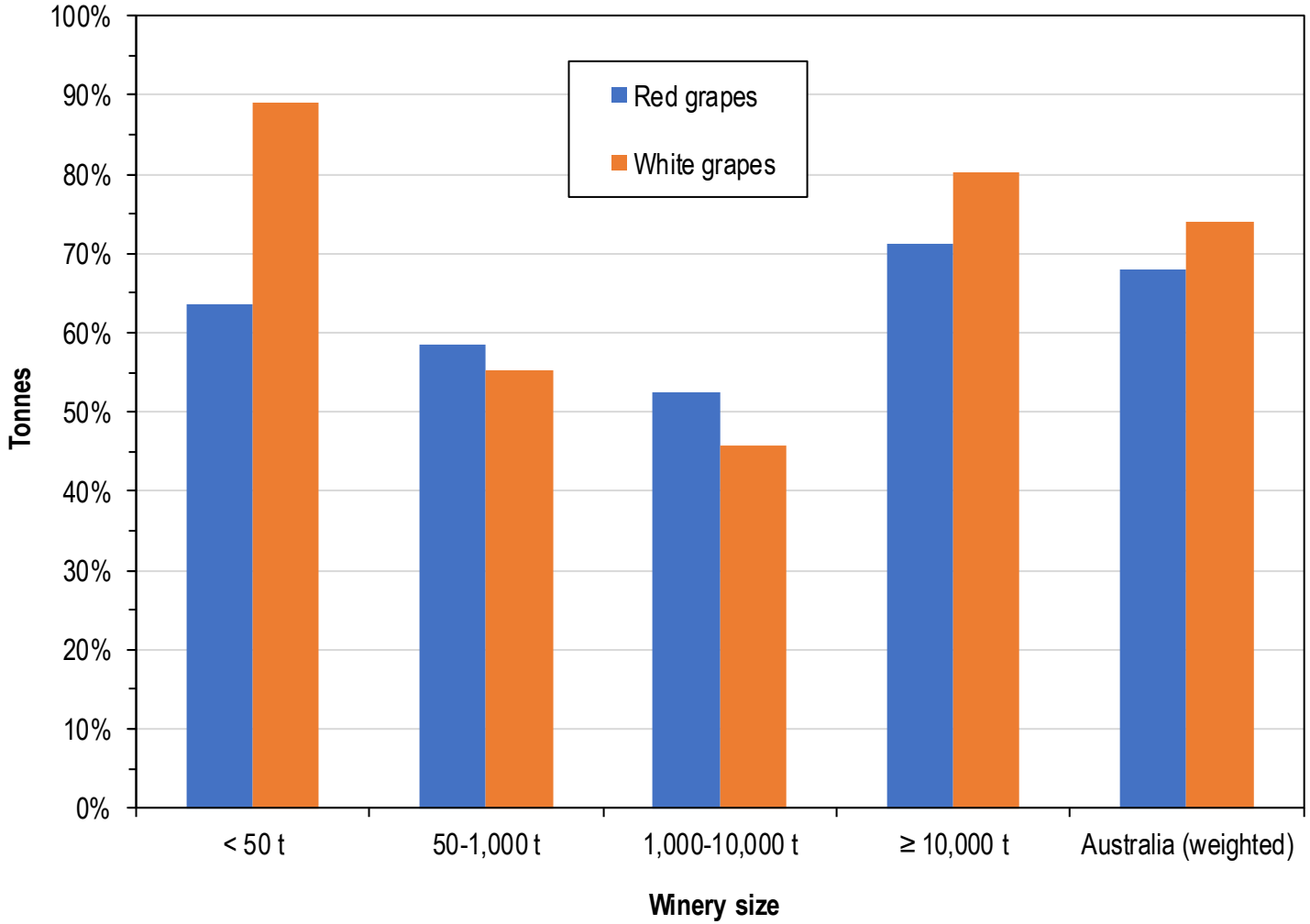
Crushers (used at all)



- Roller crushers were the dominant crusher type in use.
- Many wineries used no crusher at all (~20% of wineries ≥50 t).

*Respondents were asked to select from a list all types of crusher that were used.

Crushed



Grapes explicitly crushed in Australia

68% red
74% white

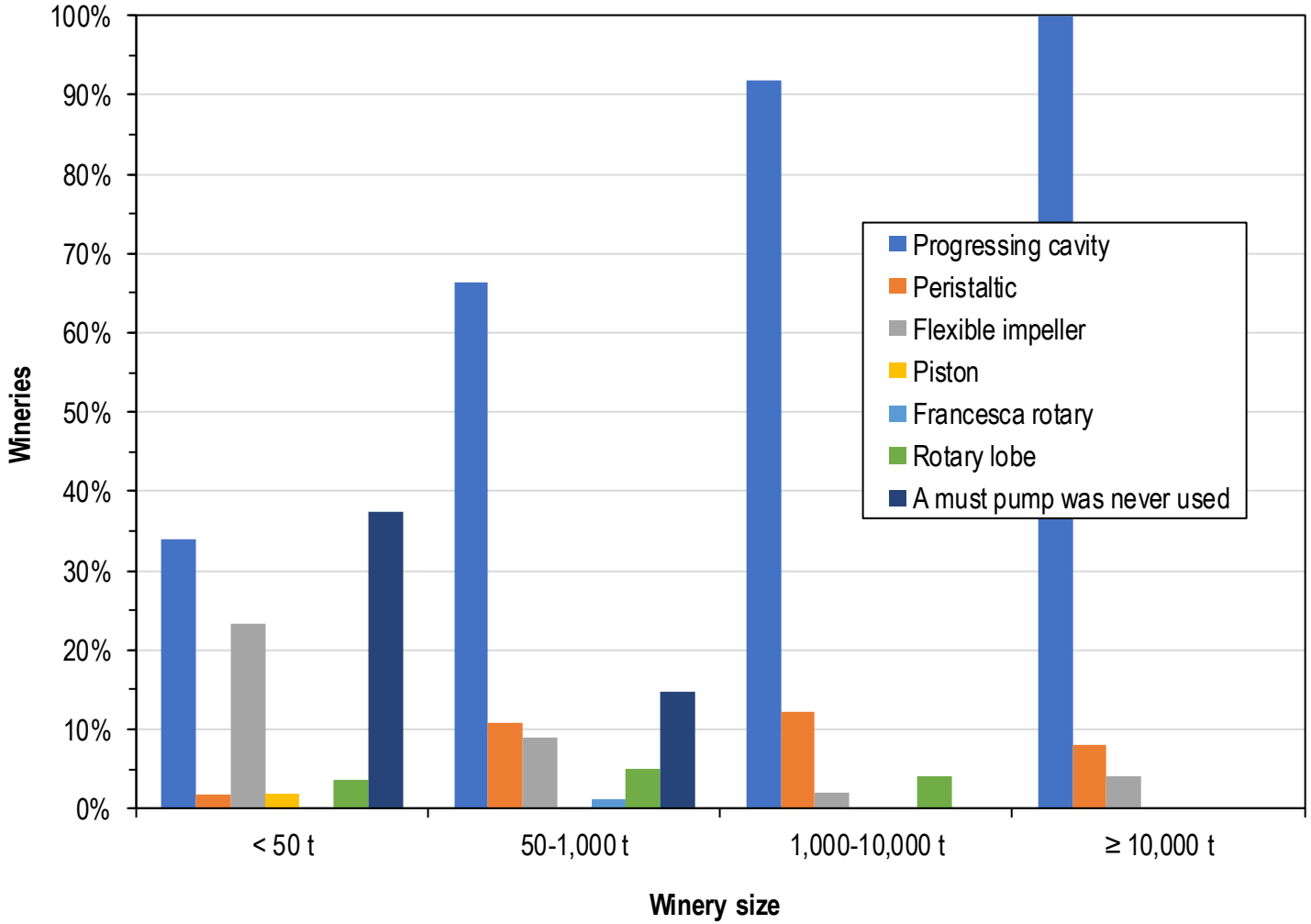
- A considerable proportion of grapes were not explicitly crushed, including in large wineries.

Reasons given for not crushing:

- Grapes machine-harvested, destemmed and pumped, so they get crushed enough already
- Whole berry ferment characters wanted for red wine
- Risks of excessive maceration causing press screen blockages
- Minimising phenolics in white wine
- Crusher rollers sometimes responsible for breakdowns.

*Respondents were first asked to select whether excluding any whole bunch pressing, all whole grape loads arriving at the site were processed with both a destemmer and a crusher. If they answered yes, then their tonnage was assigned as all being crushed. If they answered no, they were asked to select what % of red and white grapes were processed with a crusher to the nearest 10%. Crushed tonnage was calculated based on this, the winery intake tonnage and the fraction of red and white grapes. There was guidance at the first question to answer no if the crusher unit was sometimes removed, or rollers spaced so as to not crush.

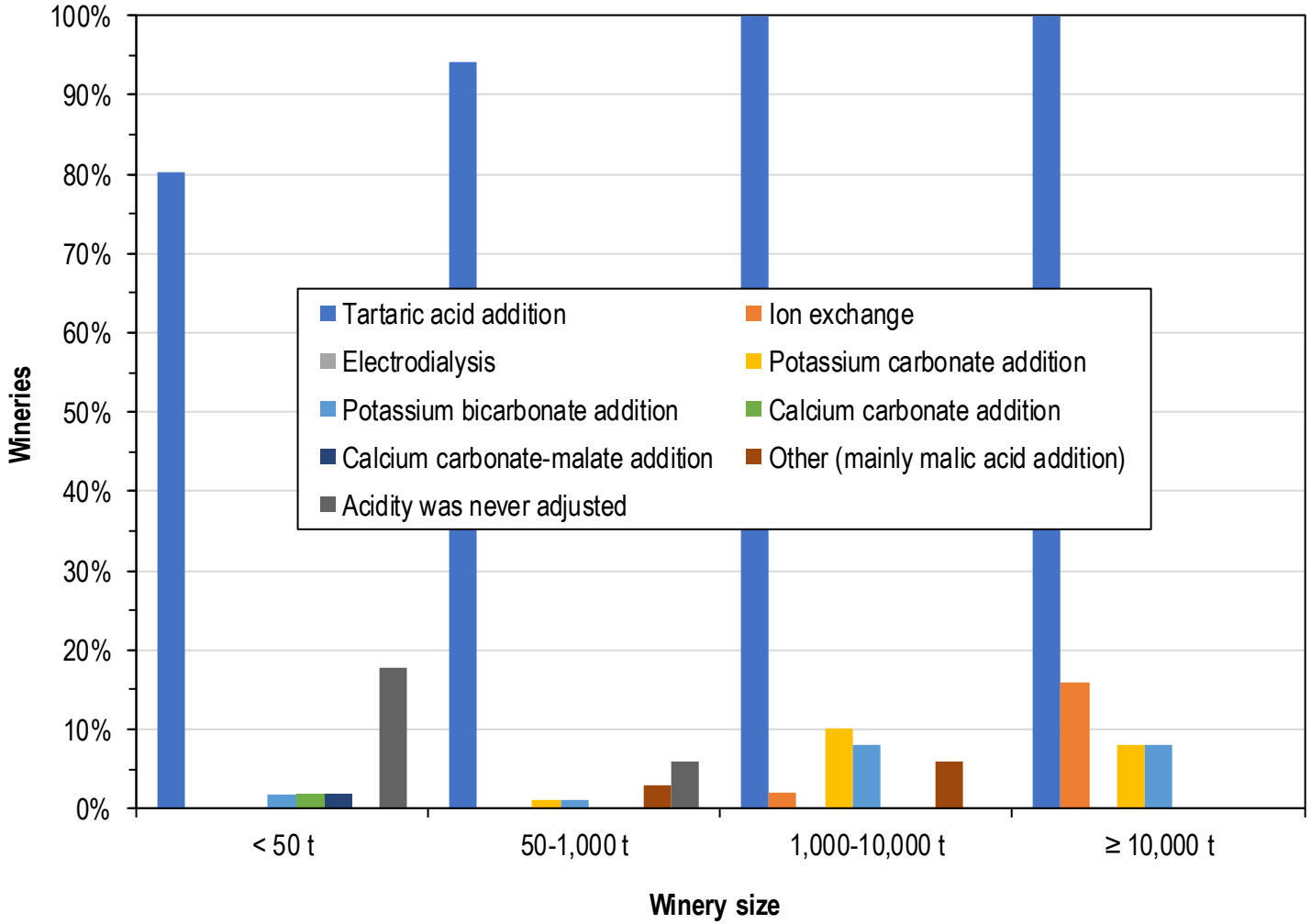
Must pump types (used at all)



- Progressing cavity pumps were the most common style of must pump used.
- Peristaltic pumps were only used by a much smaller number of wineries.
- Many small wineries didn't use a must pump at all.

*Respondents were asked to select from a list all types of pumps that were used to pump whole or crushed grapes.

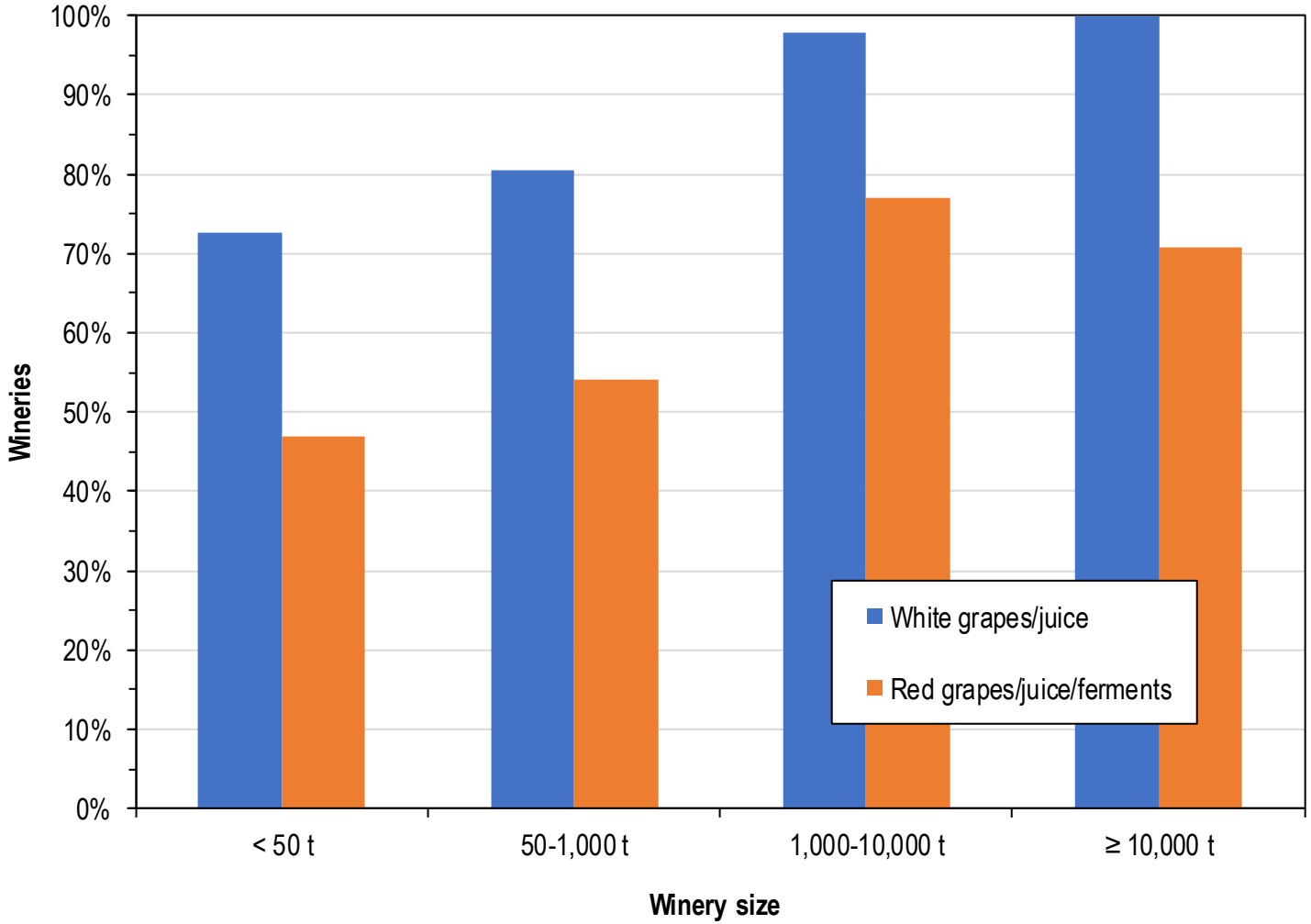
Juice acidity adjustment techniques (used at all)



- Tartaric acid was used by most wineries some of the time.
- Addition of de-acidification agents to must/juice was rare (in follow-up discussions with some of the few wineries that selected that they used potassium carbonate or bicarbonate at all on must/juice, they said that this was unusual and would have only been for one batch).
- Ion exchange was used by a small number of wineries, including for the acidification of juice to be used later for yeast propagation or sweetening.
- Some wineries mentioned that ion exchange had been used more historically but had been scaled back and/or their columns had been removed completely.

*Respondents were asked to select from a list all techniques that were used to adjust juice acidity.

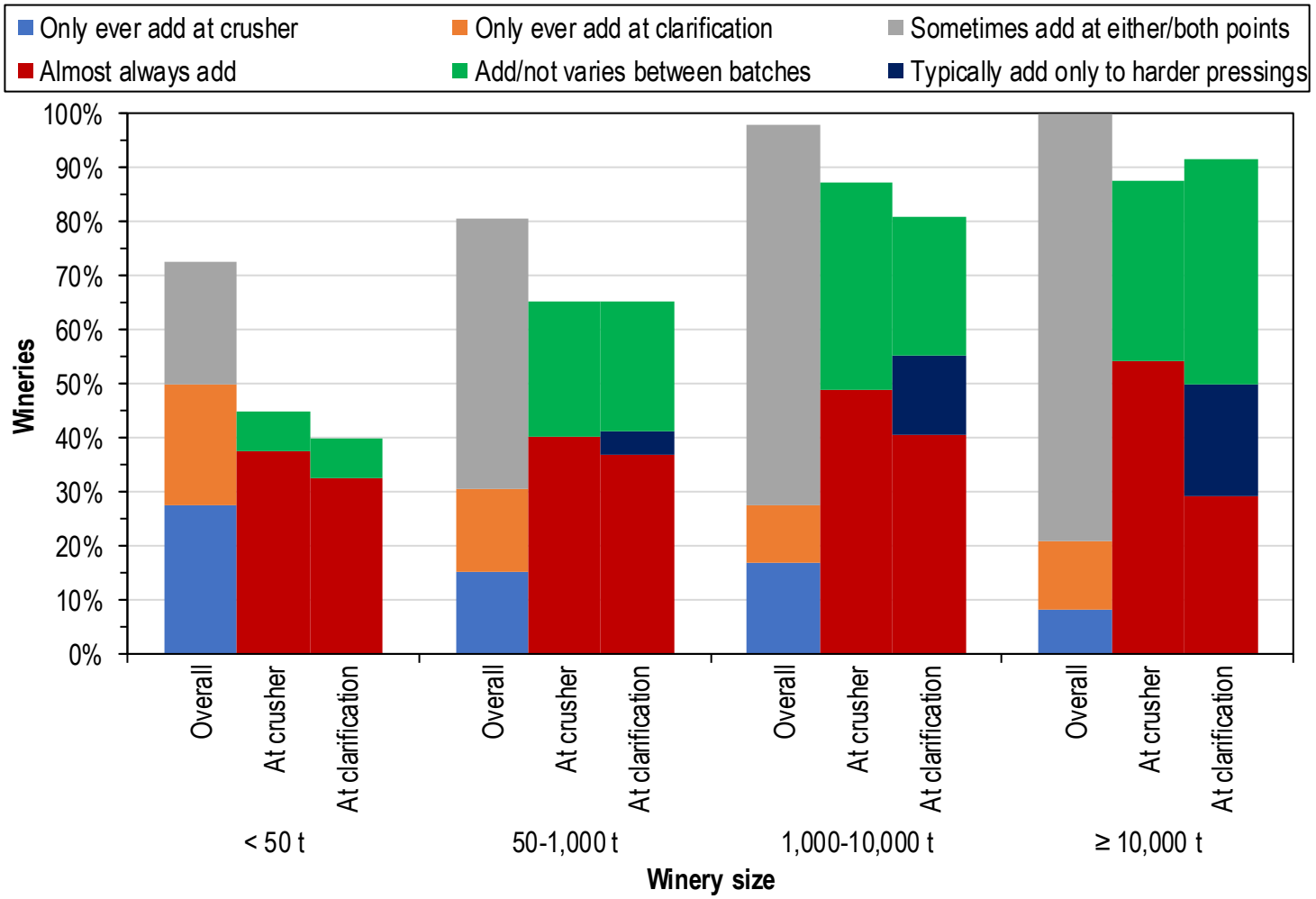
Enzyme addition to white and red grapes/juice/ferments (used at all)



- Most wineries added enzymes to some white grapes or juice.
- The addition of enzymes to red grapes, juice or ferments was less common and more contentious.
- Several respondents mentioned that the main driver for their enzyme addition in red wine production was for clarification, not for extraction.
- Several respondents also noted that they had seen no compelling evidence that enzymes enhanced colour extraction in red wine production.

*The question asked whether enzymes were added to any white grapes, must or juice. In a question on red fermentation extraction management techniques the use of enzymes was an option that could be selected. These have been aggregated for this plot.

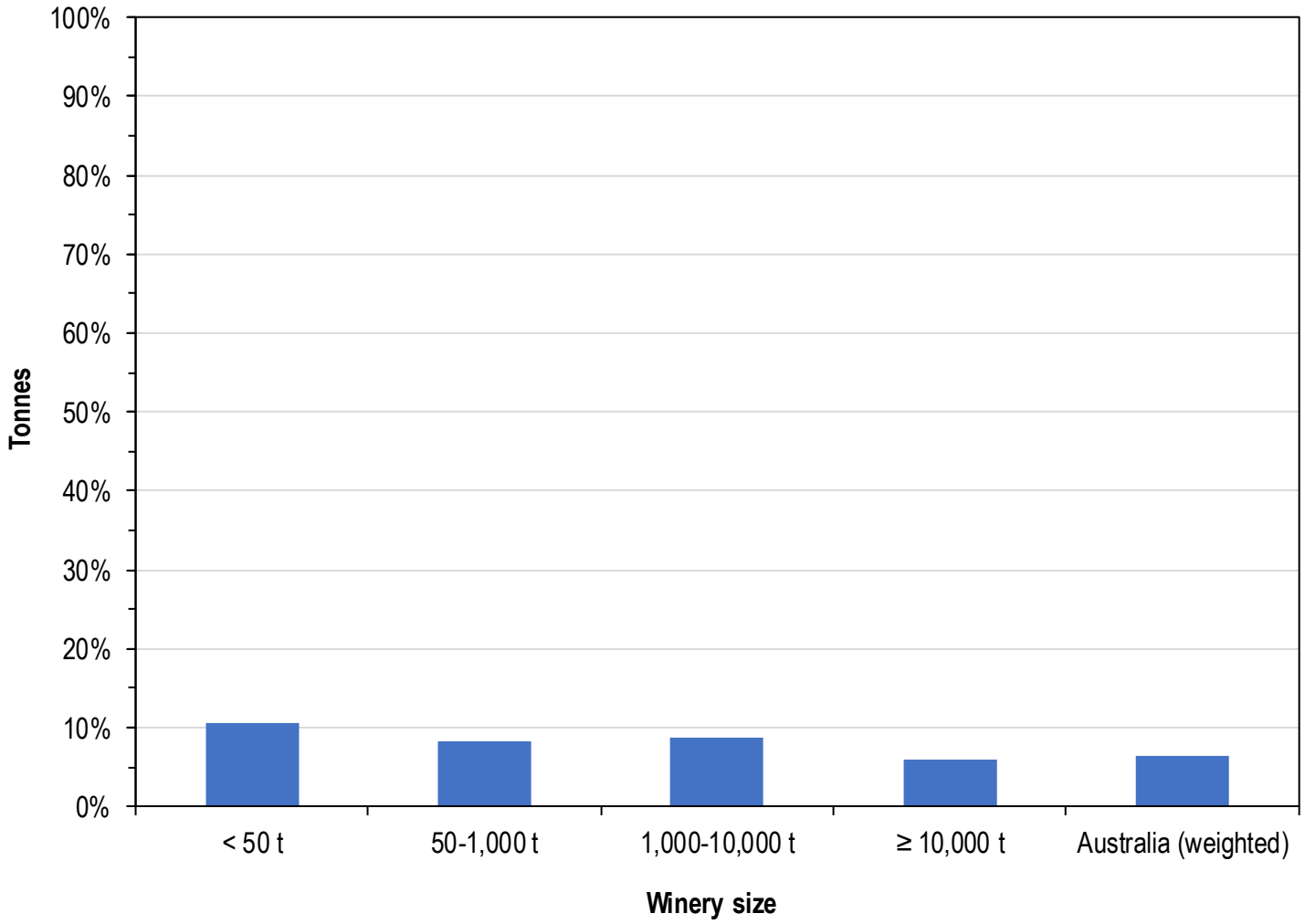
Timing of enzyme additions to white grapes/juice



- Some wineries were concerned about phenolic pick-up so only made enzyme additions after draining/pressing for some products.
- Others noted that they had seen no compelling evidence of undesirable phenolic pick-up and therefore always added enzymes at the crusher.
- The proportion of wineries sometimes adding enzymes at either or both points increased with winery size.
- Practices sometimes varied within wineries based on grape variety, whether the batch was receiving skin contact and whether it was being clarified pre-fermentation.
- A strategy mentioned on several occasions was to add enzymes at the crusher and then make top-ups to juice fractions as required – often this was based around ensuring that juice was 'pectin-negative' prior to flotation.

*Those wineries that added enzymes to any white grapes, must or juice were asked whether they added any prior to draining/pressing (i.e. at the crusher or must pump) and whether they added any after draining/pressing (i.e. at clarification) and what their practices generally were at each point.

Intentional white grape skin contact after crushing



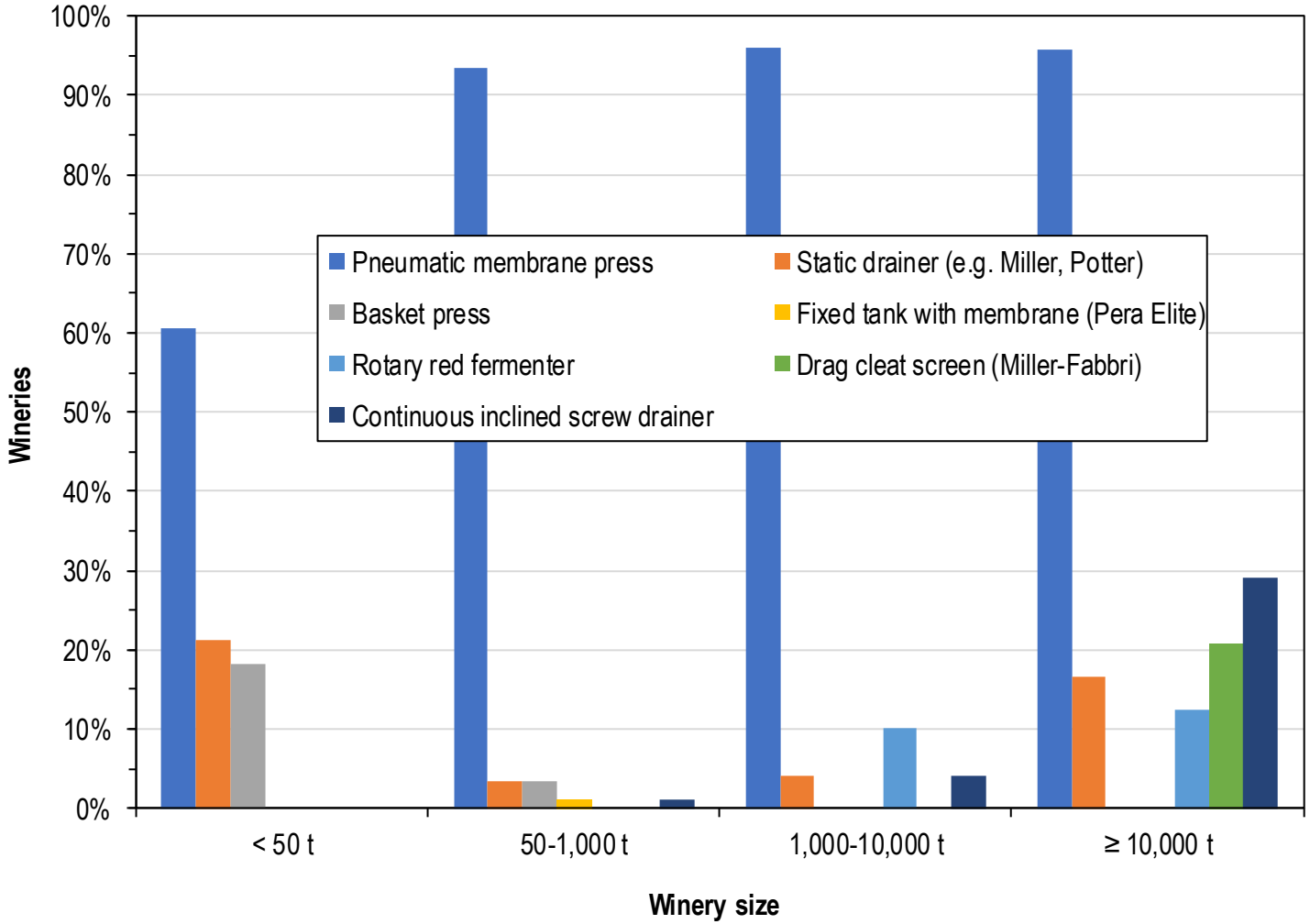
Use of skin contact for white wines in Australia

6% skin contact

- Many wineries performed small quantities of intentional skin contact after crushing.
- The most common variety receiving skin contact was Sauvignon Blanc.
- Another variety often mentioned as receiving skin contact was Gordo, primarily to increase its pressability.
- Fiano was also mentioned a few times in discussions on skin contact.
- Some wineries indicated that they would like to do more skin contact but that it was difficult for logistical reasons (e.g. press availability).

*Respondents were first asked whether any intentional white skin contact was practised at the site (i.e. after white grape crushing at the winery, prior to draining beginning). If they answered yes, they were asked to select what % of white grapes underwent intentional skin contact to the nearest 10%. Skin contacted white tonnage was estimated based on this, the winery intake tonnage and fraction of white grapes in that intake.

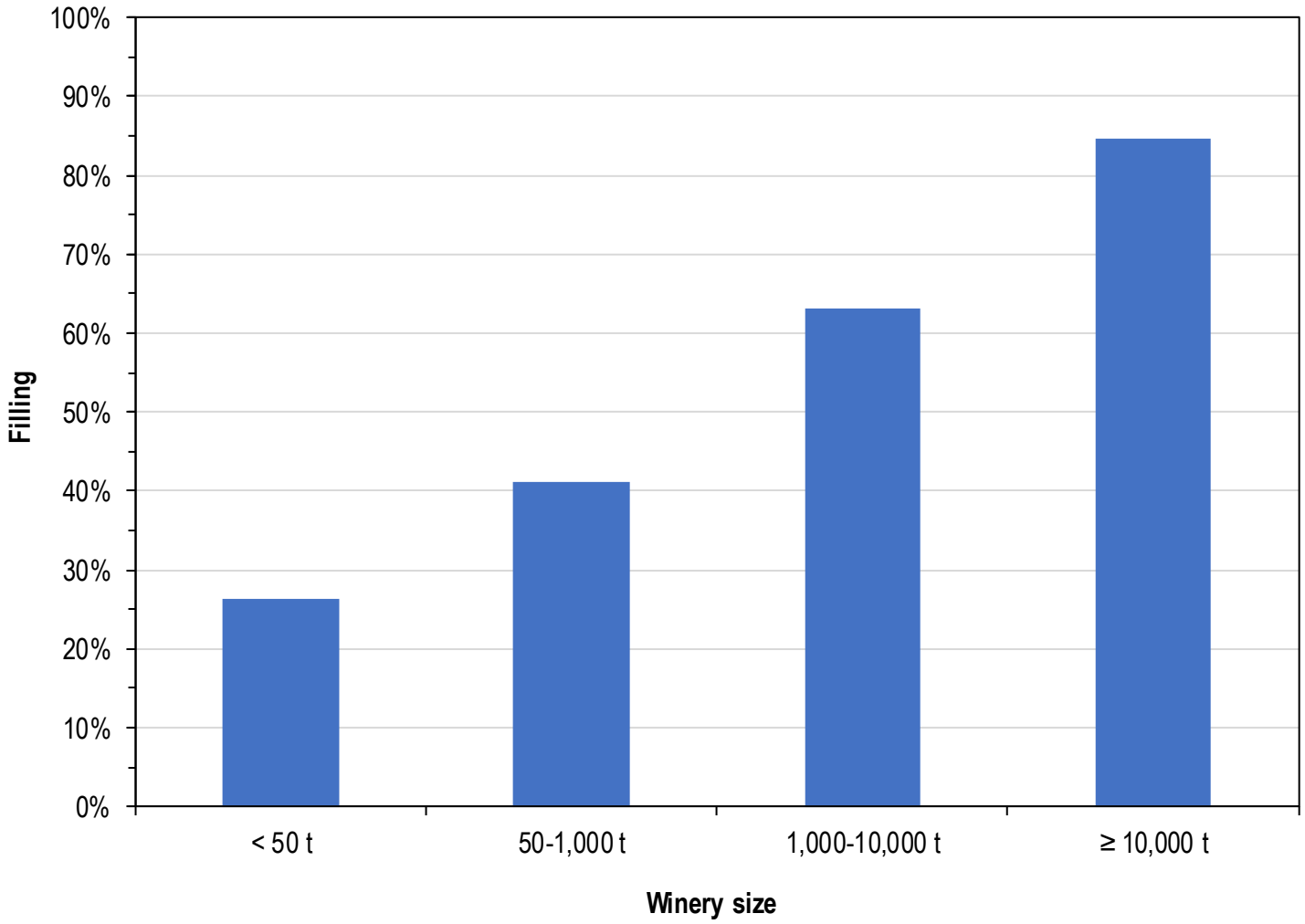
White juice draining equipment (used at all)



- Membrane presses were the dominant equipment used for white juice draining in wineries of all sizes.
- Large wineries also used older specific draining equipment, such as Miller and Potter static drainers and inclined screw drainers.
- Rotary red fermenters and drag-cleat screen drainers were not specifically given as options in the survey question but were added based on responses to 'other' and follow-up visits. The specific operation of these devices was not considered (e.g. whether Miller-Fabbri drag-cleat screen drainers were operated with continuous skin removal or as static drainers with skin removal only at the end of the cycle).
- Basket press was also not specifically listed as an option in the original survey but was added based on responses to 'other'. It is also possible that respondents in small wineries selecting static drainers were referring to basket presses.

*Respondents were asked to select from a list all equipment that was used to drain white juice prior to beginning pressing.

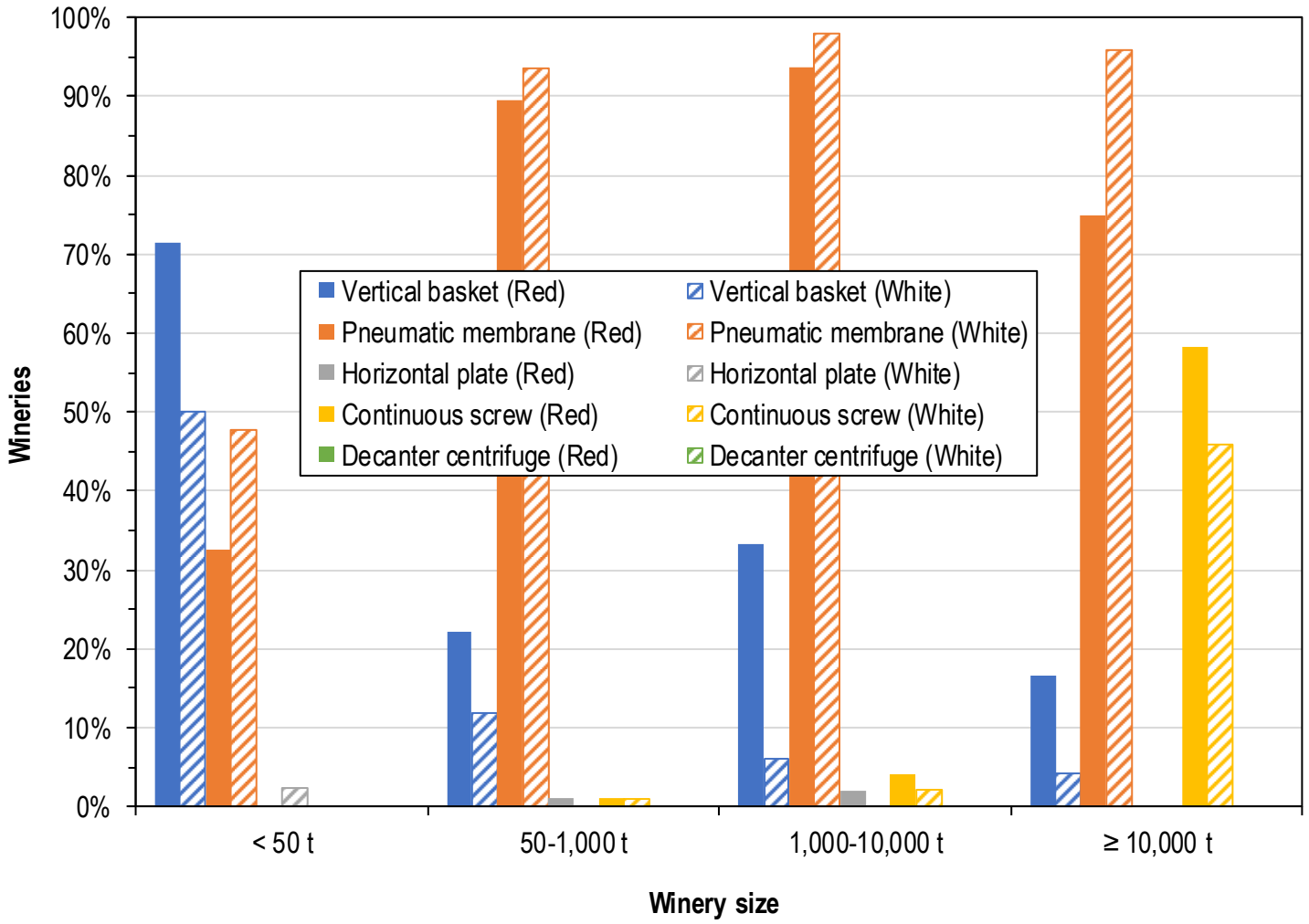
Average fraction of axial filling when using a membrane press for white draining



- The use of axial filling was more common in larger wineries, but practices varied.
- Responses were often quite binary, with essentially everything or nothing being axial filled, probably reflecting the installed infrastructure.
- Axial filling was more common in larger wineries likely mainly for efficiency reasons (e.g. greater draining during filling because of intermittent rotations and to facilitate automation).
- Reasons given for filling through press doors included because the grapes had not been destemmed or crushed and were being direct tipped, a desire to minimise maceration, or to allow processing of material that had already been partially drained in a separate drainer.

*Respondents that had selected that they used a membrane press to drain white juice prior to beginning pressing were asked to select to the nearest 10% what % of the time it is filled axially when it is used as a drainer. The results are presented as the average of the % in that winery size category, not based on the tonnages actually processed by the method.

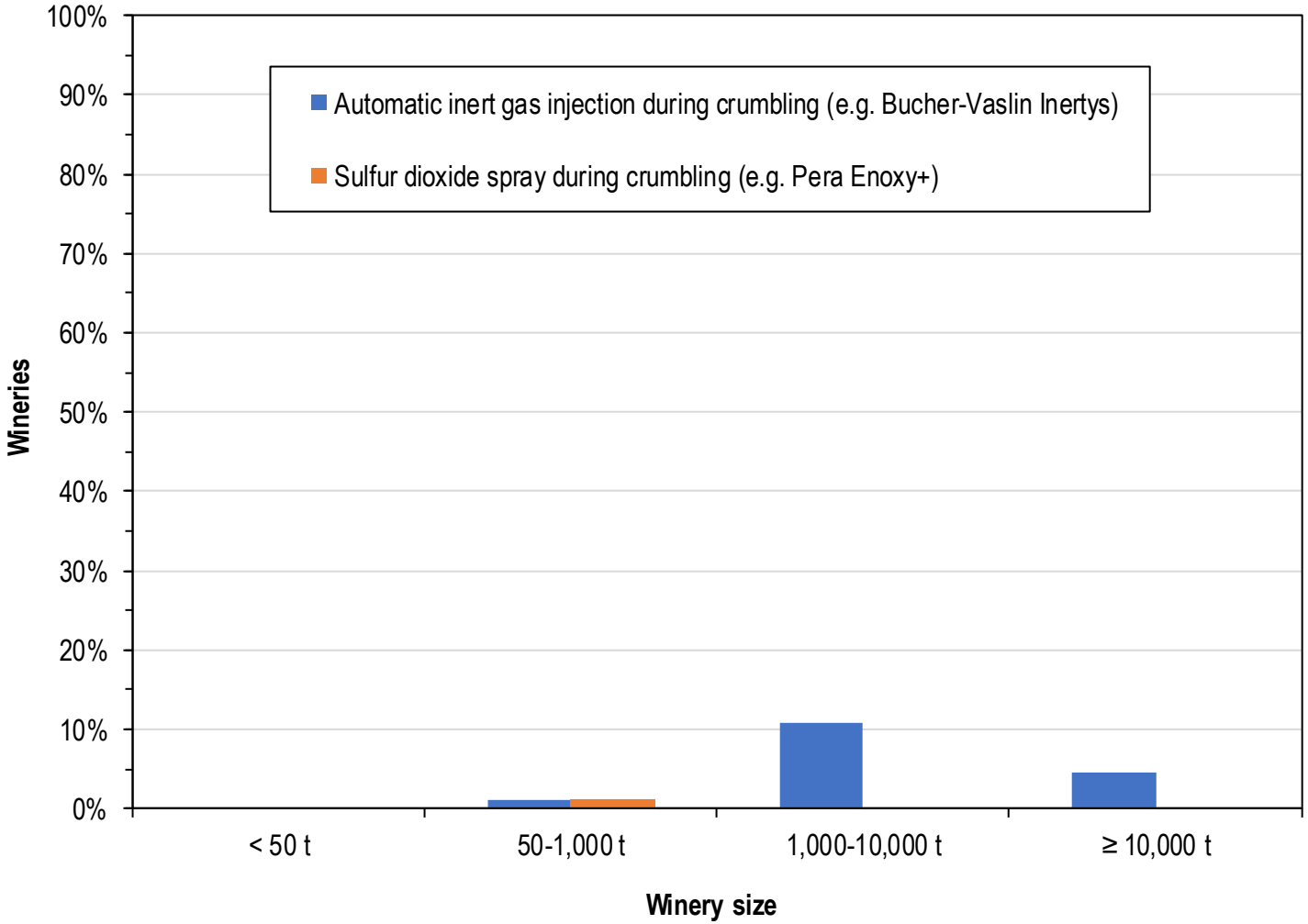
Pressing equipment for red ferments and white grapes (used at all)



- Membrane presses were most common in all apart from small wineries where basket presses were most common.
- Basket presses were, however, still quite often used in larger wineries for some red wine production.
- Most large wineries used membrane presses, but many also used continuous screw presses. Since 2016 use of continuous screw presses has fallen by at least a further 8% for whites and 4% for reds from the levels shown.
- Decanter centrifuges were not used as a press substitute by any wineries.
- Continuous screw presses were preferred to membrane presses by some wineries in some applications, not just for reasons of throughput, but because of concerns of blocking screens in membrane presses when used in combination with macerative red ferment and/or fermenter emptying conditions (e.g. static red fermenters emptied by jetting).

*Respondents were asked to select from a list all equipment that was used to press white grape material. In a separate question they were asked to select the equipment used to press red grape material. The question included separate options for manual, automated and water-operated vertical basket presses, but these have been aggregated in the plot.

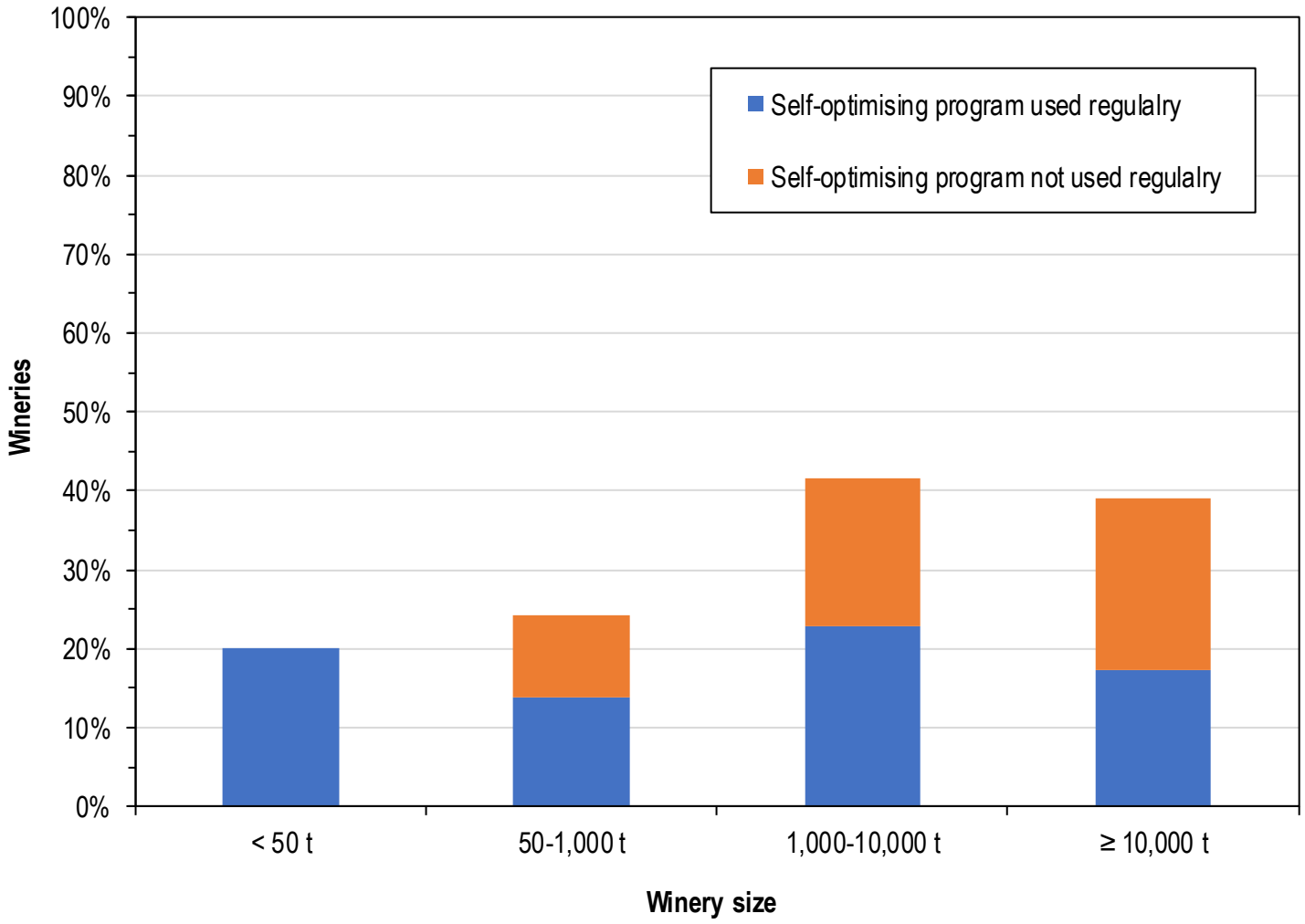
Oxidation prevention systems with white grapes on membrane presses (used at all)



- A small number of wineries had at least one press fitted with a system to inject inert gas during crumbling.
- Of the three wineries visited that had an inert gas system on at least one of their presses, one used the system regularly, and two did not.

*Respondents that had selected that they used a membrane press to press white grape material were asked whether any of their membranes presses were fitted with systems to prevent oxidation during crumbling and to select the systems used from a list.

Self-optimisation based on flow rate on presses for white grape pressing



- The likelihood of having a press fitted with a self-optimising program increased somewhat with winery size but the likelihood of it being used regularly decreased slightly.
- Wineries that used these systems regularly were very happy with them.

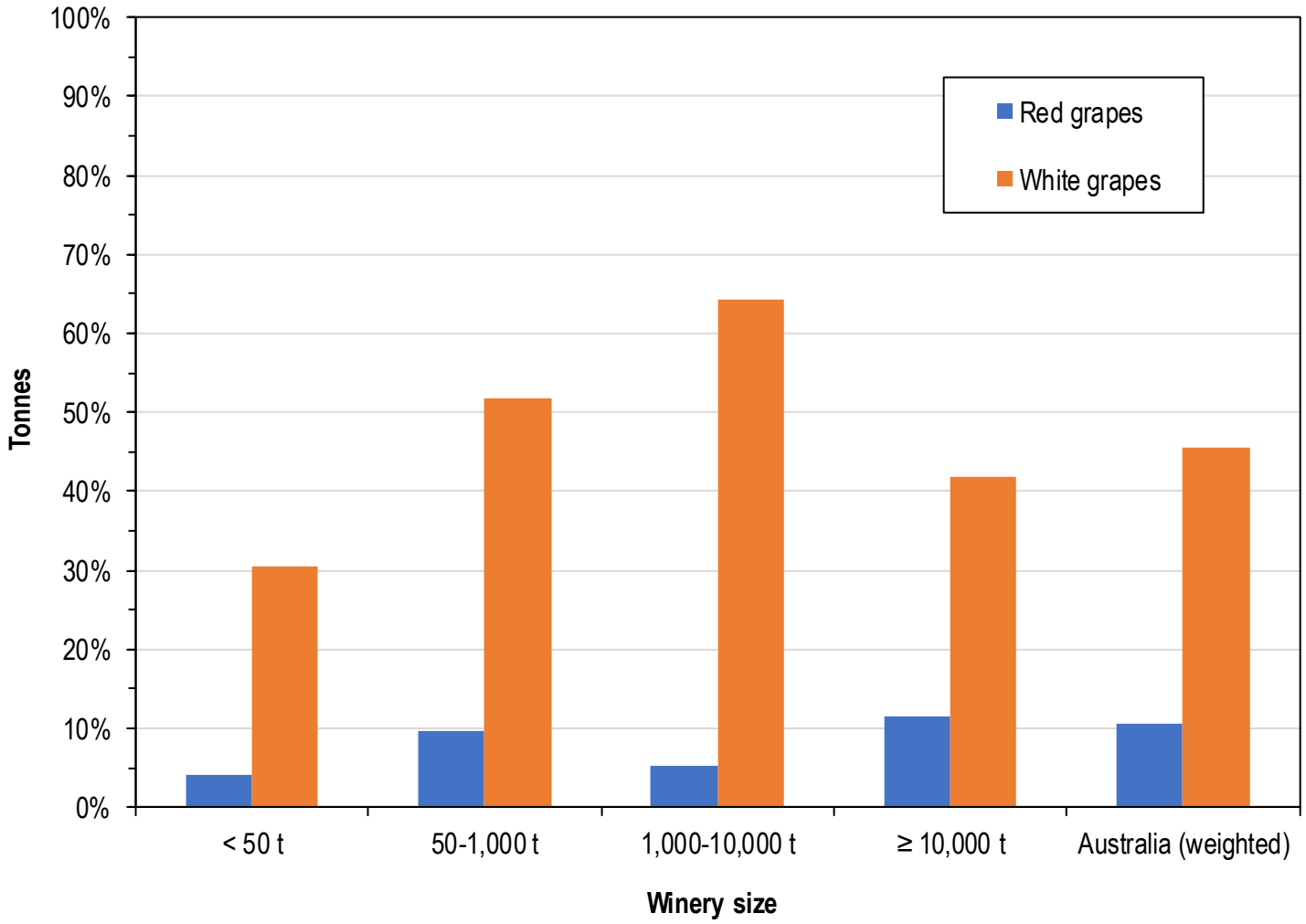
Reasons given for not using:

- Self-optimising program can take a long time and the time it takes varies.
- Winemaker is able to be at the press to monitor so it is not needed.
- Don't think it makes much difference.
- Winemaker is more familiar with the local grapes and has a better program.
- Issues with flow meter accuracy because of foaming.

- One press supplier also noted that systems vary between brands, with flow rate being measured in different ways, and some systems only automate pressing, while others automate draining as well.

*Respondents that had selected that they used a membrane press to press white grape material were asked whether any of their membrane presses were fitted with a system that optimises the press program automatically based on juice flow rate, and if so whether this system was used regularly or not.

Whole bunch pressing of hand-picked grapes



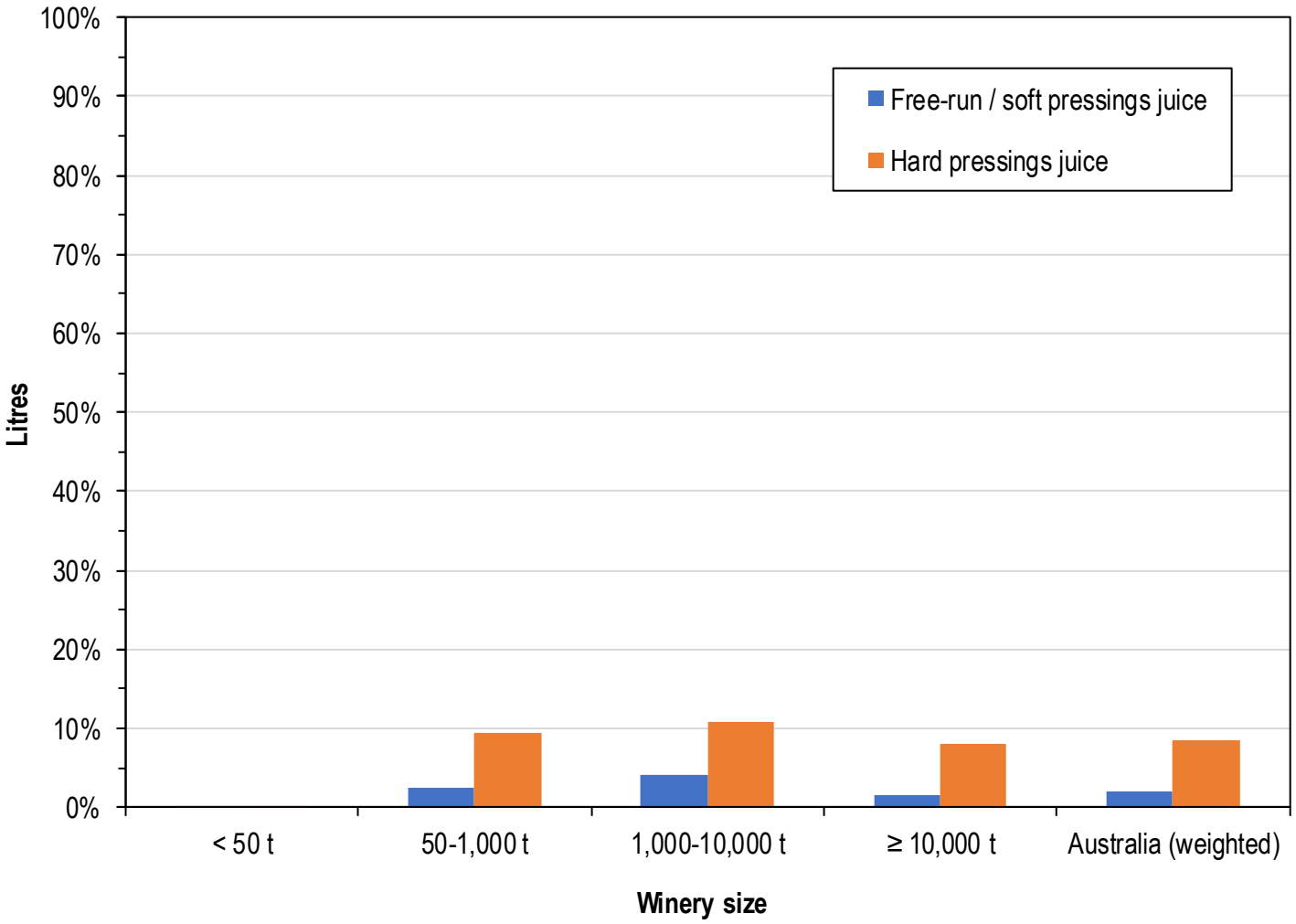
Whole bunch pressing of hand-picked grapes in Australia

10% red
46% white

- While only 4% of white grapes were hand-picked, almost half of these were whole bunch pressed.
- This was not just for sparkling base, but also for table wines (high-end barrel fermented Chardonnay was given as an example on one visit).

*Respondents that hand-picked grapes were first asked whether any whole bunch pressing was performed on those grapes. If they answered yes, they were asked to select what % of hand-picked red and white grapes were whole bunch pressed to the nearest 10%. Whole bunch pressed tonnage was estimated based on this, the winery intake tonnage and the fraction that was hand-picked.

Hyperoxidation of white juice



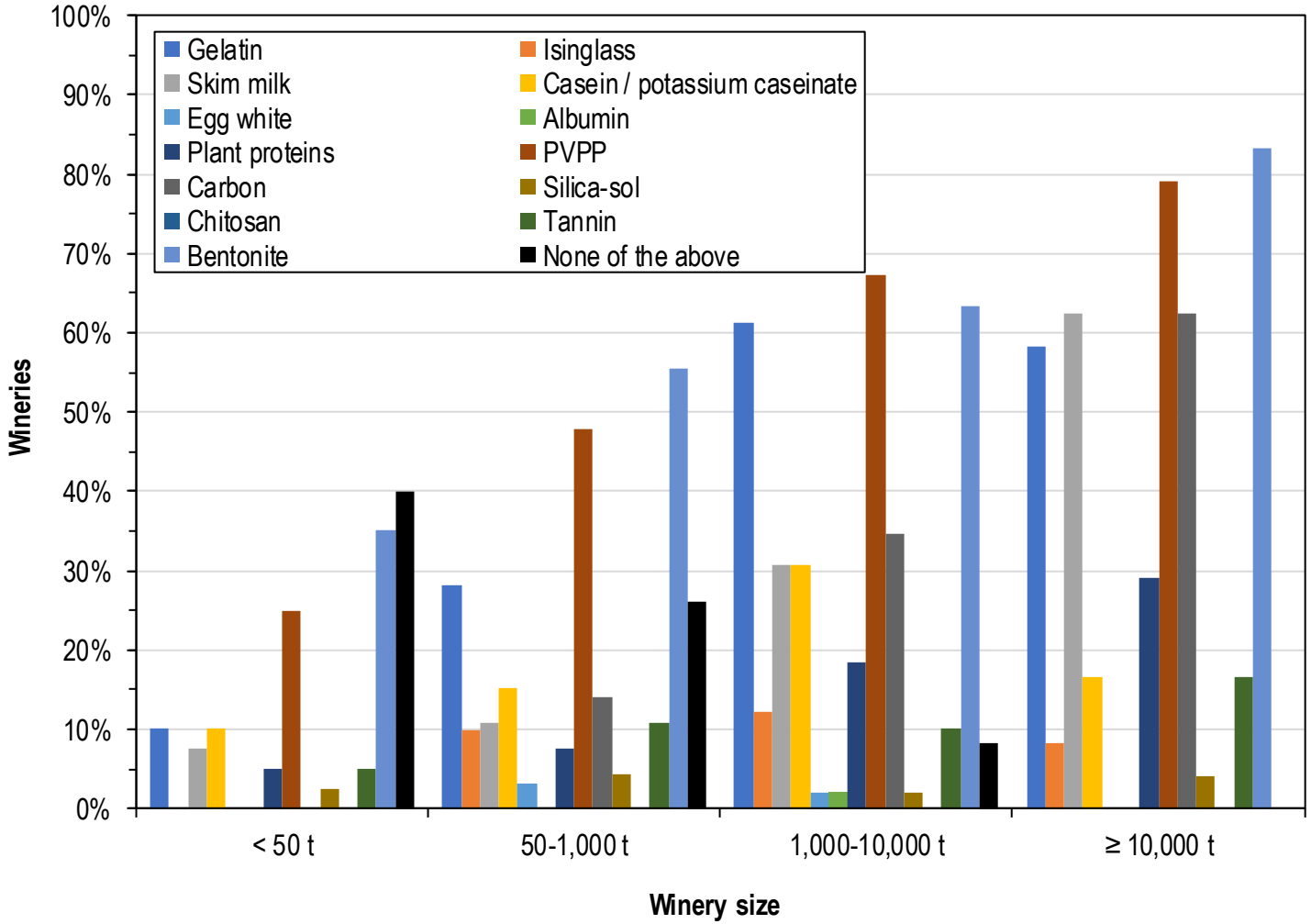
Hyperoxidation of white juice in Australia

2% free-run/soft pressings
8% harder pressings

- The definition of hyperoxidation provided in the question was the intentional introduction of oxygen into juice by sparging with air or oxygen.
- Hyperoxidation was more commonly performed on harder pressings juices.
- Removal of colour from Pinot Gris was the most common use mentioned when it was applied to free-run/soft-pressings juice.
- Several respondents noted that while they don't hyperoxidise juice, they don't add SO_2 to the pressings in the juice tray either.

*Respondents were first asked whether any white juice from drainers/presses was hyper-oxidised (hyperoxidation was defined as the intentional introduction of oxygen by sparging with air or oxygen). If they answered yes, they were asked to select what % of free-run/soft pressings and harder pressings juices were hyperoxidised to the nearest 10%. Hyperoxidised litres were estimated based on this, the winery intake tonnage, and fraction which was white grapes.

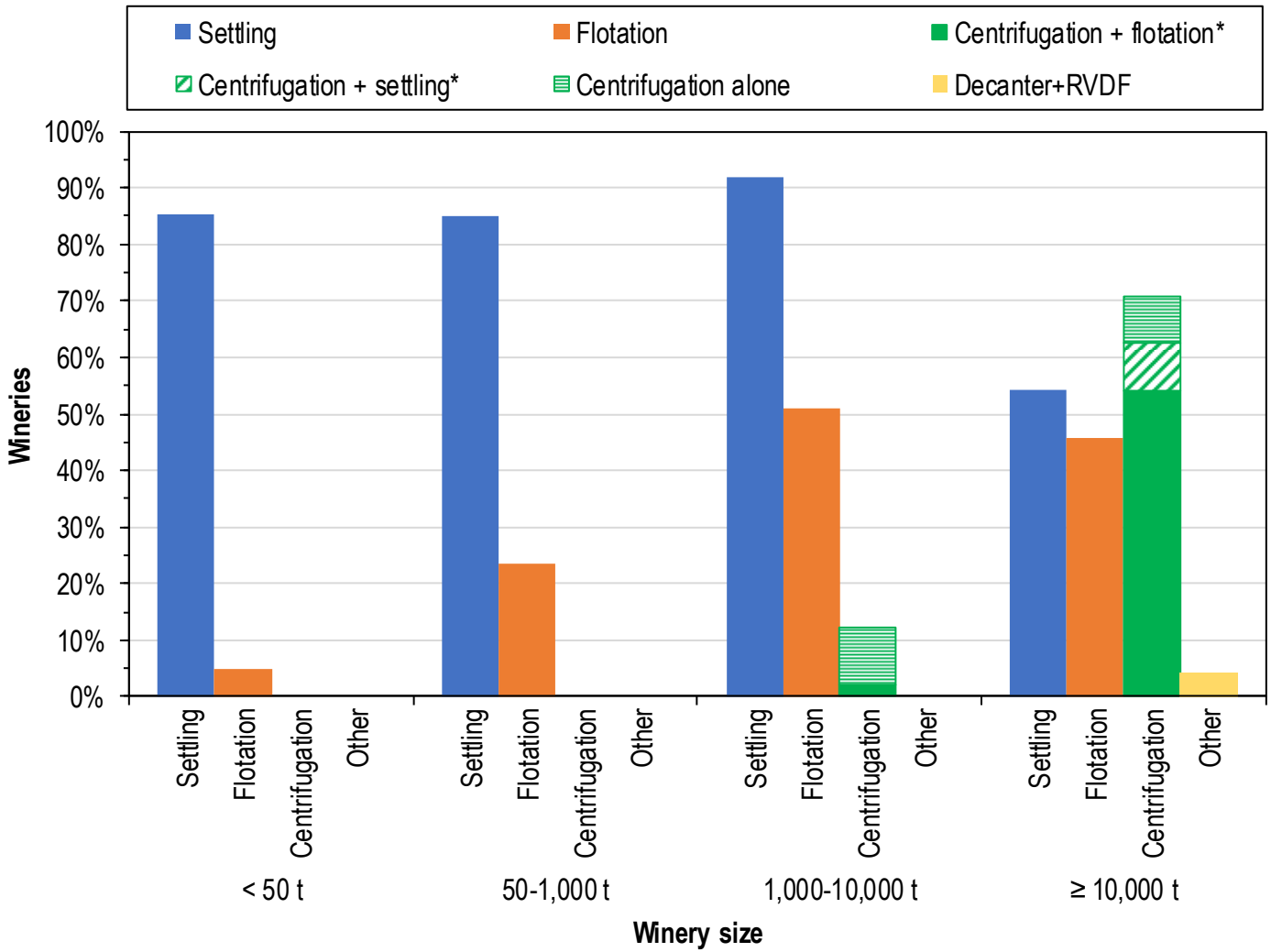
Processing aids used on white juice (used at all)



- PVPP and bentonite were the agents most commonly used at all by wineries.
- In follow-up visits, in addition to their fining function, some respondents thought that the prominence of these ingredients may relate to compatibility with allergen-free and vegan-friendly wines.
- Plant proteins (e.g. from potatoes and peas) were also used by wineries (e.g. ~30% of wineries ≥ 10,000 t).
- Plant proteins were mentioned by several wineries as being more expensive and/or requiring higher doses.
- While no wineries reported using chitosan on juice, this may have been a component of some of the products reported as 'plant proteins'.
- Please see pages 133-144 for data on processing aids used on wine.

*Respondents were asked to select from a list which processing aids were added to any white grapes, must or juice.

White juice clarification techniques (used at all)

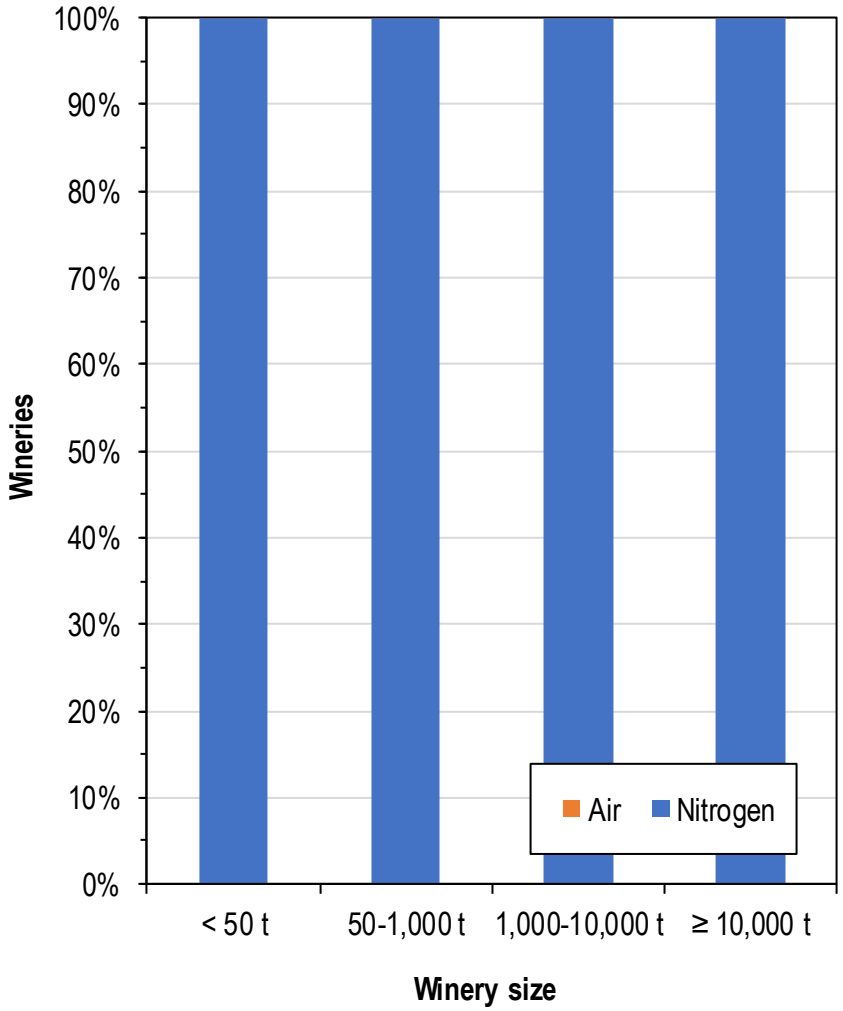


- Settling is the traditional method used to clarify white juice. It was used in wineries of all sizes – even 15% of wineries ≥ 10,000 t only used settling.
- Larger wineries were more likely to use centrifugation, most commonly in combination with flotation on the centrifuge outlet.
- Single-stage flotation without prior centrifugation was common across medium and large wineries – speed, lower cooling requirements and less juice in lees were some of the benefits over cold settling driving adoption.
- **Flotation was the practice that was second most commonly nominated by wineries as having a positive impact on their operations in the last five years (see page 154).**
- Relatively cheap flotation systems working via batch recirculation on a tank (e.g. Juclas EasyFloat) were the most common systems in use.

(continued next page…)

†Respondents were asked to select from a list all methods or combinations of methods used to clarify white juice prior to fermentation. *Wineries occasionally bypass the second process (e.g. they may skip flotation after centrifugation for some higher-solids Chardonnay ferments).

Gas most commonly used for flotation (and white juice clarification techniques comments cont.)

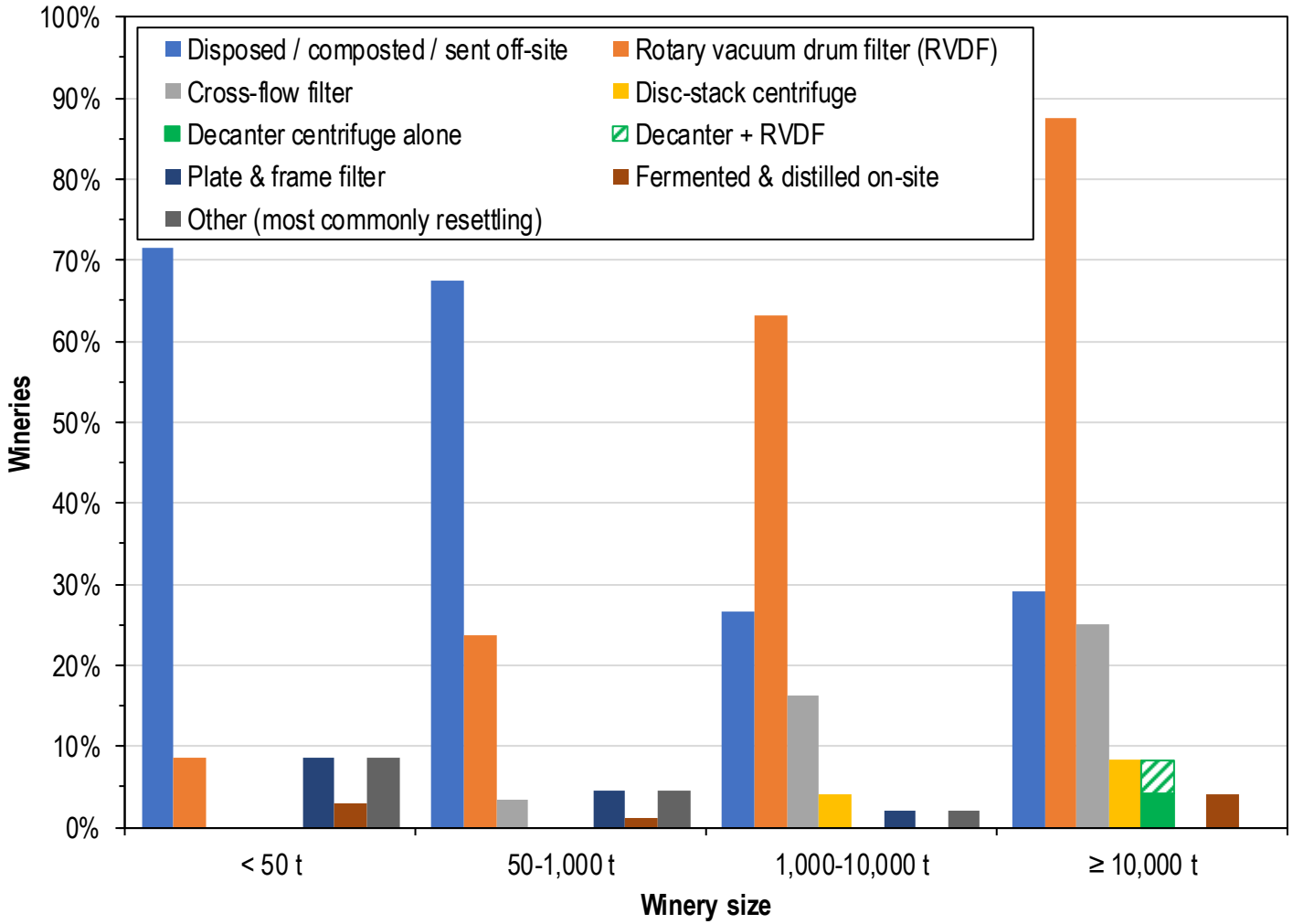


(…from previous page)

- Some larger wineries that were early adopters of flotation were using batch tank-to-tank flotation systems, and around 20% of wineries ≥ 10,000 t were using continuous flotation systems with a separation basin. At least a further 10% of wineries ≥ 10,000 t had this type of system installed by the 2019 vintage.
- The gas most commonly used for flotation in all wineries was nitrogen, although air was occasionally used by some wineries for particular batches.
- One of the benefits mentioned of cold settling (either when used alone or after centrifugation) was that it provides operational flexibility by allowing fermentation to be held off, which might, for example, allow blending of juice parcels from different vineyards if desired.
- The original question included cross-flow filtration as an option for juice clarification, to which several respondents answered yes; however, in follow-up visits this was generally being used to clarify juice lees from a prior clarification step rather than whole juice, or alternatively to further clarify juice for later use in sweetening or for use in yeast propagation.
- Some cross-flow filter suppliers have now started promoting the use of cross-flow filtration for whole juice clarification (some using cross-flow filter membranes with larger than normal pore sizes, and some using membranes with normal pore sizes) but it does not appear that this technique was used in 2016 and it would still be very unusual.

*Wineries that employed flotation (with or without prior centrifugation) were asked to select the most common gas used.

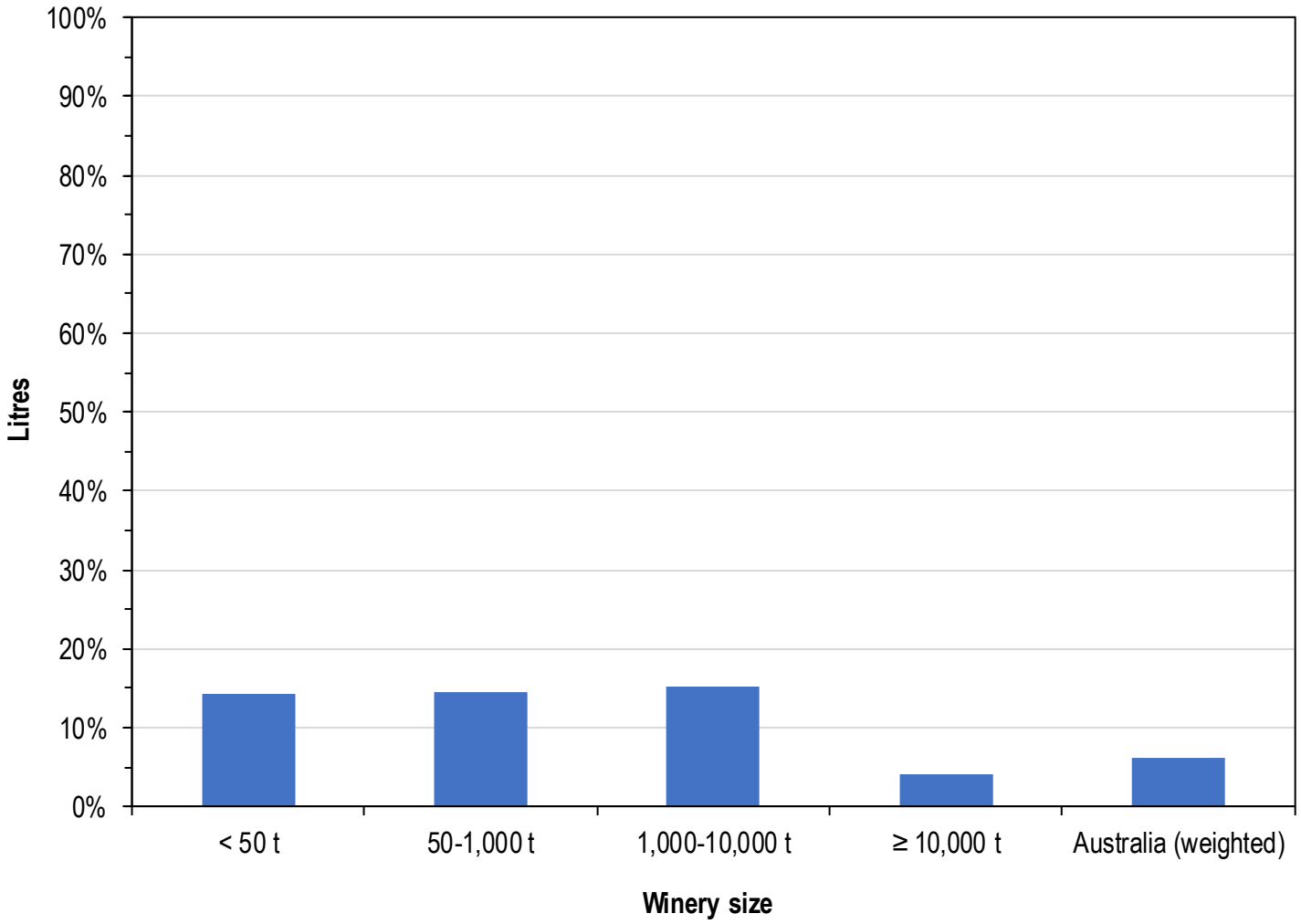
White juice lees/floats/desludge management techniques (used at all)



- Juice was more likely to be recovered in large wineries, but many large wineries did not recover juice in some instances (e.g. from centrifuge sludge).
- Rotary vacuum drum filtration was the most common technique for recovering juice from lees, followed by wide-bore cross-flow filtration.
- Some wide-bore cross-flow filter adopters were very satisfied with the technique, while others considering it weren't able to achieve flow rates high enough to justify the investment, particularly where the low speed would prevent re-blending of the recovered juice into the original batch.
- Some wineries had instead adopted decanter or disc-stack centrifuges to achieve acceptable flow rates.
- The specifics varied depending on the mix of processes at a winery (e.g. some wineries did not need to clarify their lees as much as others because they were able to blend it with juice from another initial juice clarification technique that gave a low turbidity).

*Wineries were asked to select from a list all the techniques that were used to manage the lees/bottoms/floats/desludge/retentate from the juice clarification processes selected in the previous question.

White ferments without specific juice clarification



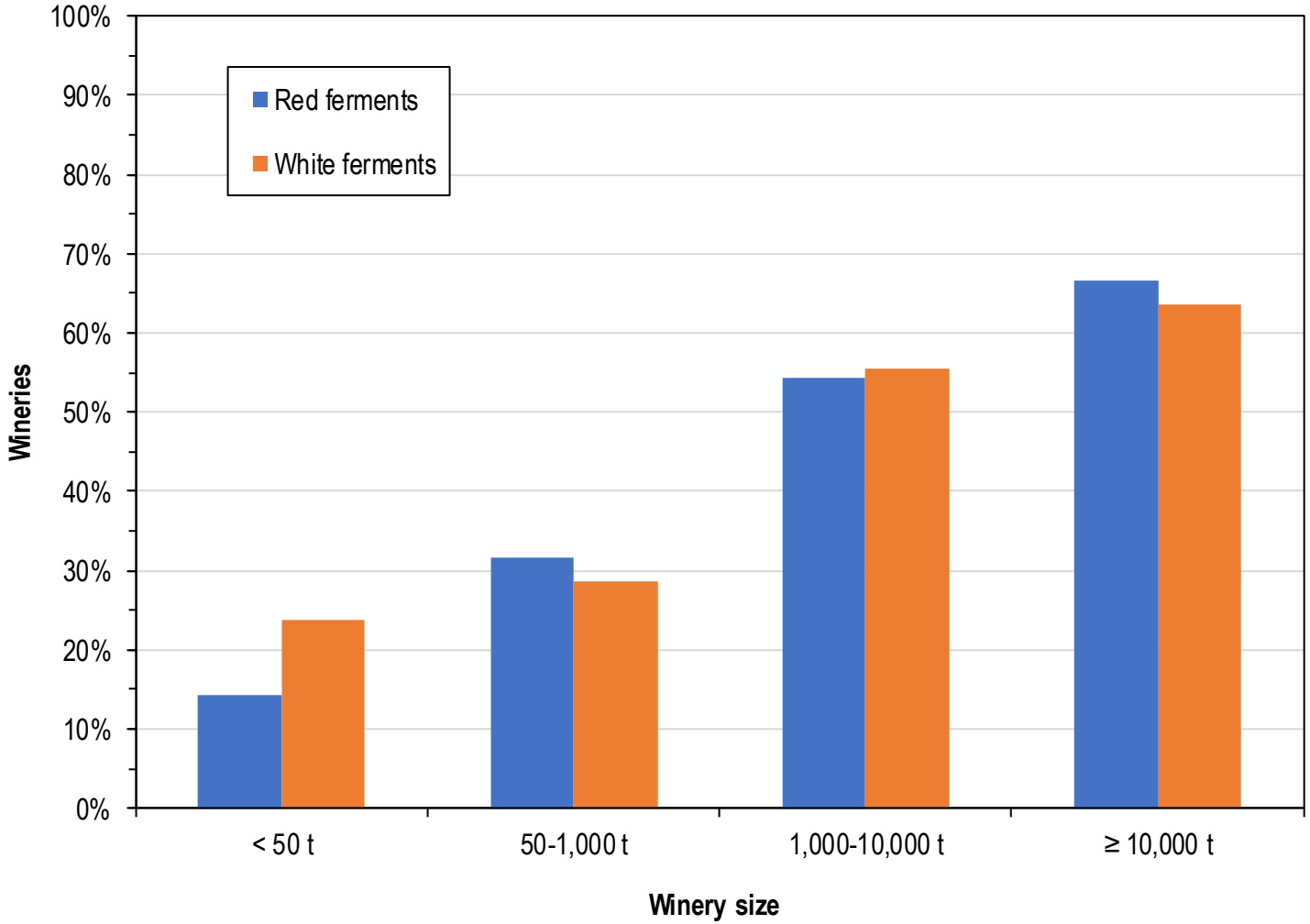
Ferments of unclarified juice in Australia

6% not clarified

- A small proportion of ferments were performed on unclarified juice at many wineries, with a few wineries doing this frequently.
- Chardonnay was mentioned most often in this context.
- While still clarifying the juice, some wineries were also back-adding fluffy solids (lighter lees).

*Respondents that performed white ferments were asked whether any ferments were performed without juice clarification after draining/pressing (i.e. without cold settling, flotation, centrifugation, etc.). If they answered yes, they were asked to select what % to the nearest 10%. Unclarified litres were estimated based on this, the winery intake tonnage and the fraction that was white grapes.

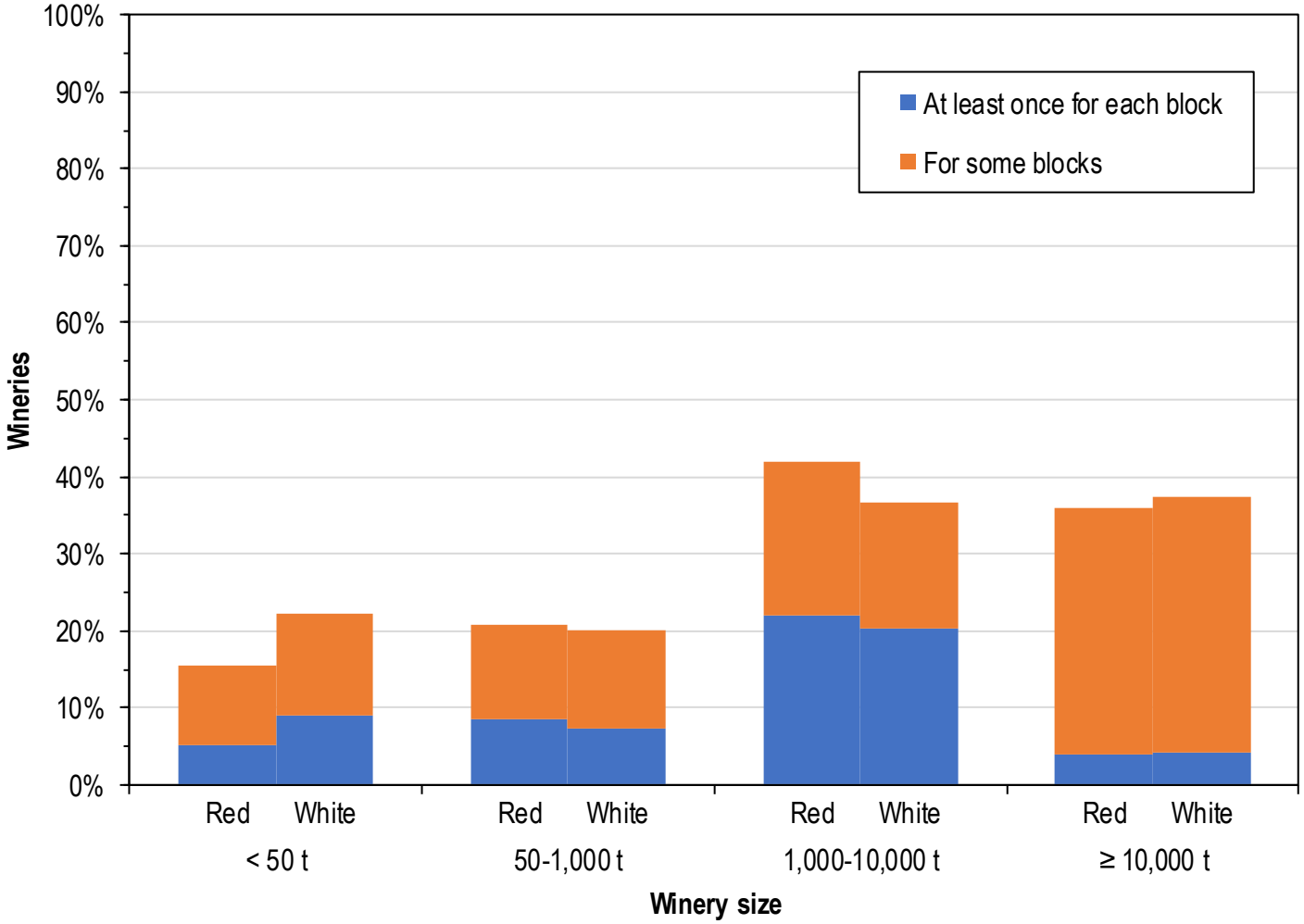
Nitrogen addition rates adapted based on grape/juice YAN measurements



- YAN measurements were more commonly performed by larger wineries, but many still did not.
- Larger wineries that did measure YAN tended to routinely perform measurements on the full juice/ferment tank.
- One respondent noted that while large wineries are more likely to perform YAN measurements, they may face less risk than a smaller winery because there will be multiple parcels in the same tank that may balance each other out.
- Some wineries that did not currently make YAN measurements indicated that they were considering performing some in the future.

*Respondents performing fermentations were asked whether nitrogen addition rates were adapted based on grape/juice YAN measurements.

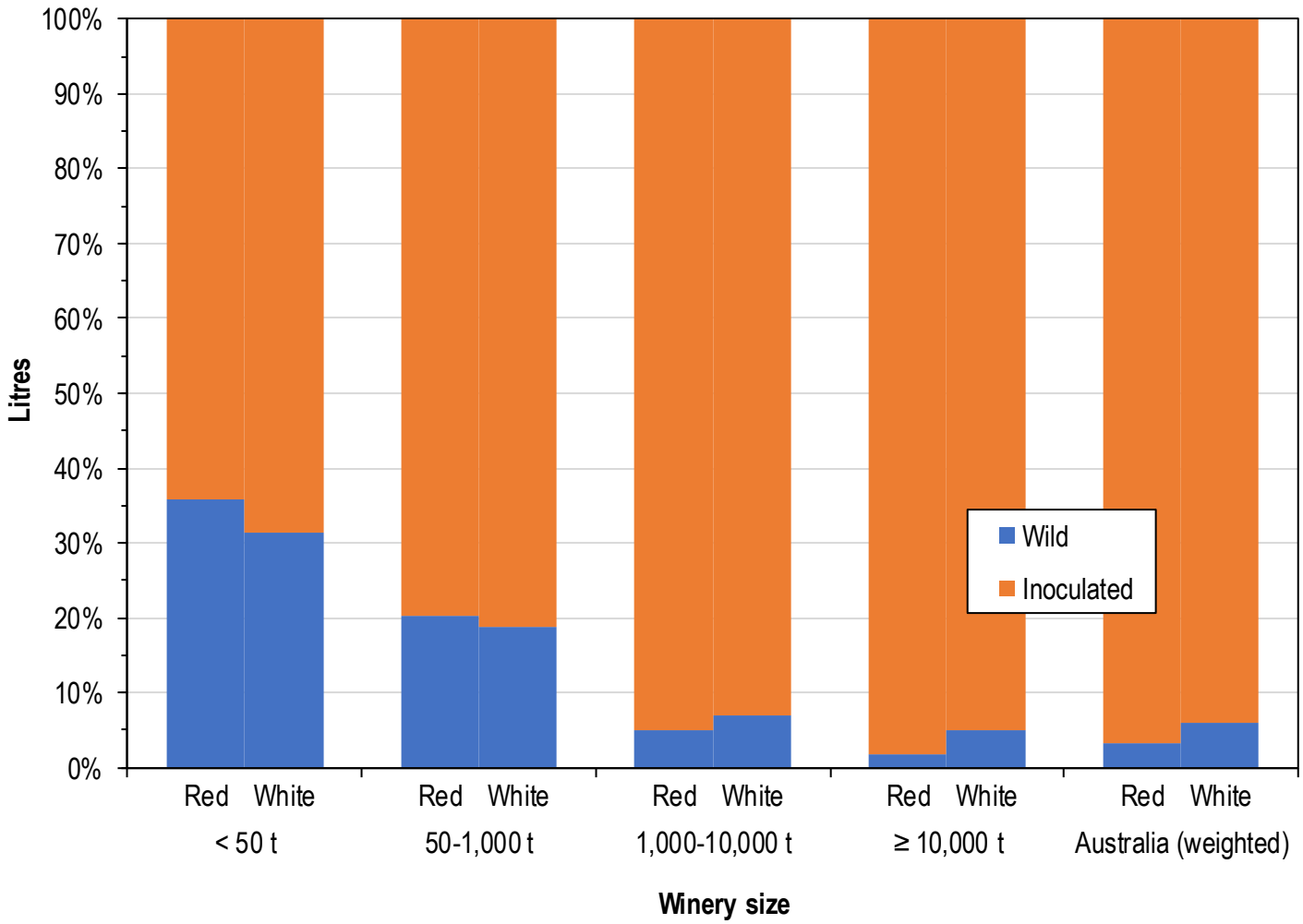
Perform pre-harvest measurements of YAN



- Pre-harvest YAN measurements were most commonly only performed on some blocks when performed at all.
- Typically, this related to testing only blocks where there had been problems in the past or testing blocks early in the season to get a feel for levels.
- Please see the previous page for more general statistics on pre-ferment YAN measurements, irrespective of whether they were performed pre-harvest or on grapes/juice at the winery.
- Larger wineries appeared to generally favour routine testing of the tank at the winery rather than blocks pre-harvest, since this blend is what is being fermented and this strategy requires fewer analyses to be performed.

*Respondents crushing grapes were asked whether YAN measurements were performed pre-harvest and whether this was performed on all blocks or only on some blocks.

Wild or inoculated primary ferments



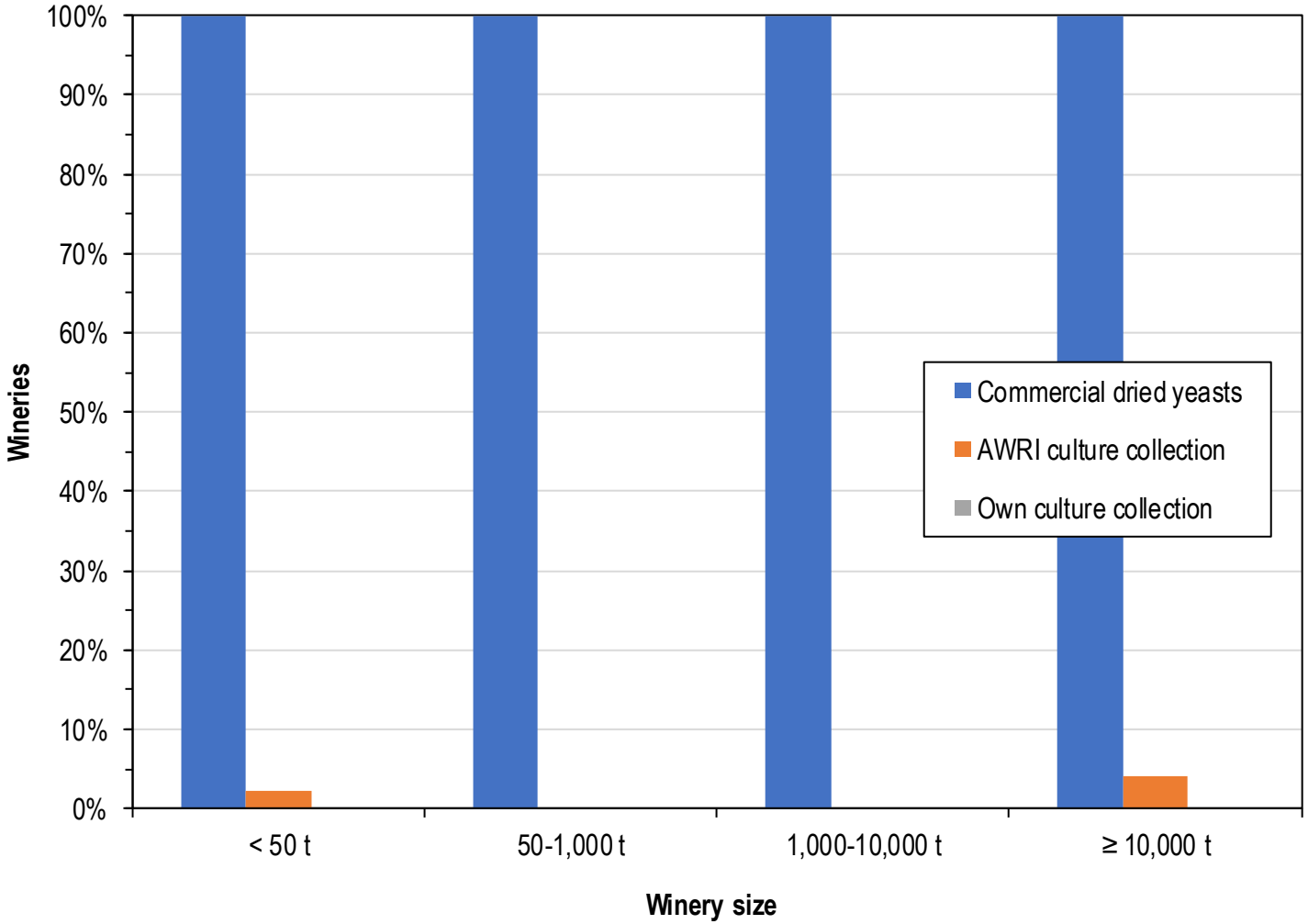
Wild ferments in Australia

3% red
6% white

- Wild ferments were more commonly performed in smaller wineries than larger wineries; however, many large wineries performed at least a small amount of wild fermentation.
- For more premium products, wild ferments were sometimes used whole, while in other products, wild ferments were used as a blending component to add complexity and mouth-feel.
- One respondent noted that logistically wild ferments can be easier for white than red wines, because there are deadlines on the use of specific red fermenters before they must be ready for the next batch, making inoculation a safer option.

*Respondents were first asked whether inoculated or wild ferments or both were performed at the winery. If they indicated both, they were then asked to select what % of red and white ferments (by volume) were inoculated to the nearest 10%. Inoculated and wild litres were estimated based on this, the winery intake tonnage and fractions of red and white grapes.

Sources of yeasts for inoculation of primary ferments (used at all)



- All wineries that inoculated ferments used commercially available dried yeasts.
- A small number of wineries used yeast from the AWRI wine microorganism culture collection.
- No wineries used yeasts from their own culture collection (but many were performing some wild uninoculated ferments – see previous page).

*Respondents that inoculated any ferments were asked to select where the strains used were sourced from.

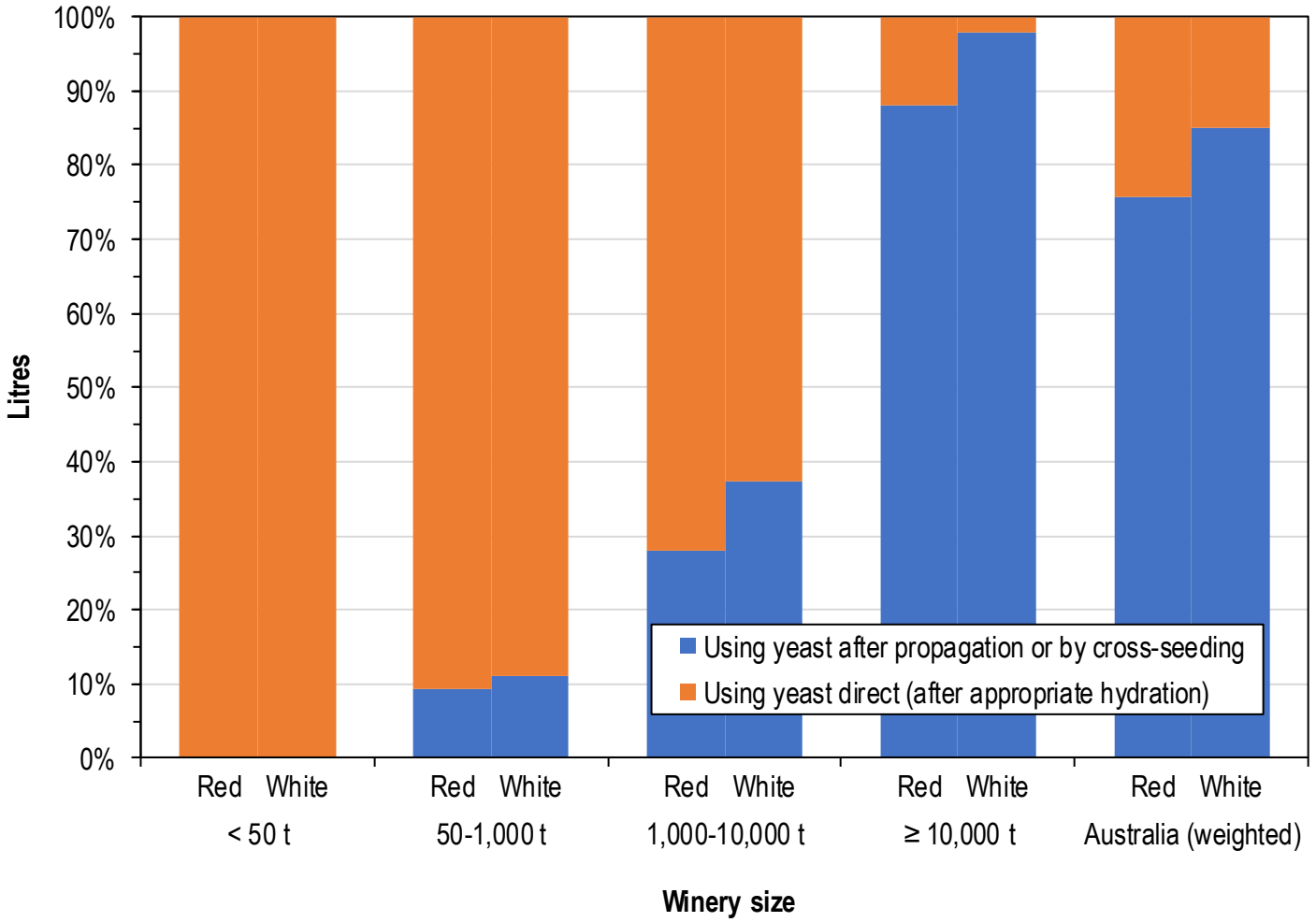
Most common yeast inoculation strains in Australia

	Red wine		White wine	
	By litres fermented	By number of wineries	By litres fermented	By number of wineries
1.	Maurivin AWRI796	Enoferm BDX (n=26)	Lalvin QA23	Lalvin QA23 (n=55)
2.	Maurivin BP725	Enoferm Syrah (n=22)	Lalvin CY3079	Zymaflore X5 (n=34)
3.	Lalvin EC1118	Lalvin RC212 (n=22)	Lalvin EC1118	Lalvin EC1118 (n=32)
4.	Lalvin ICV D254	Zymaflore FX10 (n=22)	Fermol Chardonnay	Lalvin CY3079 (n=22)
5.	Lalvin Rhône 2226	Lalvin Clos (n=18)	Maurivin PDM	Lalvin DV10 (n=13)
6.	Zymaflore FX10	Lalvin EC1118 (n=17)	Maurivin Elegance	Zymaflore VL3 (n=10)
7.	Lalvin Rhône 2223	Lalvin Rhône 2223 (n=15)	Enoferm T306	IOC 18-2007 (n=9)
8.	Lalvin Clos	Lalvin ICV D254 (n=14)	Zymaflore X5	Zymaflore X16 (n=6)
9.	Enoferm BDX	Lalvin Rhône 2226 (n=13)	Lalvin BA11	Lalvin ICV D47 (n=5)
10.	Uvaferm 43	Maurivin AWRI796 (n=12)	Zymaflore VL3	Zymaflore CH9 (n=5)
11.	Zymasil Bayanus	Zymaflore RX60 (n=12)	Lalvin DV10	Zymaflore VL1 (n=5)

- Maurivin AWRI796 and BP725 were used to ferment the largest volume of red wine.
- Lalvin QA23 was the most common yeast used for white wine both in terms of volume fermented and the number of wineries using it.
- Lalvin EC1118 was commonly used in both red and white wine production.
- Key drivers in yeast choice were wine style and ferment efficiency.
- While cost is a factor, yeast strains are more likely to be chosen based on a specific branded yeast than other winery processing aids and additives.

*Wineries that inoculated ferments were asked to select from a list the two inoculation yeast strains that were used for the largest volume of each of red and white fermentation. They then were asked to select what % of the volume of their inoculated fermentations these yeast were used for. Volumes fermented with each strain were then estimated based on this, the winery intake tonnage and fractions of red and white grapes. n gives the actual number of respondents using each strain as one of their top two.

Propagation of yeast for inoculated primary ferments



Use of propagated yeast in Australia

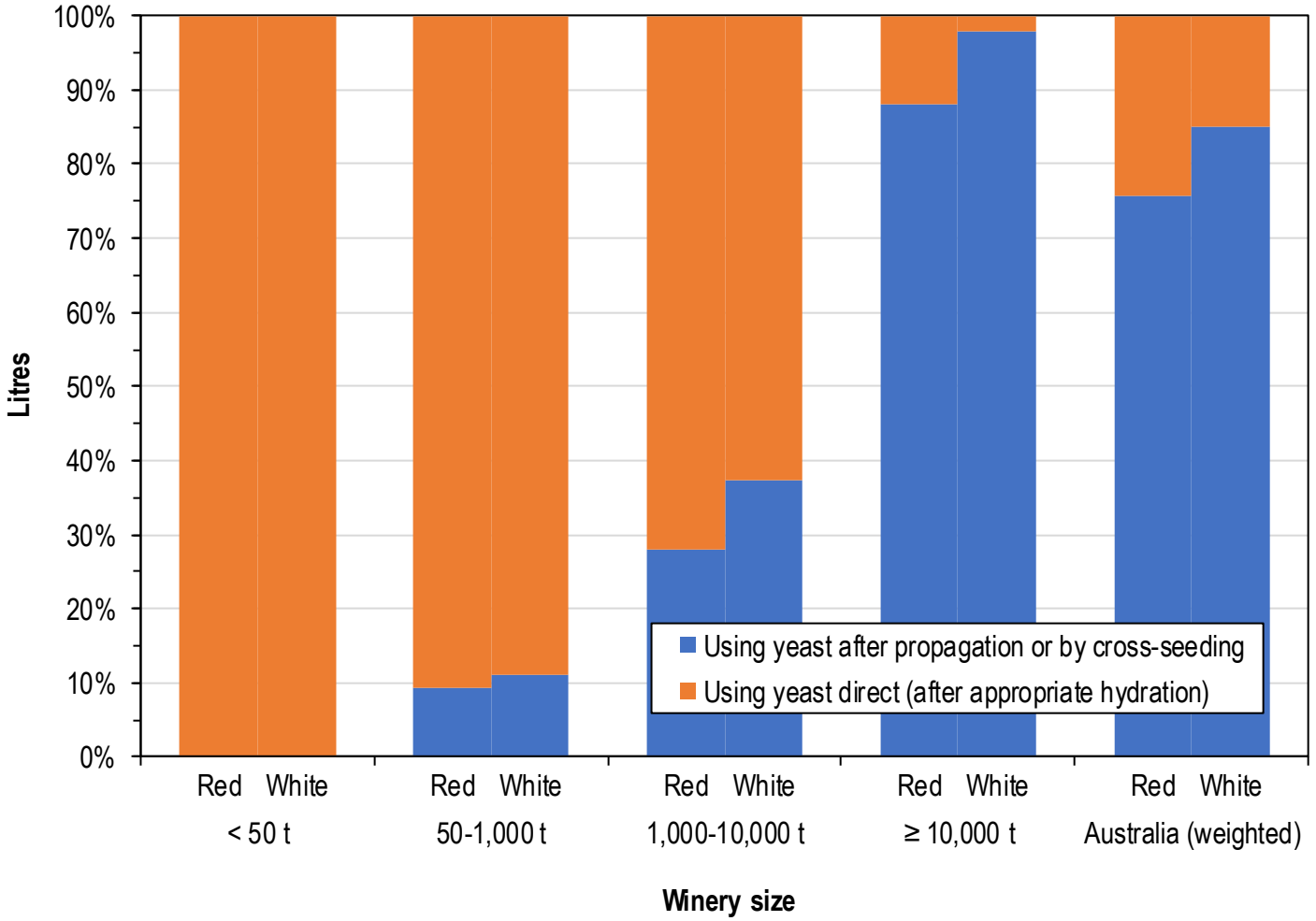
76% reds
85% whites

- The original question grouped propagation and cross-seeding, but in follow-up visits wineries appeared to primarily be propagating using dedicated tanks rather than cross-seeding from general ferments.
- Juice used for propagation varied between sites, with some using white juice for both red and white propagation, while others used red for reds, or matched varieties.
- White wine was slightly more likely to be produced with propagated yeast than red wines, with one respondent noting that with red ferments, you need to have the culture ready at the correct time, while with cold settled white juice it is not so urgent.

(continued next page…)

*Respondents that inoculated ferments were first asked whether they used yeasts directly from the supplier (with appropriate hydration), or by propagating yeasts up to larger quantities in the winery or cross-seeding from another tank, or both. If they selected both they then were asked to select what % of red and white ferments (by volume) were inoculated directly to the nearest 10%. Direct and propagated litres were estimated based on this, the winery intake tonnage, and fractions of red and white grapes.

Propagation of yeast for inoculated primary ferments (continued)



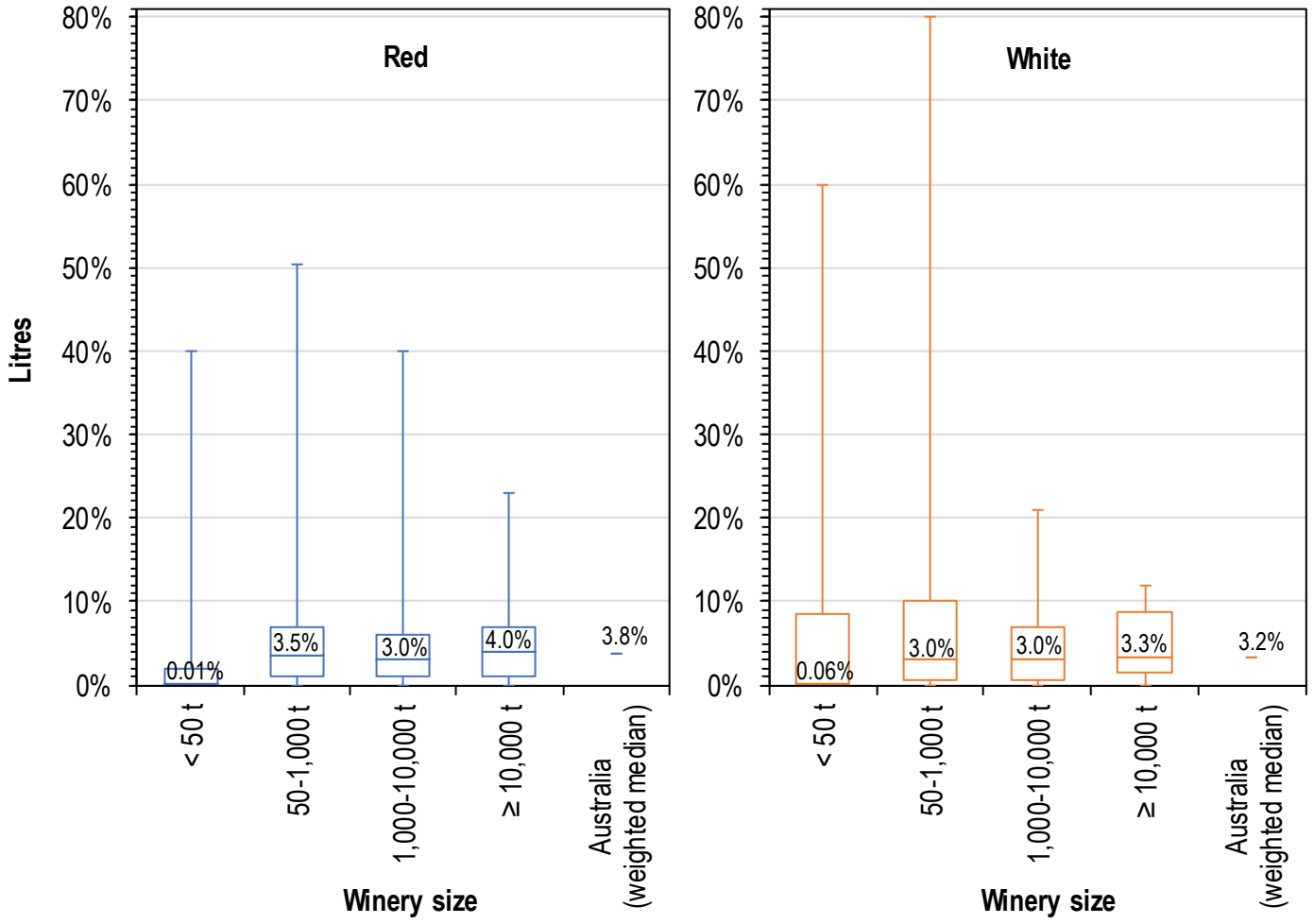
(…from previous page)

- Direct inoculation is simpler and less labour-intensive for smaller batches.
- Two of the smallest wineries using propagation were primarily sparkling wine producers and they suggested that the reason they use propagation more than other similarly sized wineries is because of their experience with tirage.

Reasons given by wineries that propagated on why they propagate:

- Cheaper
- No lag phase in the main fermenter
- For large ferments it is easier to pump from a propagation tank than to prepare large quantities of dry yeast.
- Dried yeast suppliers sell more yeast to medium-sized wineries that do not propagate than they do to much larger wineries.

Sluggish or stuck alcoholic ferments (in the last five years)



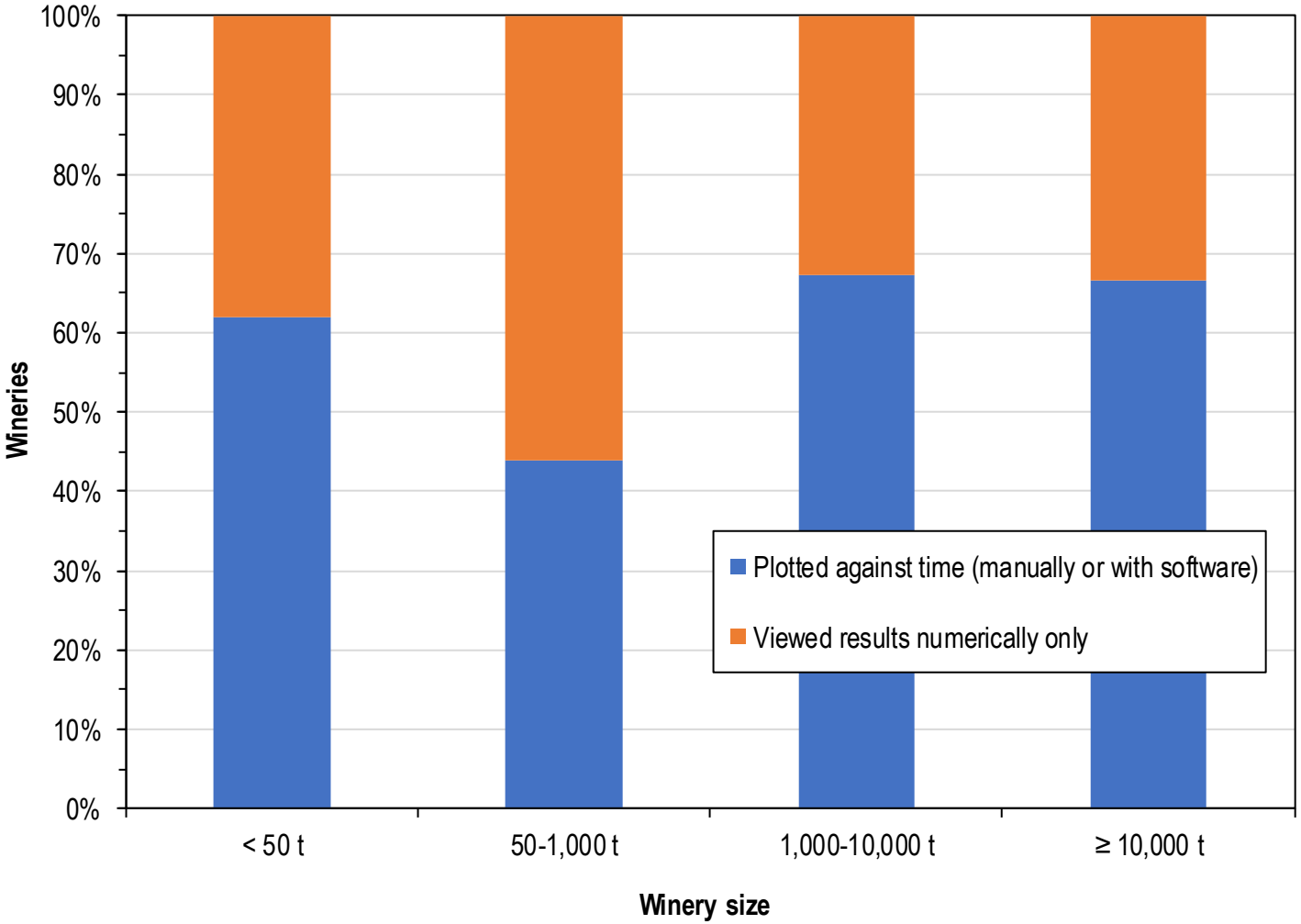
Problem alcoholic ferments in Australia

4% ferments

- Considerable variability was seen in estimates of sluggish and stuck ferments. This likely reflects seasonal variability and differences in definitions of what is a sluggish or stuck ferment.
- Very small wineries reported low levels of problem ferments, but their deadlines for ferments to finish may not be as tight as in larger wineries.
- Some wineries were more proactive than others in monitoring, re-seeding as soon as ferments started to slow, or even over-seeding routinely with efficient strains.
- Some yeast suppliers thought the estimate may be on the low side based on their sales of fructophilic strains, often used to restart ferments.

*Respondents were asked what % of red and white ferments by volume were sluggish (but not stuck), and stuck. They were asked to select from a drop-down box which had options of <0.01%, 0.01%, 0.05%, 0.1%, 0.5%, 1%, 2%, …etc.. Sluggish and stuck estimates have been aggregated for each producer into a single value, and box plots drawn with the median value in each size category annotated on the plot.

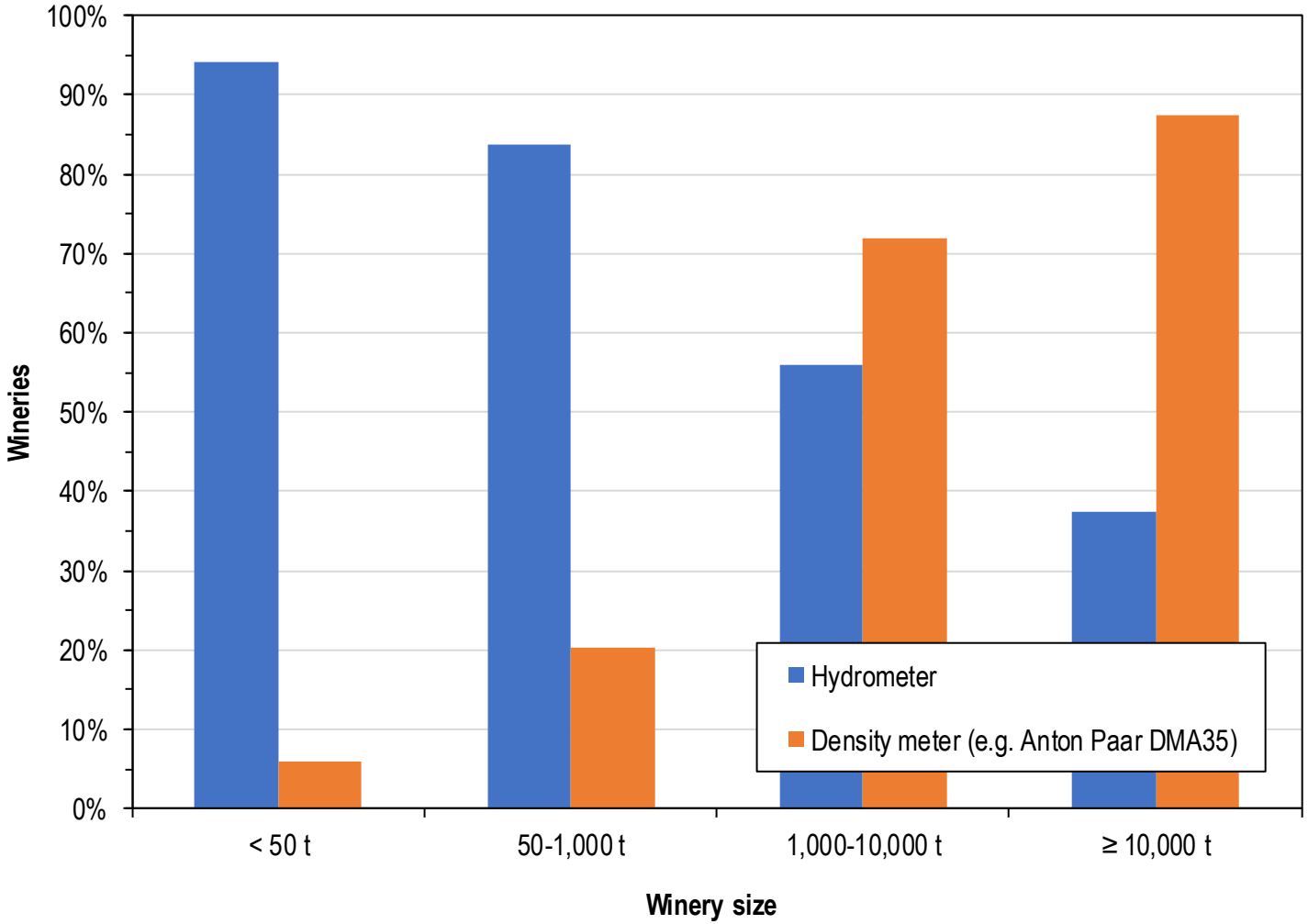
Ferment sugar/density typically plotted or viewed numerically



- Some wineries plotted ferment density against time, while others relied only on numerical results.
- Various manual and software-based solutions were in use.

*Respondents that performed any sugar tracking analyses were asked whether sugar/density measurements were typically plotted against time to track ferment process or just viewed numerically.

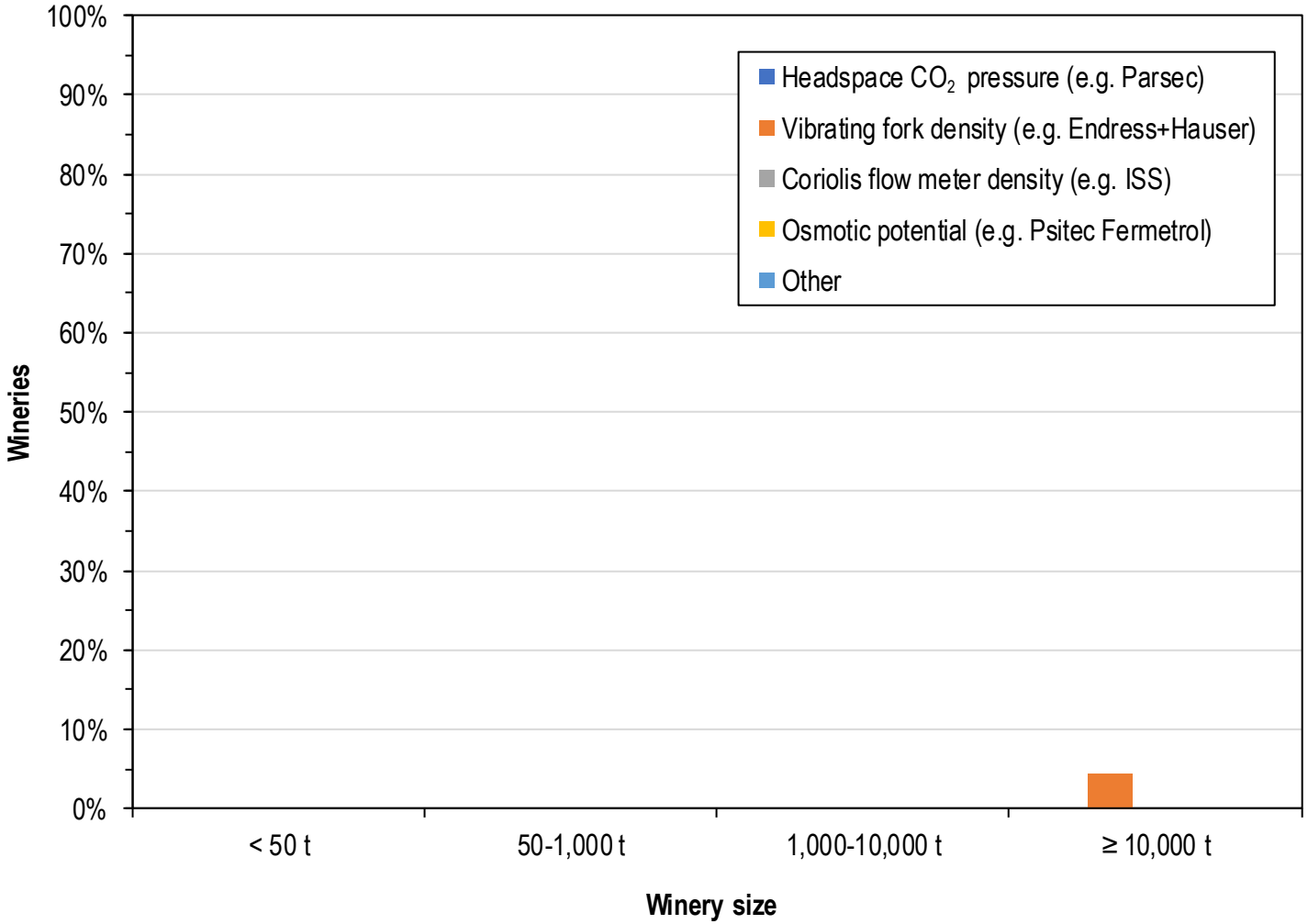
Ferment density analytical measures (used at all)



- Small wineries were most likely to use hydrometers, but with increasing size, wineries transitioned to density meters.
- In addition to these options, several noted the use of tests for residual sugar (e.g. enzymatic assays, Clinitest) that many others would likely also have used, and three mentioned the use of an Oenofoss instrument.

*Respondents were asked to select which methods were used to track fermentation sugar conversion to alcohol.

Fermentation progress sensors fitted in-tank or in-barrel (used at all)



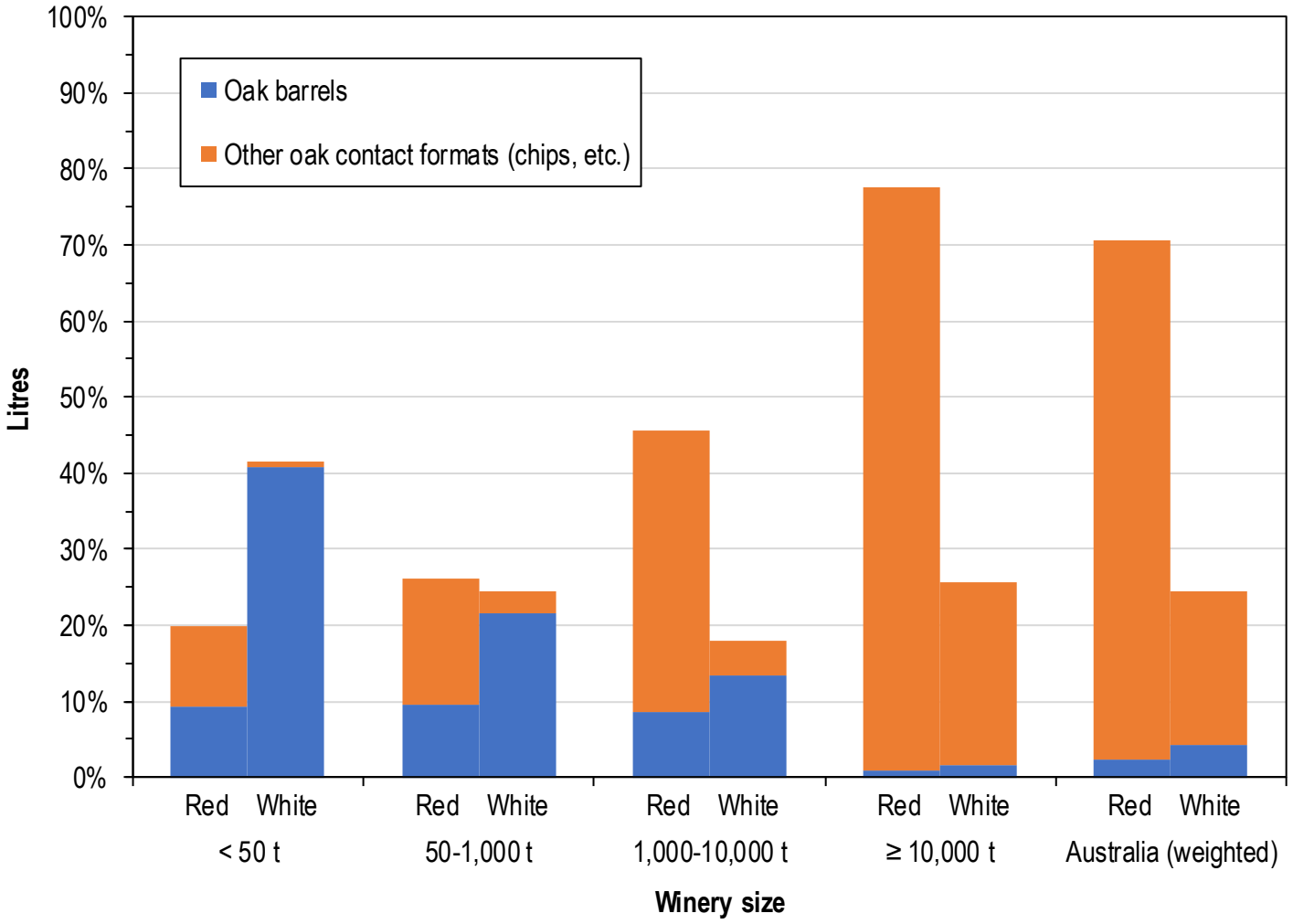
- Only one winery was using in-tank sensors to monitor ferment progress and at that winery the system was only fitted to a small number of tanks.
- Another winery had single pressure transducers on many tanks, and these had been trialled many years ago for monitoring ferment progress but were now used only to monitor liquid levels.

Reasons given for not using in-tank ferment progress sensors:

- High cost of fitting them to many tanks
- Simple enough to measure in the lab since ferment samples are needed for sensory analysis anyway
- Risks of fouling by skins/other solids
- Difficulties cleaning sensors.

*Respondents were first asked whether fermentation progress was measured by sensors fitted in any tanks or barrels. If they responded yes, they were asked to select from a list all the types of sensor that were used.

Ferments with oak contact



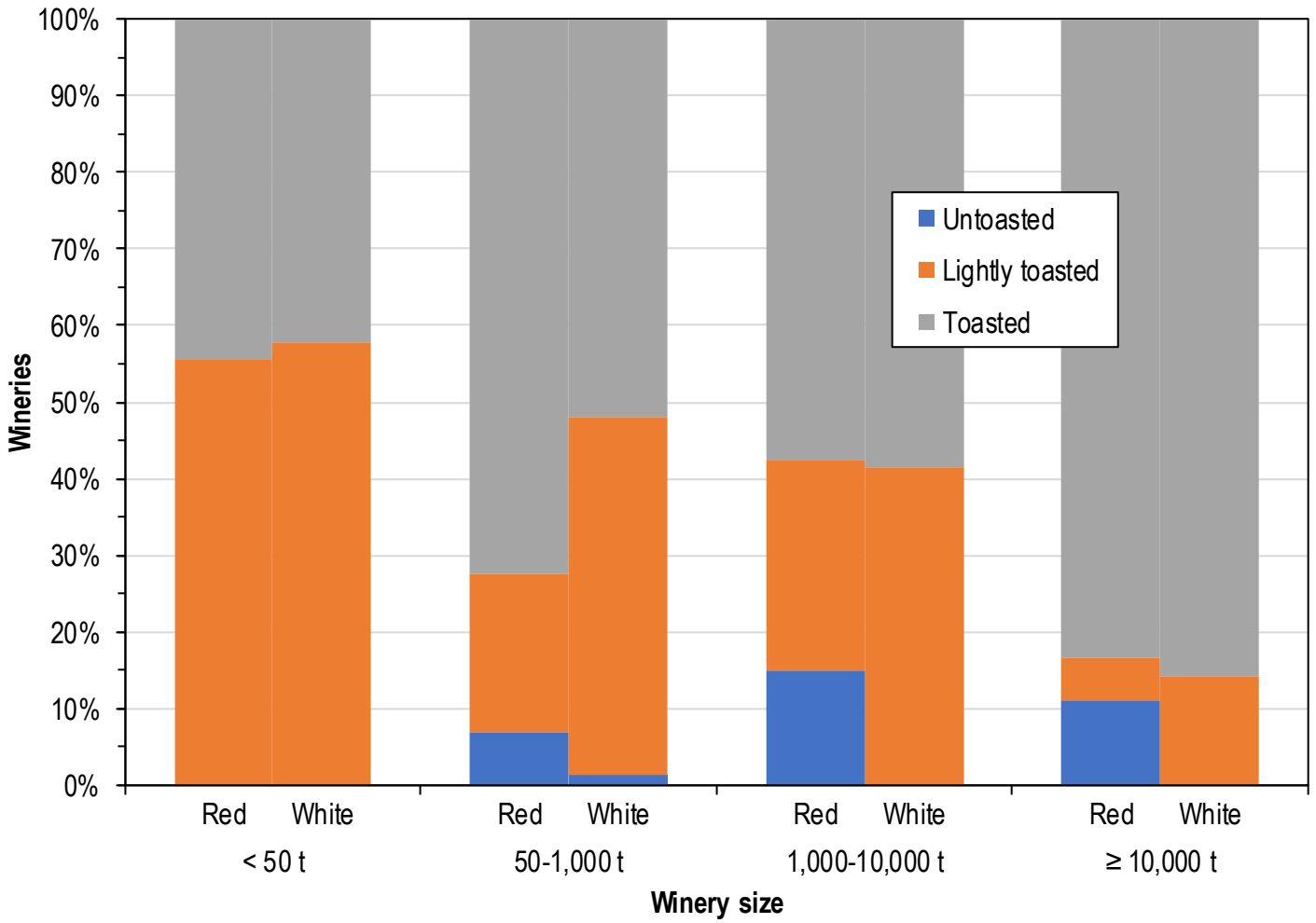
Oak contact during ferments in Australia

71% red wine
24% white wine

- In smaller wineries, oak contact for white wine was mainly in-barrel ferments.
- Larger wineries were more likely to use other oak formats, such as chips.
- Red ferments were more likely to be performed in contact with oak.
- The main drivers for oak use during ferments were flavour and mouth-feel and early integration of these characteristics, while increased colour stability was a factor for some wineries.
- In three wineries visited that indicated some in-barrel red fermentation, this was oak contact after pressing while there was still some residual sugar rather than on-skins barrel ferments.

*Respondents were asked whether any ferments were performed in contact with oak. If they answered yes, they were asked to select what % by volume of red and white ferments were performed in contact with oak. If any ferments were performed in contact with oak, they were also asked whether any ferments were performed in oak barrels. If they answered yes, they were asked to select what % by volume of red and white ferments were performed in oak barrels. Oak-fermented litres were estimated based on this, the winery intake tonnage and fractions of red and white grapes.

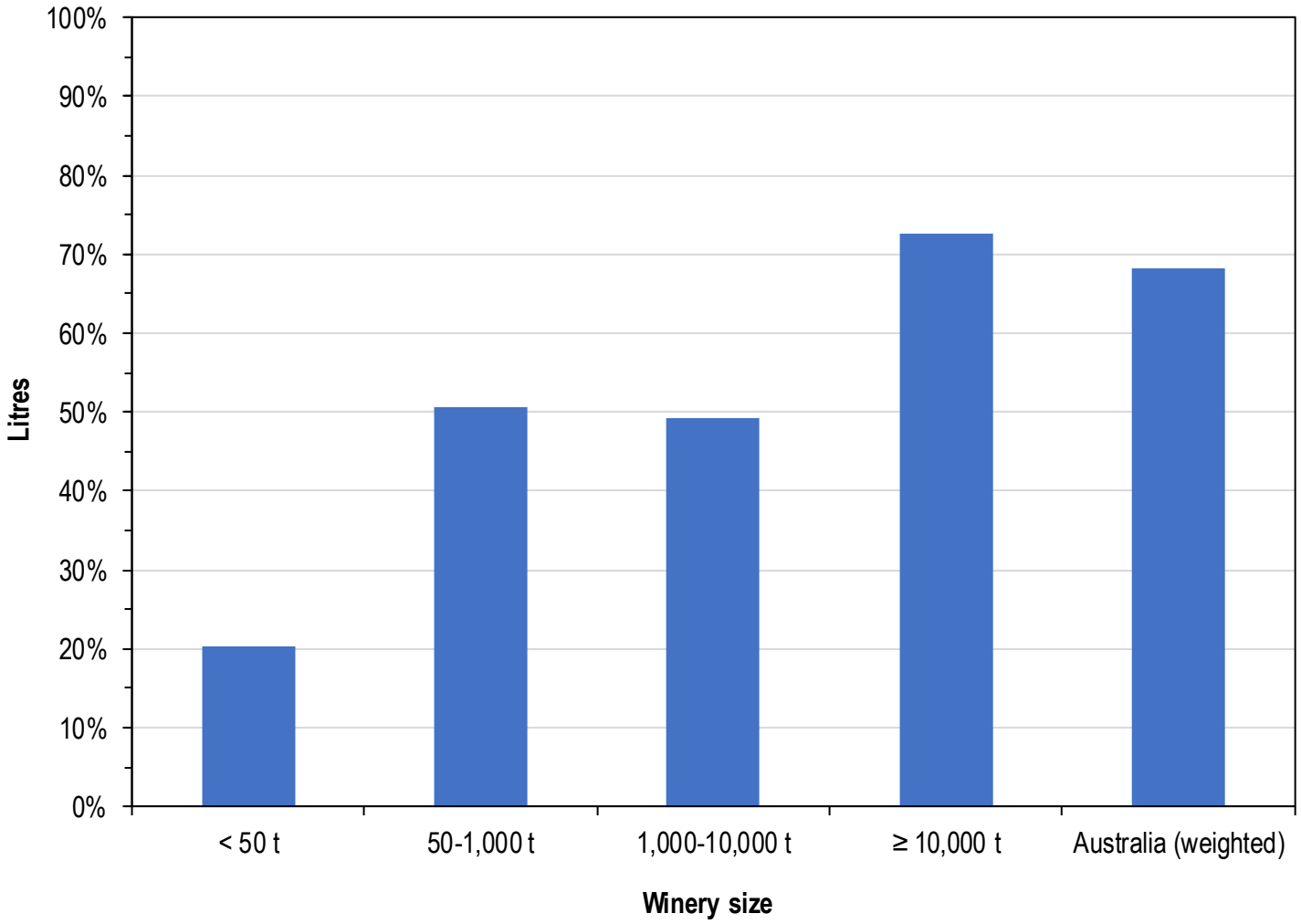
Most common oak style for ferment oak contact



- Generally, larger wineries indicated that toasted oak was used more commonly for contact during ferments than lightly toasted oak, which perhaps reflects a desire to obtain greater early extraction and integration of oak flavour.
- In follow-up visits to two wineries commonly using untoasted oak, one noted that the main driver was the removal of excessive herbaceous characters, while the main driver for the other winery was colour stabilisation.

*Wineries that performed ferments in contact with oak were asked whether the oak was most commonly untoasted, lightly toasted or toasted for red and white ferments.

Red ferments with tannin addition



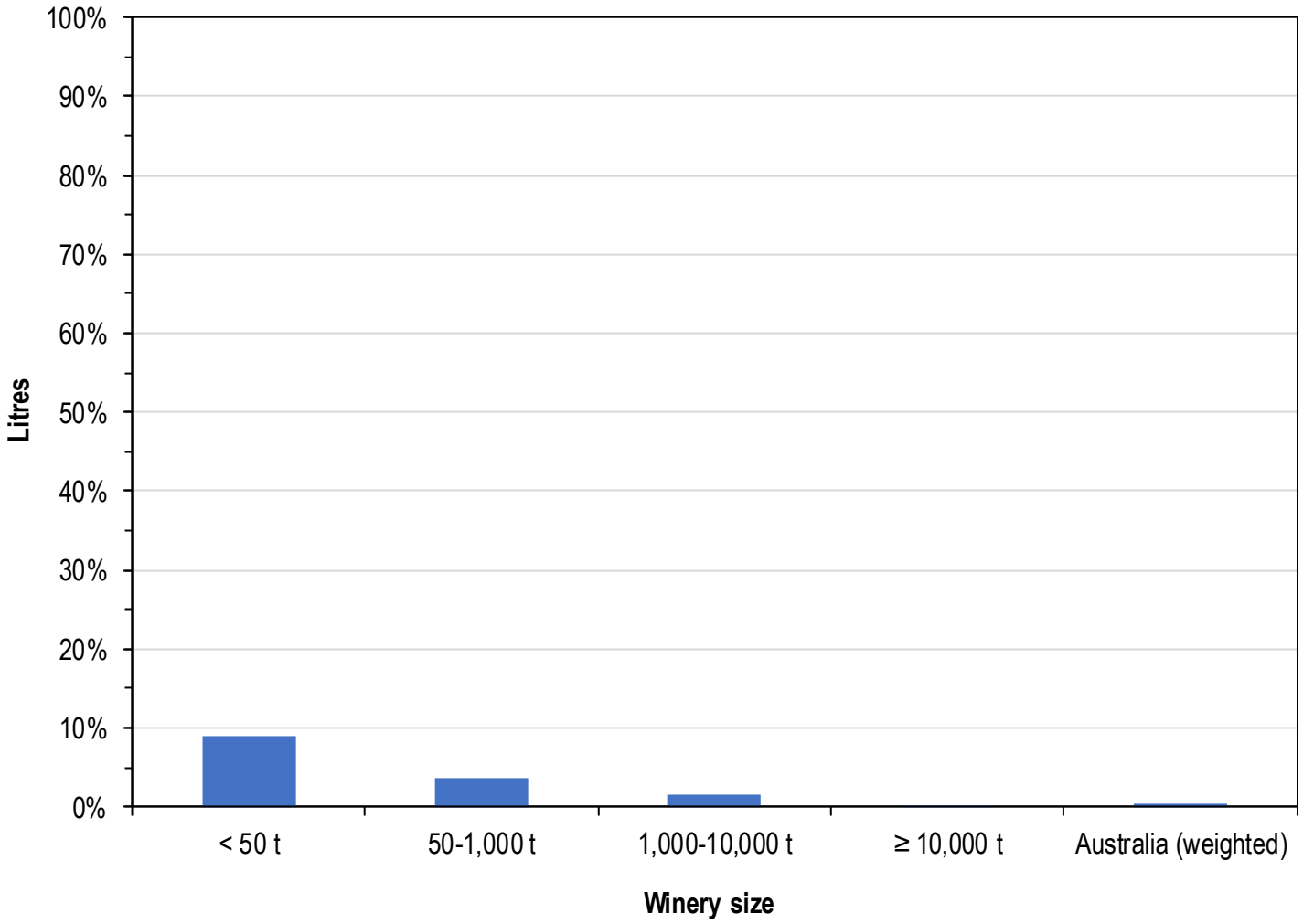
Tannin addition in Australia

68% red ferments

- Reasons given for tannin addition included flavour and mouth-feel, colour stabilisation, protection of grape tannins by sacrificial precipitation of grape proteins and management of *Botrytis*-affected grapes.
- Some wineries noted that lower doses are used now than in the past.
- The effectiveness of some tannin products vs marketing claims made about them was questioned by some producers, particularly in relation to colour stabilisation. However, there was also pragmatism - the tannins may or may not help with colour stabilisation but if they do that is a bonus, and if you have always added them can you take the risk of not adding them?

*Respondents were asked whether any tannins were added prior to or during red ferments. If they answered yes, they were asked to select what % by volume of red ferments received a tannin addition prior to or during ferment. Litres fermented with tannin were estimated based on this, the winery intake tonnage and fraction of red grapes.

Back-addition of stems to red ferments



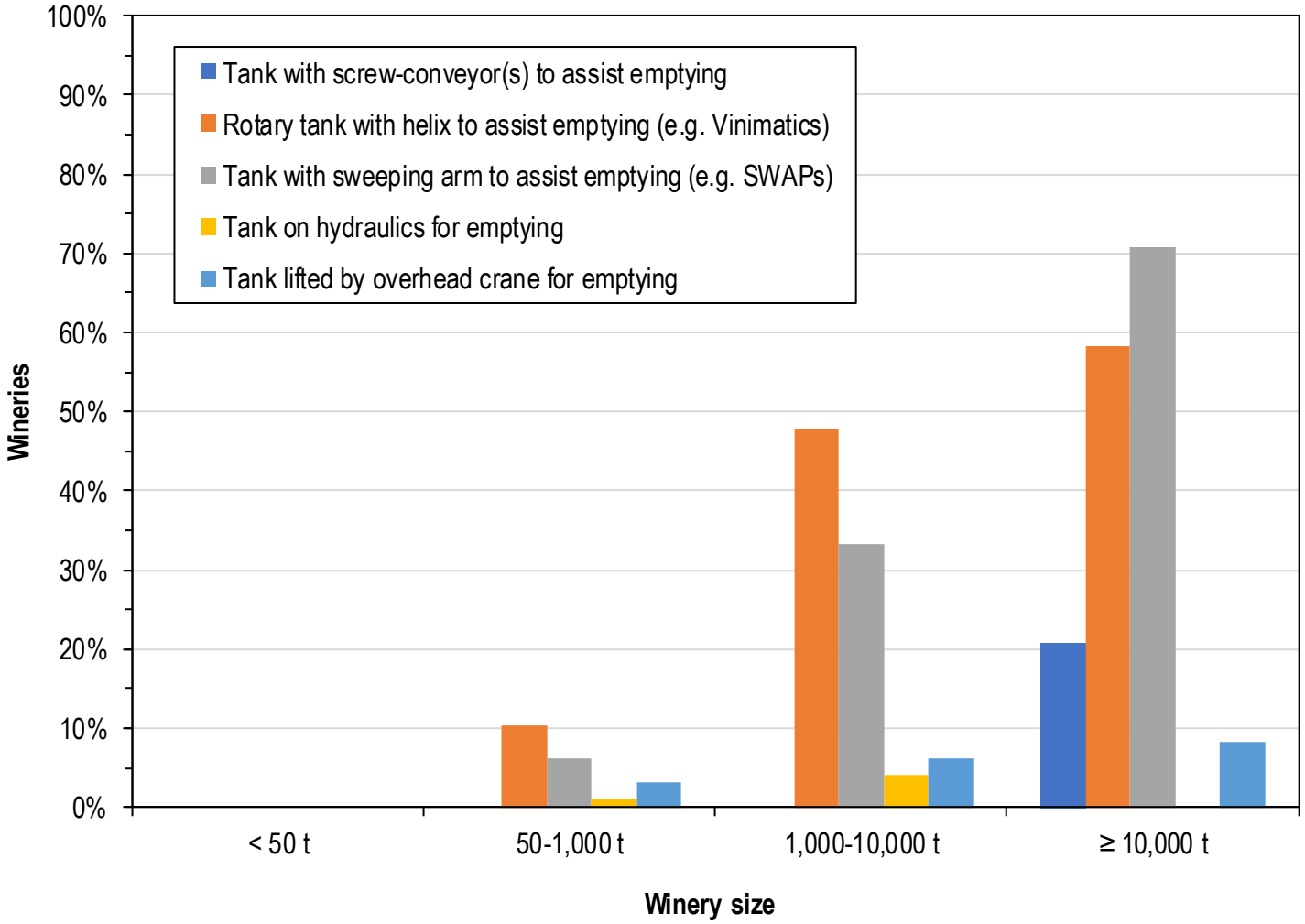
Back-addition of stems in Australia

0.5% red ferments had stems added

- Back-addition of separated stems to red ferments was uncommon, but smaller wineries used this technique for a greater proportion of their production than larger wineries.

*Respondents were asked whether any stems were back-added to red ferments. If they answered yes, they were asked to select what % by volume of red ferments received some back-addition of stems. Litres fermented with back-added stems was estimated based on this, the winery intake tonnage and fraction of red grapes. The question included guidance not to count grapes that were just not destemmed.

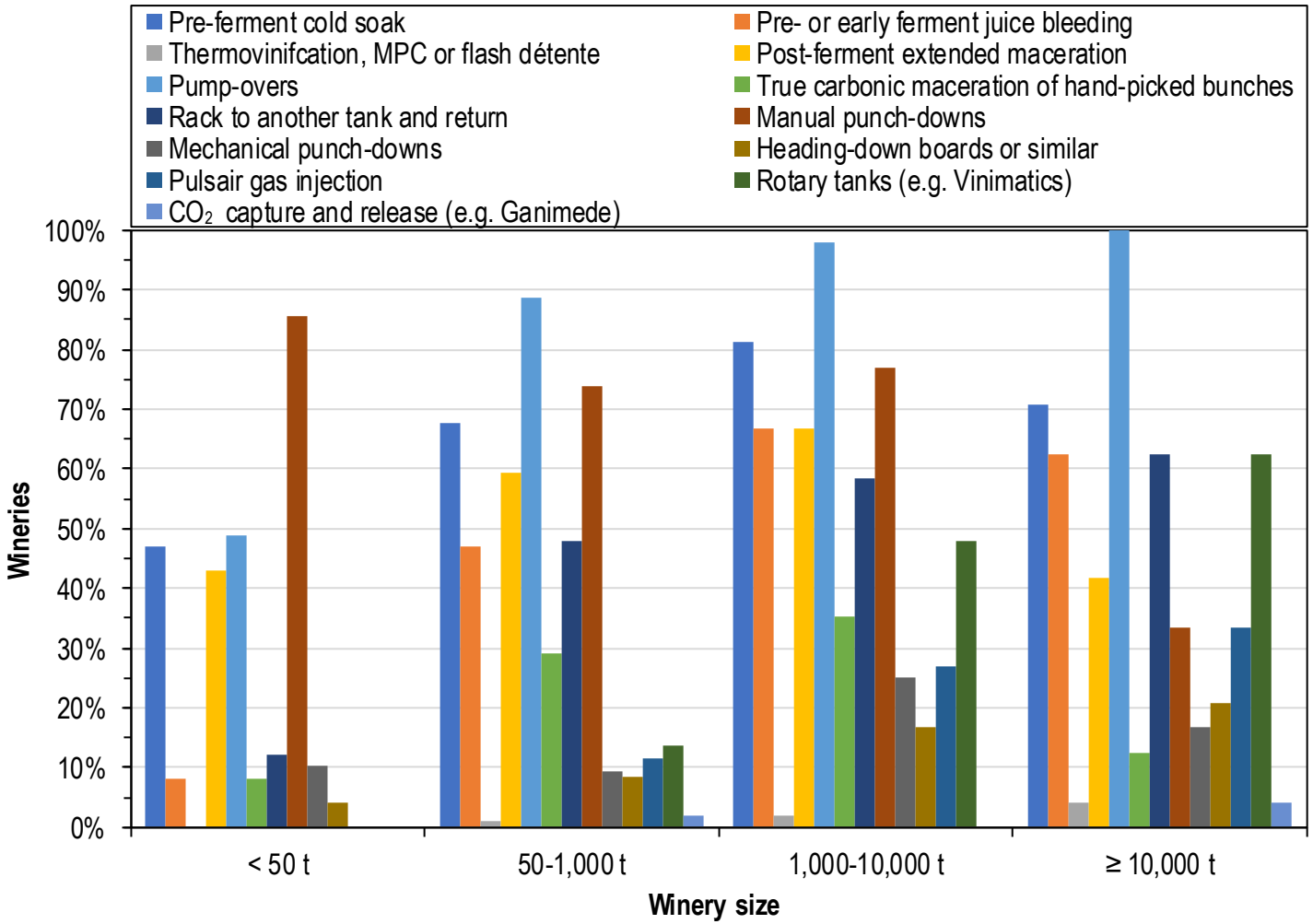
Specialised mechanical emptying red fermenter designs (used at all)



- Of the mechanical emptying red fermenter designs, SWAPs were preferred by the most winemakers.
- Vinimatics were viewed less favourably by many wineries because of their association with reductive characters, and by some wineries because of their mechanical complexity, poor reliability and opportunities for mistakes to be made (e.g. rotating while hoses are connected, damaging breathers, etc.).
- In addition to these mechanical emptying red fermenters, various static fermenters were in use in wineries of all sizes.
- Large ground-level static fermenters with mildly sloped floors, emptied by jetting, were common in large wineries (~50% of wineries ≥ 10,000 t used some of these tanks).
- These jetting tanks were seen by some as being more economical than other fermenter designs, but others noted the high generation of solids and labour requirements for jetting.

*Respondents were asked to select from a list all the specialised red fermentation tank designs used. Mildly sloped tanks emptied by wine jetting was an option included in the question but is not shown in the plot.

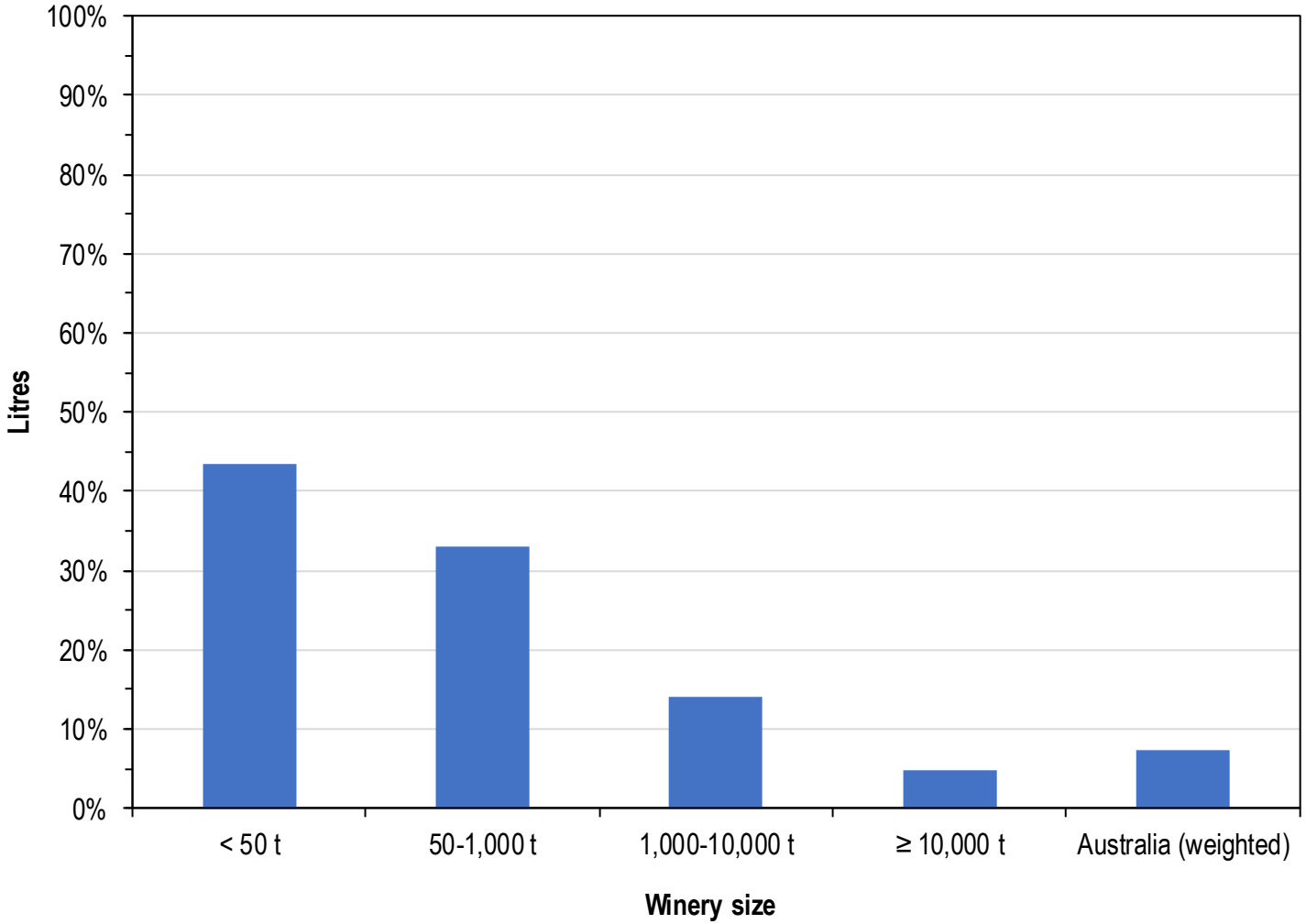
Red ferment extraction techniques (used at all)



- Manual punch-downs were the most common extractive technique used in small wineries, while pump-overs were most common in large wineries.
- Cold soaks, extended maceration and rack and return were also quite common.
- Thermovinification/hot pre-ferment skin maceration (MPC)/flash détente, was rare, as was agitation by CO_2 capture and release.
- Use of Pulsair (or equivalent compressed air mixing systems from other brands) increased with winery size, with ~30% of wineries >1,000 t using this technology.
- In follow-up visits, some wineries were quite positive about mixing with compressed air as an alternative to pump-overs, with some mentioning benefits in reduced jetting times and labour when emptying fermenters.

*Respondents were asked to select from a list all the extraction management techniques used. Enzymes were included in the question but those results are presented on page 83, together with enzyme addition to white grapes/juice.

Red ferments having undergone cold soaks



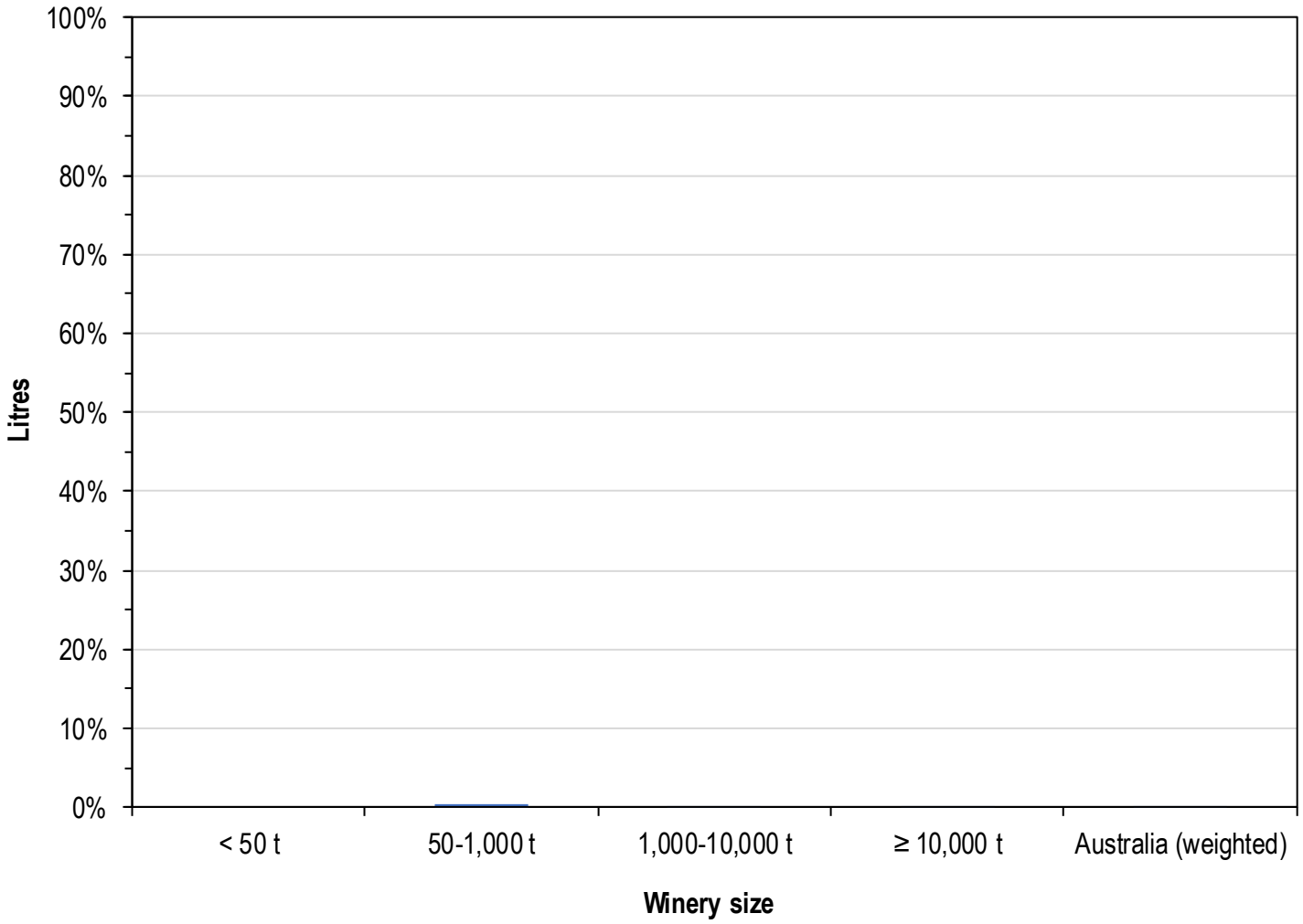
Cold soaks in Australia

7% red ferments

- While many wineries in all size categories performed some cold soaks, smaller wineries cold soaked a greater proportion of their production than large wineries, partly because of throughput considerations in larger wineries.

*Respondents that performed cold soaks were asked to select what % of red ferments by volume underwent a pre-fermentation cold soak. Volume fermented after a cold soak was estimated based on this, the winery intake tonnage and fraction of red grapes.

Red ferments having undergone thermovinification/MPC/flash détente



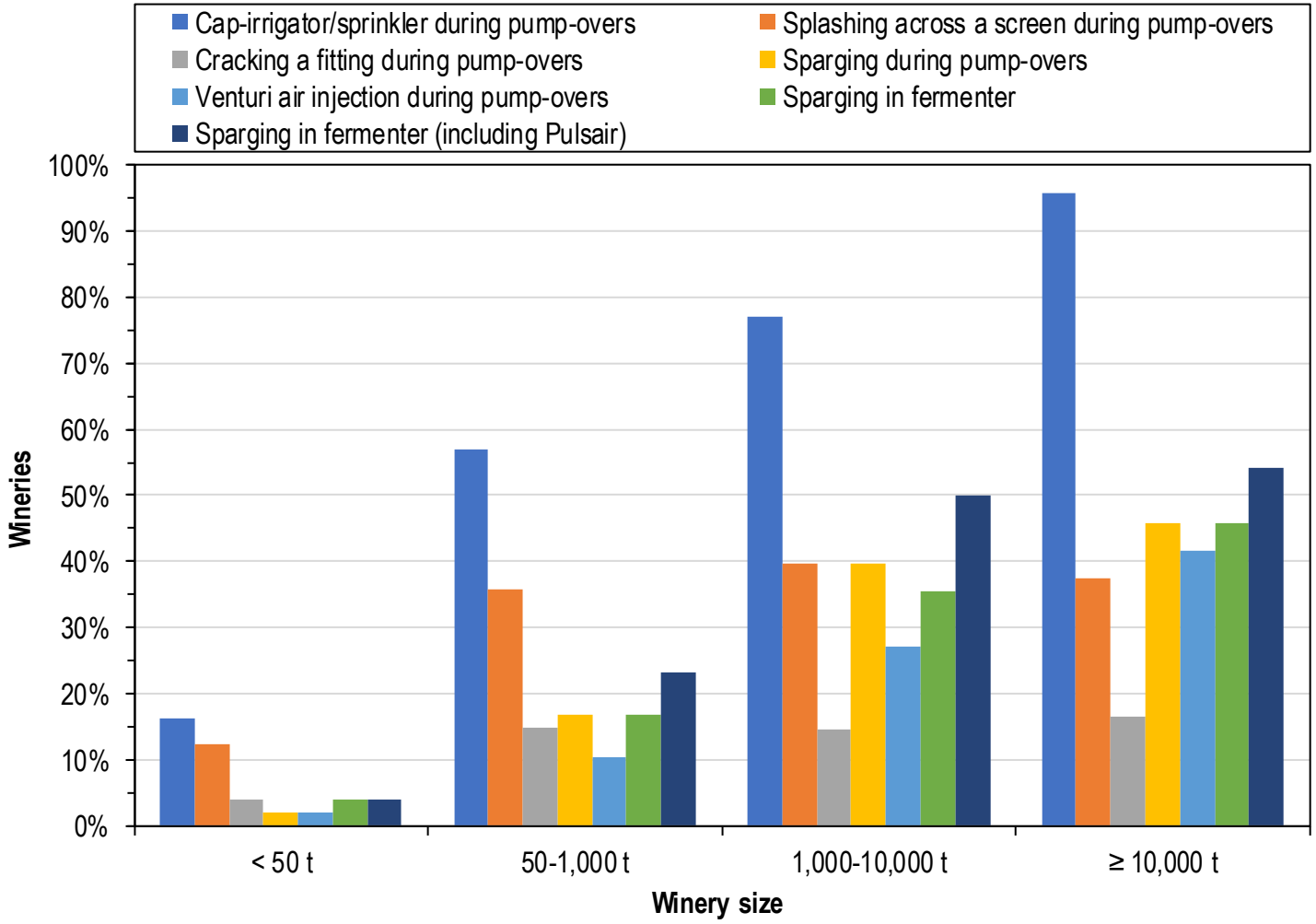
Thermovinification in Australia

0.1% red ferments

- Very little pre-fermentation heat treatment was performed.
- The heat treatment performed included a small proportion of production at one large winery trialling a flash détente unit and one smaller winery heating rosé and adding it back to fermented red skins to get further skin extraction.
- According to the literature, there is one other flash détente unit installed in Australia that was not covered by the survey.

*Respondents that performed any pre-fermentation heating or thermovinification (including any form of heating of whole or crushed grapes to greater than 50°C) were asked to select what % of red ferments by volume underwent pre-fermentation heating to the nearest 10%. Litres fermented with these techniques were estimated based on this, the winery intake tonnage and fraction of red grapes.

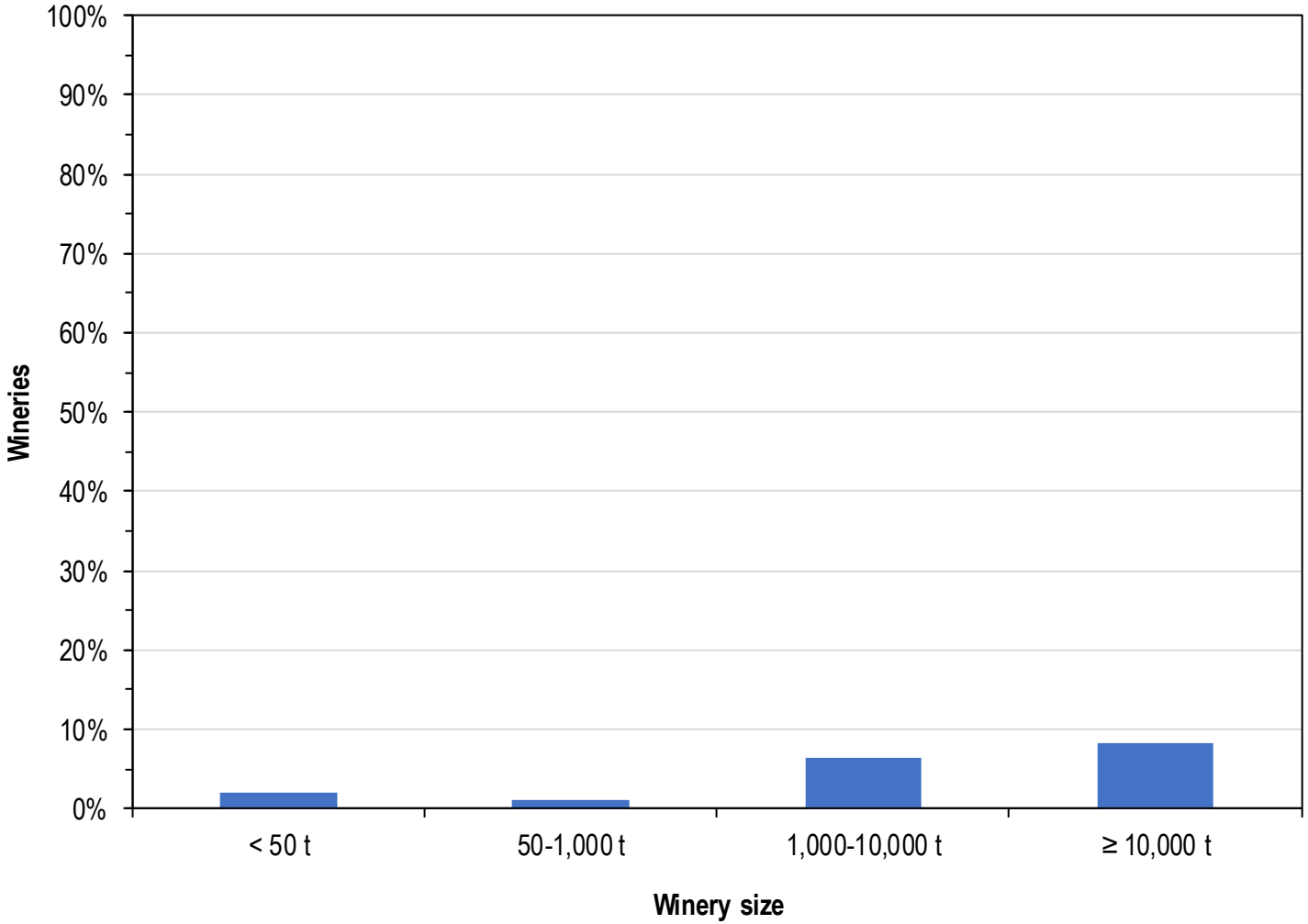
Red ferment oxygen introduction techniques (used at all)



- Cap-irrigators were the most common of the techniques to be used.
- Sparging in fermenters in large wineries was mainly in Vinimatics and 8 out of 14 wineries ≥ 10,000 t with Vinimatics were able to inject compressed air into at least one.
- Sparging with compressed air and venturi injection of air were also common during pump-overs. At some wineries (possibly most) venturis were a small valve at the top inlet bend of the cap-irrigator, not venturi shaped-injectors (e.g. Mazzei).
- Please also refer to page 114 for data on extractive methods, some of which may also introduce oxygen.
- A few wineries also introduced air during key times in white ferments to limit sluggish or stuck ferments.

*Respondents were asked to select from a list all techniques that were used to introduce oxygen into red ferments. An additional series has been included in this plot that includes both those wineries that indicated that they sparge in-fermenter and those that didn't select this option, but had selected that they use Pulsair, although large Pulsair bubbles may only provide a much more limited oxygenation.

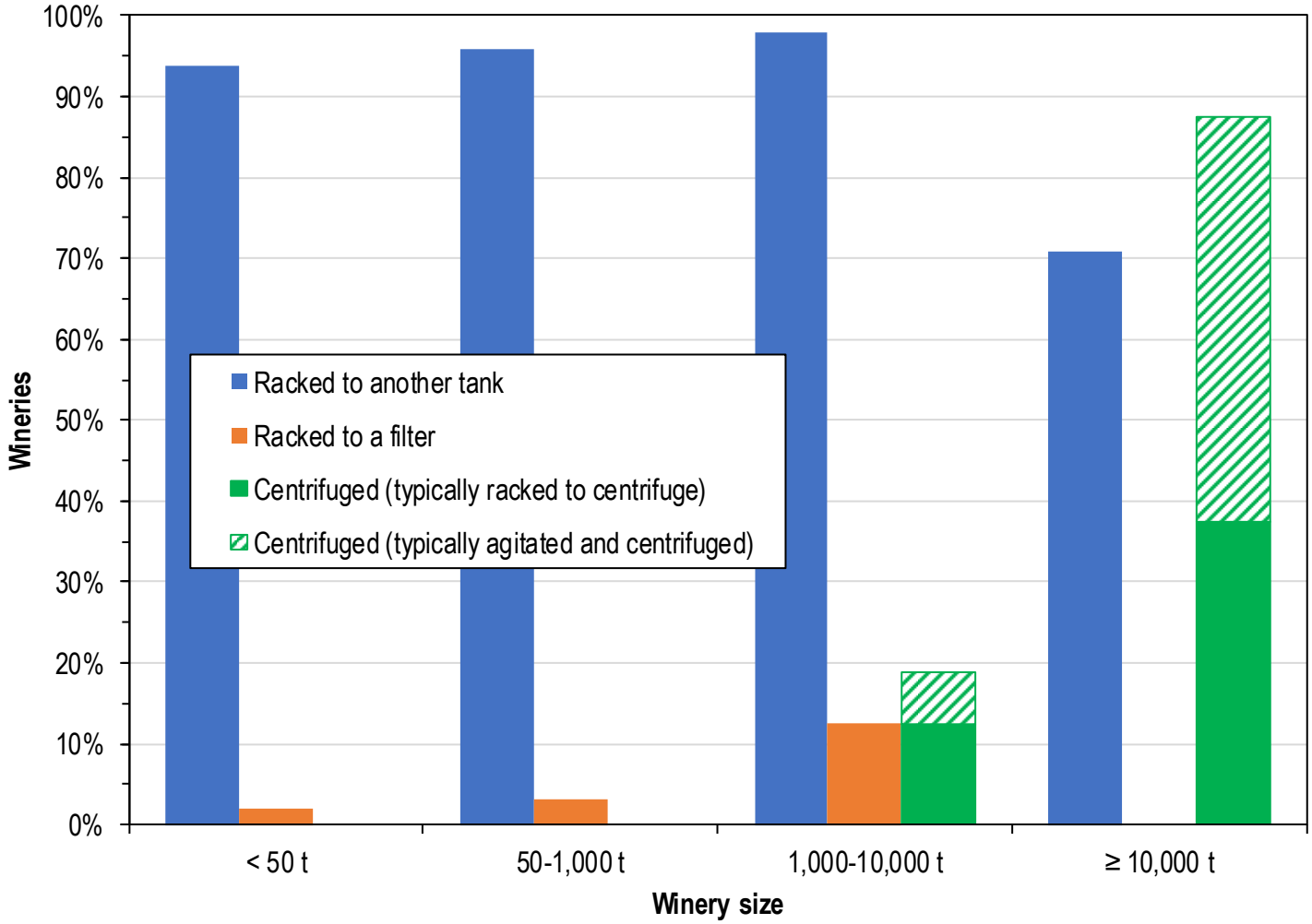
Analyses of phenolics/tannins/colour during red ferments (used at all)



- Measurements of phenolics, colour or tannin were rarely performed during ferments.
- One respondent visited that had selected yes had mainly conducted these analyses at the end of the ferment, and several other wineries also mentioned performing colour measurements on wine (although this topic wasn't explicitly covered in the survey).
- The data shows that (non-visual) measurements of colour, phenolics or tannin (either in the laboratory or in-tank) are not techniques used routinely for modulation of extraction during red wine fermentation.

*Respondents were asked whether any analyses of phenolics, tannin or colour were performed during any red ferments (not counting visual assessment).

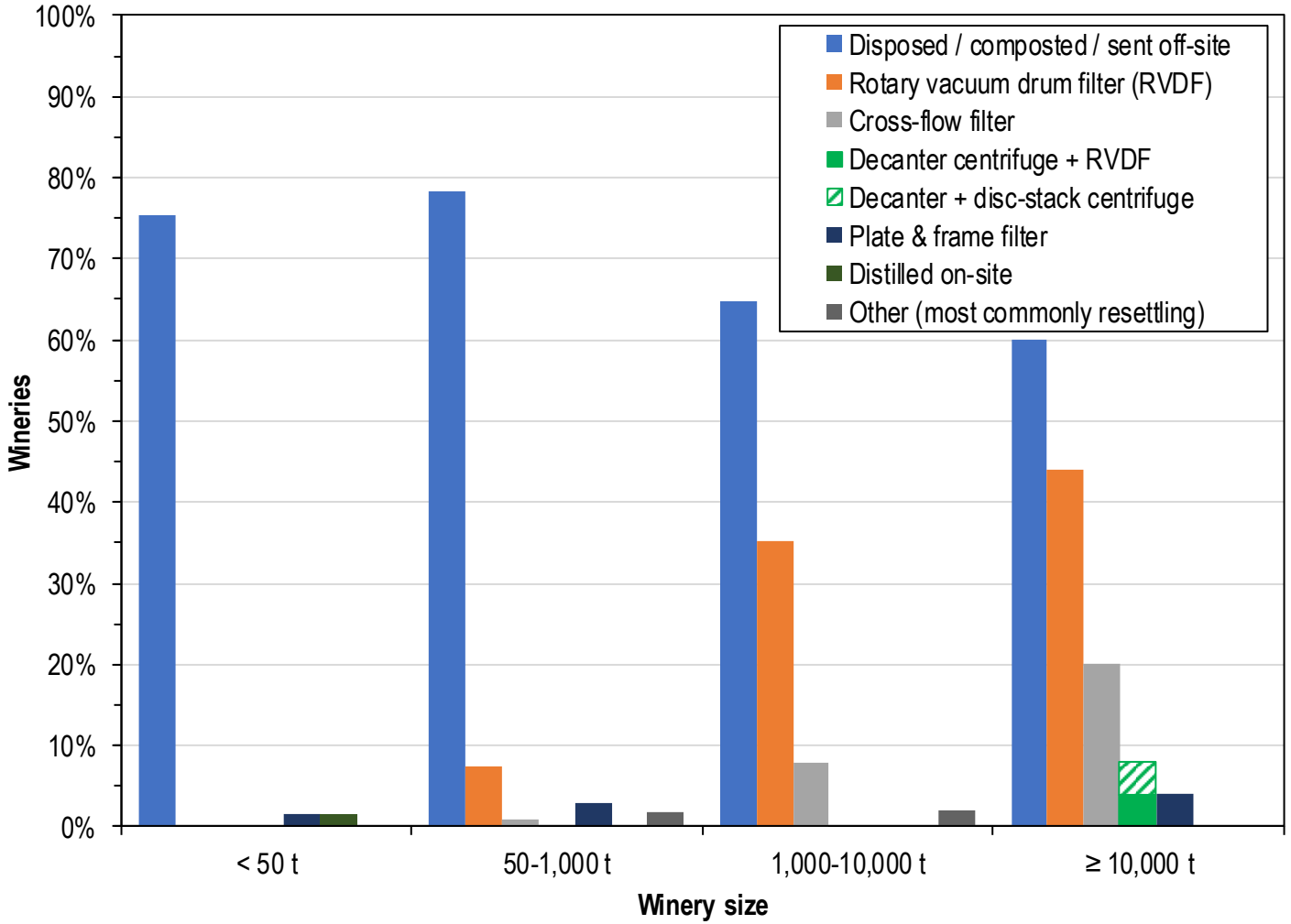
Initial separation from gross red lees (used at all)



- Racking was the principal technique used in small wineries.
- Large wineries also used centrifuges.
- Sometimes wine was racked to centrifuges and sometimes tanks were agitated and centrifuged.
- One respondent noted that they chose to rack to centrifuge because agitation can negatively affect the quality of the entire tank, while others didn't agree and thought agitation was superior because it avoids generating settled red lees that need to be reprocessed.
- Others that typically racked to centrifuge did so because of limited centrifuge capacity rather than for any quality concern.

*Respondents were asked to select which techniques were used to first separate wine from gross red ferment lees.

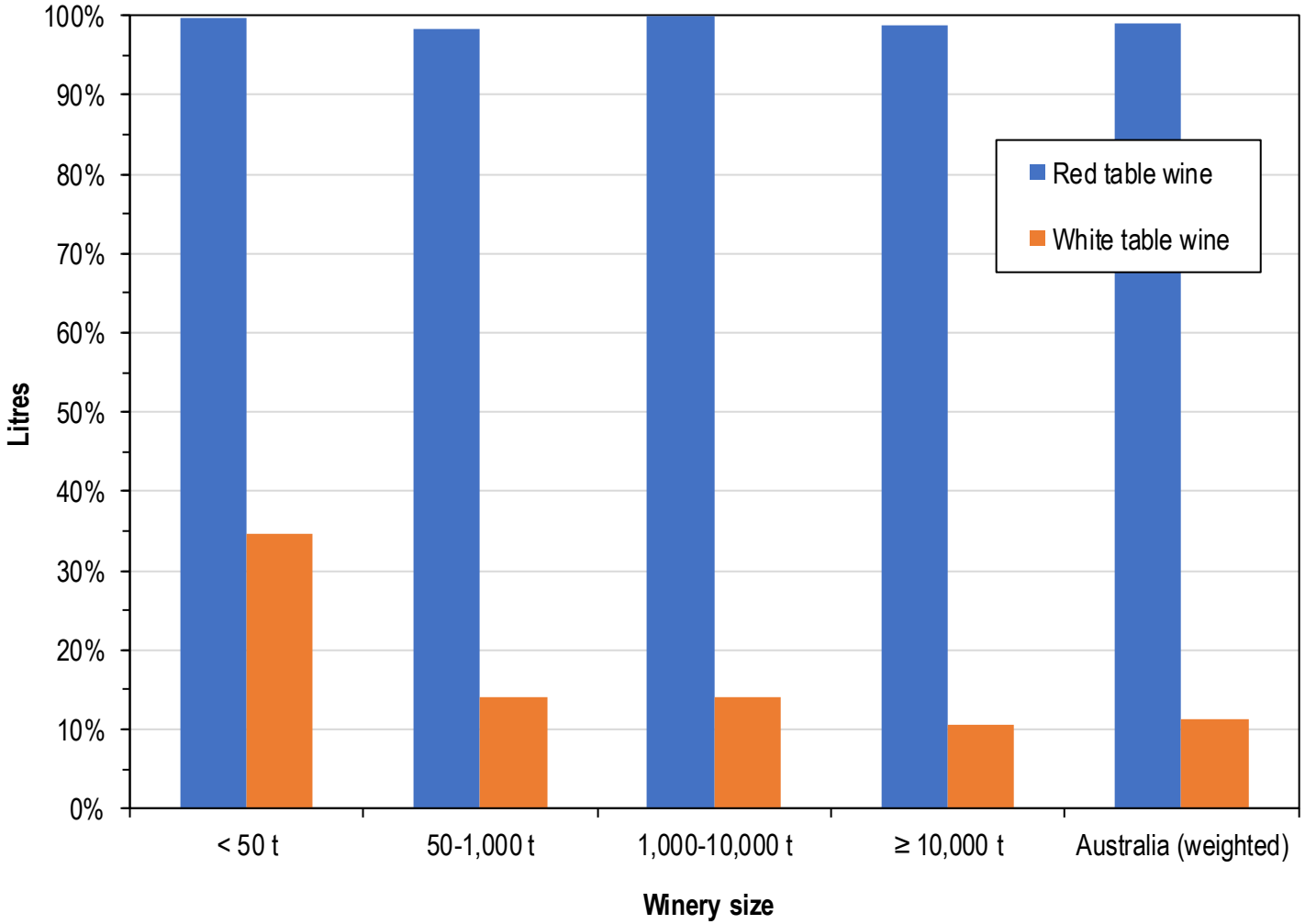
Red gross lees/desludge management techniques (used at all)



- Larger wineries were more likely to reprocess red lees/desludge than smaller wineries, but less likely than they were for juice lees/floats/desludge (see page 96), because much of it is already very thick centrifuge desludge.
- RVDF was the most common equipment used for recovery, followed by wide-bore cross-flow filtration.
- As with juice lees reprocessing, and perhaps more so given the greater thickness of red ferment lees, some wineries were not satisfied with the flow rates and recoveries from wide bore cross-flow filters.
- Decanter centrifuges had instead been adopted by some large wineries and since the time of the survey their use for re-processing red lees has at least doubled to 16% of wineries ≥ 10,000 t.

*Respondents were asked to select from a list all the techniques that were used to manage the lees/desludge from the clarification processes selected in the previous question.

Wine undergoing malolactic fermentation (MLF)



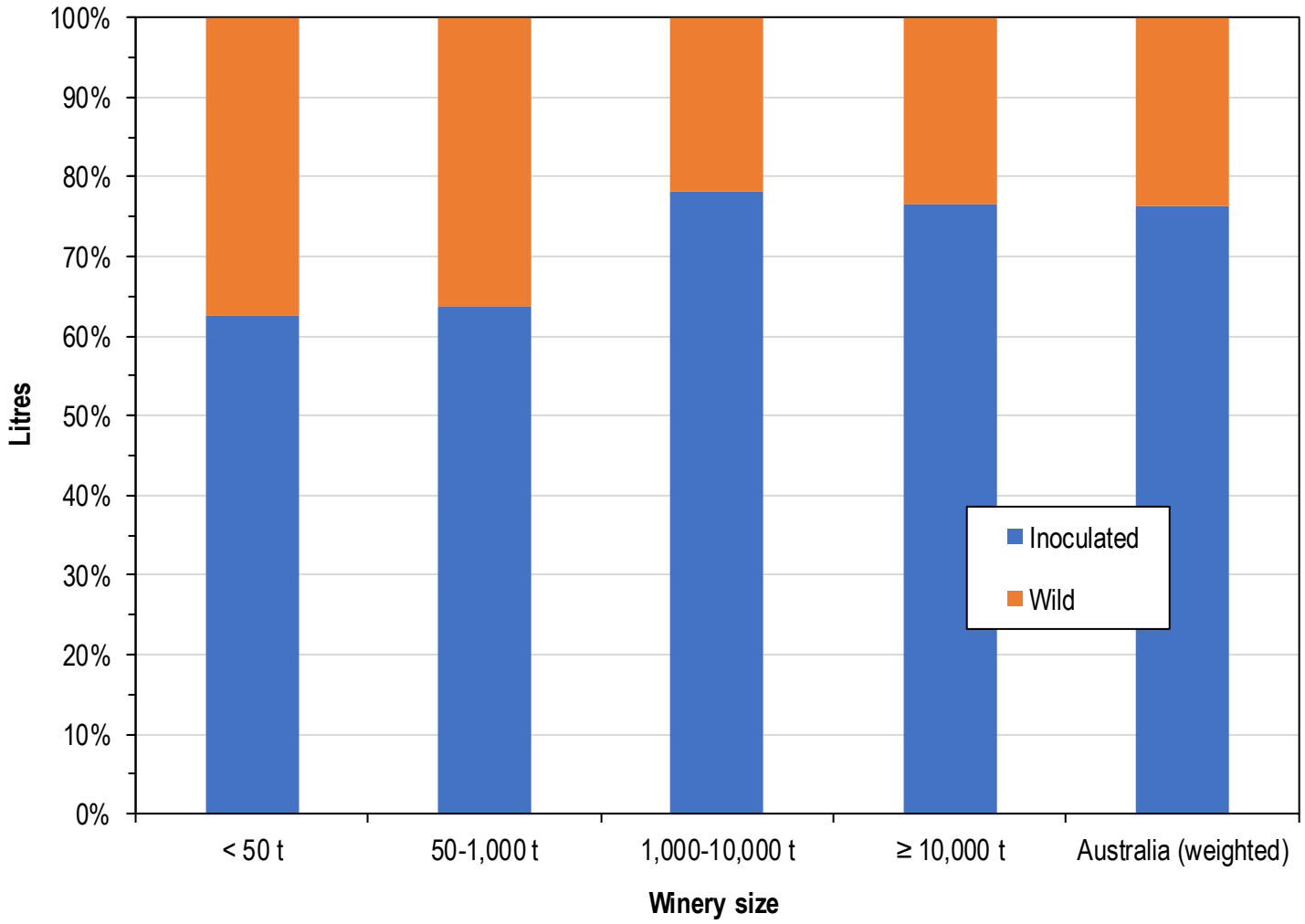
MLF in Australia

99% red wine
11% white wine

- Red table wines almost universally went through malolactic fermentation.
- A smaller fraction of white table wines underwent malolactic fermentation, with a greater proportion of white table wine in smaller wineries going through MLF than in larger wineries.

*Respondents were asked what % of red and white table wines typically go through malolactic fermentation to the nearest 10%. Litres undergoing malolactic fermentation were estimated based on this, the winery intake tonnage and fractions of red and white grapes.

Inoculated or wild MLFs for red table wine



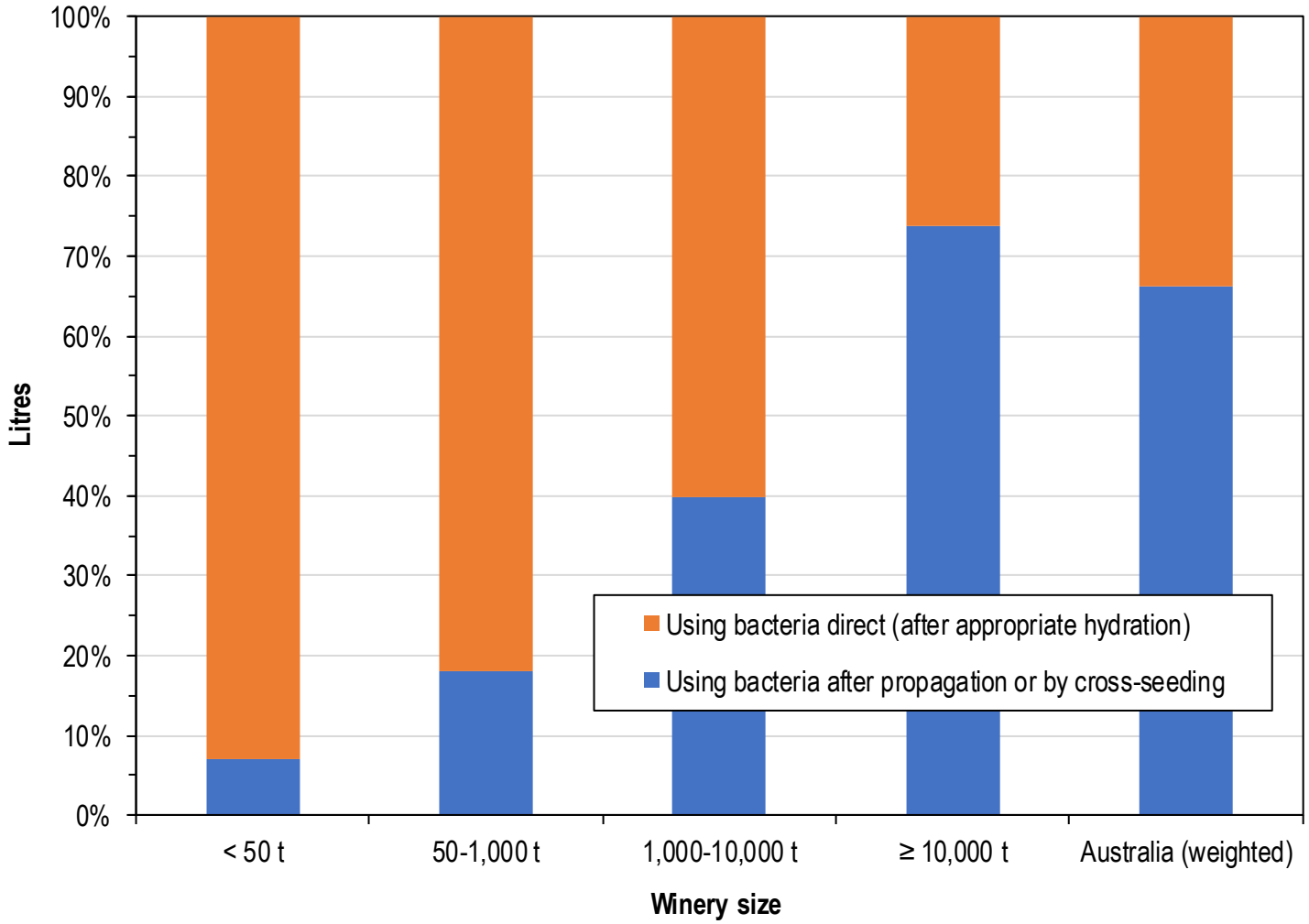
MLF in Australian red wine

76% inoculated

- More wine was inoculated for MLF (including by cross-seeding) than occurred wild, and the proportion was only slightly higher in larger wineries.
- A reason given by wineries for using wild MLFs included that they have a good strain in the winery and that the MLFs just go through without inoculation.
- Some wineries only used inoculation when wild MLF failed or they expected there to be problems (e.g. because of high alcohol), or for wines made for early release.

*Respondents were first asked whether MLFs were inoculated only, wild only, or both. If they answered both, they were asked what % by volume is typically inoculated vs wild to the nearest 10%. Litres undergoing inoculated and wild MLFs were estimated based on this, the fraction of red table wine undergoing MLF, the winery intake tonnage, and fraction of red grapes.

Direct inoculation or propagation/cross-seeding for MLF in red table wine



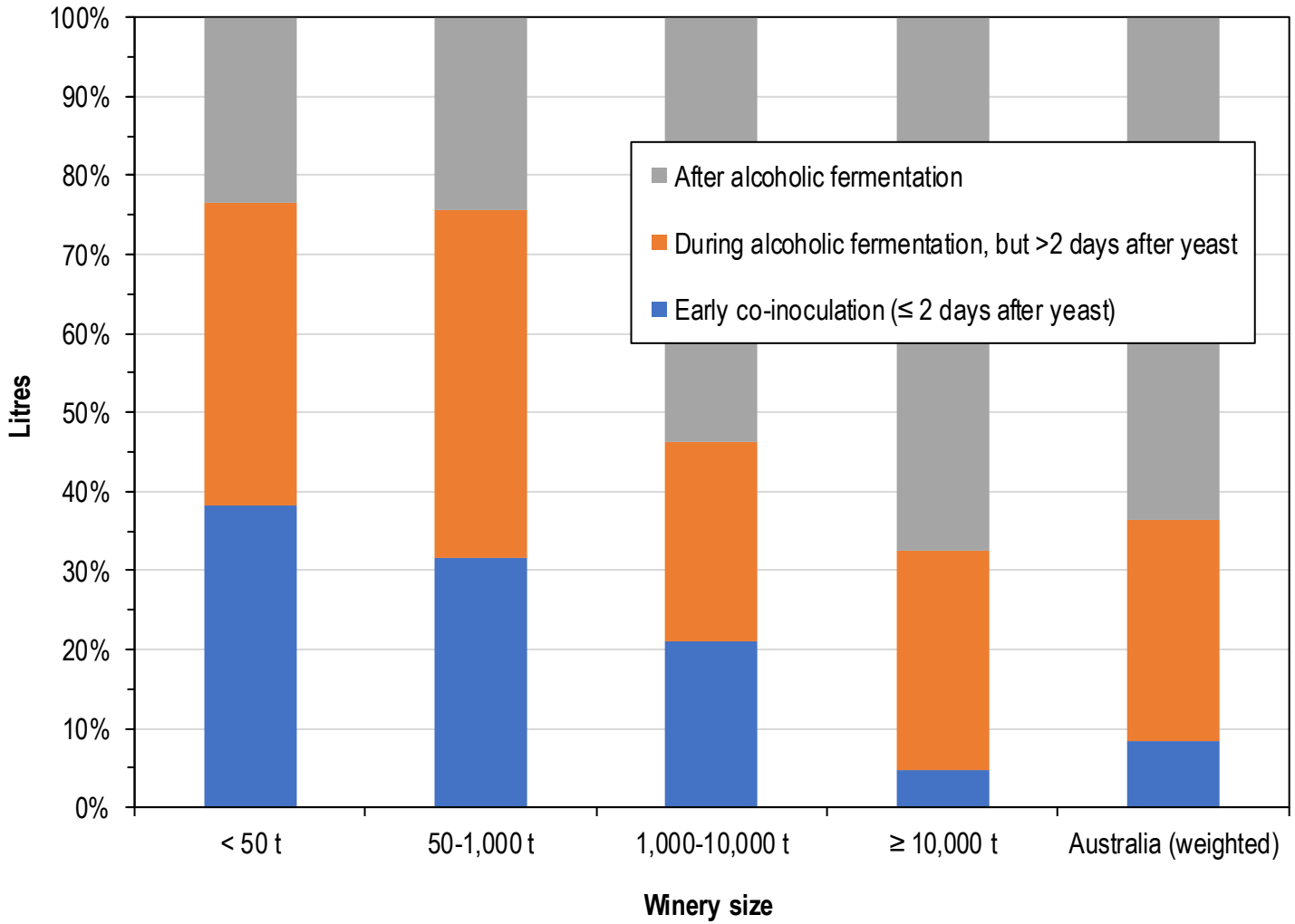
MLF inoculation in Australian red wine

66% propagated or cross-seeded

- Unlike inoculations for alcoholic fermentation, cross-seeding and not just propagation was common.
- Some large wineries performed a lot of propagation, while others performed a relatively small number of direct inoculations and then cross-seeded from those tanks.
- Interestingly, in ≥ 10,000 t wineries direct inoculation for MLF was slightly more common than it was for alcoholic fermentation.
- The survey did not cover specific forms of MLF bacteria available, and it is possible some products could have been counted as direct with hydration by some but as propagation by others.

*Respondents that inoculated MLFs were first asked whether inoculations were performed only directly with bacteria from the supplier (after appropriate rehydration), only after first propagating to a large quantity at the winery or cross-seeded from another tank, or some of both. If they answered both, they were asked what % by volume was typically directly inoculated vs propagated or cross-seeded to the nearest 10%. Litres undergoing MLF by direct inoculation or after propagation/cross-seeding were estimated based on this, the fraction of red table wine undergoing MLF, fraction inoculated, the winery intake tonnage and the fraction of red grapes.

Timing of MLF inoculations for red table wine



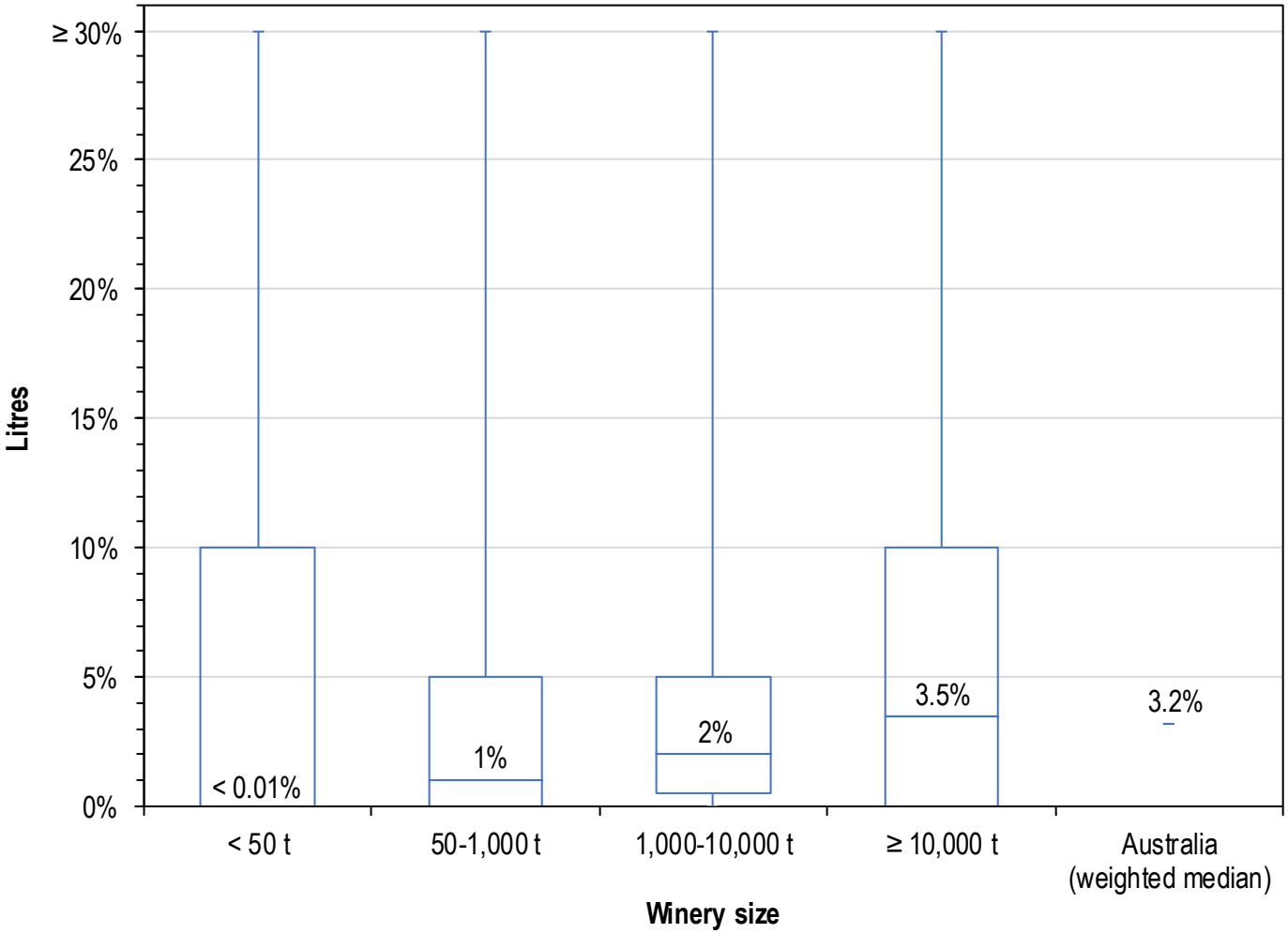
MLF inoculation timing in Australia

8% early co-inoculation (≤ 2 days after yeast)

- Early co-inoculation was much more common in smaller wineries than in larger wineries.
- The original survey question defined co-inoculation as any time during alcoholic fermentation (therefore potentially including after pressing), but the popularity of early co-inoculation is more interesting.
- Follow-up emails/visits were made to co-inoculating wineries to find out how many days after yeast inoculation MLF inoculation was performed.
- One apparent reason for not performing early co-inoculations is that cross-seeding is not as easy and wineries would likely need to spend more on bacteria to use them directly or specifically propagate bacteria.

*Respondents that inoculated MLFs were asked what % by volume was typically inoculated during alcoholic fermentation (co-inoculated) to the nearest 10%. Co-inoculated MLF litres were estimated based on this, the fraction of red table wine undergoing MLF, the fraction inoculated, the winery intake tonnage and the fraction of red grapes. Co-inoculation was broken up into early co-inoculation and other co-inoculation based on follow-up emails. An arbitrary simple cut-off of two days was assigned.

Sluggish or stuck red table wine malolactic fermentations in the last five years



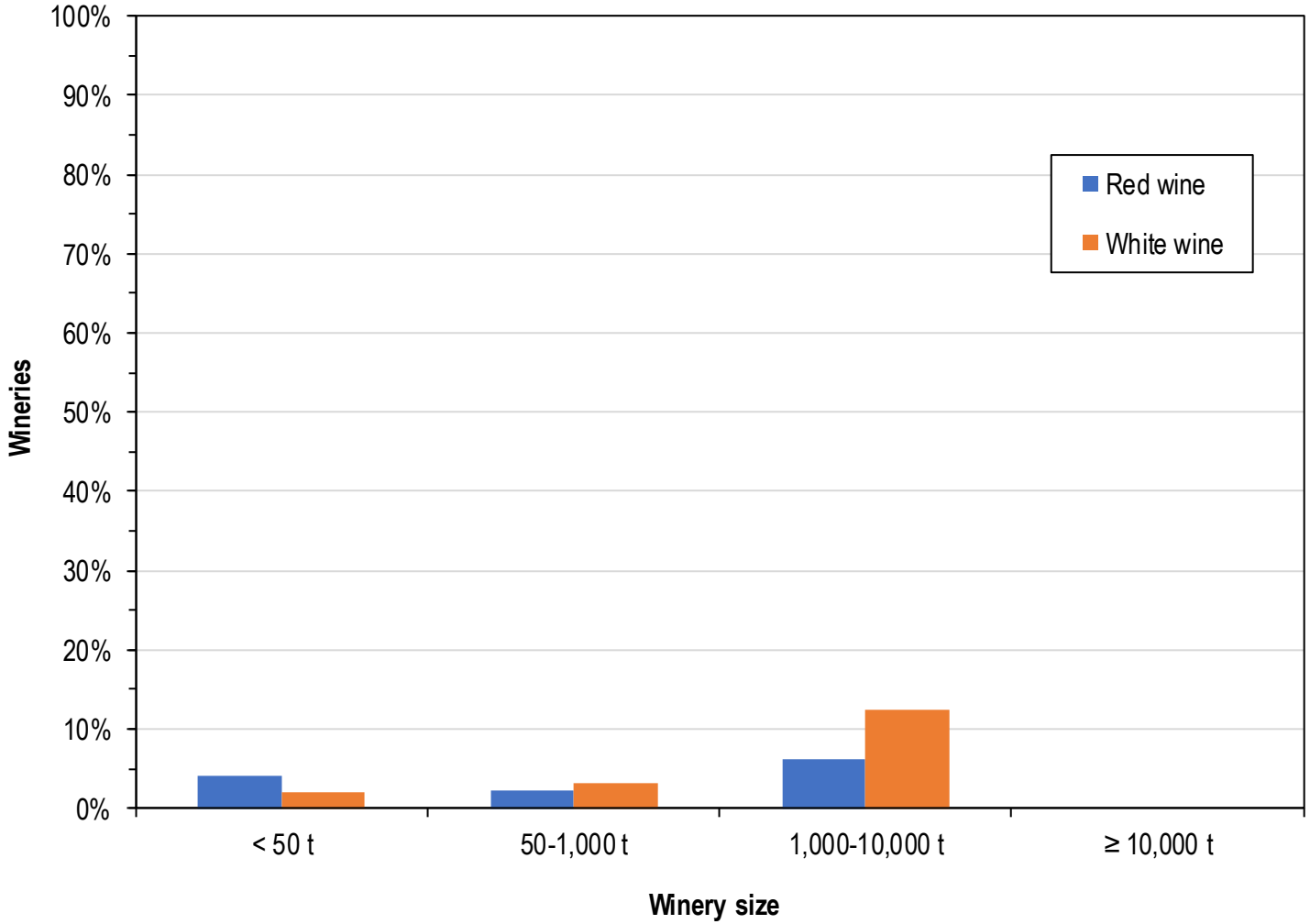
Problem red MLFs in Australia

3%

- As with alcoholic fermentations, there was considerable variability in estimates of sluggish and stuck MLFs.
- This may reflect seasonal variability and differences in definition of what is a sluggish or stuck ferment.
- Very small wineries reported low levels of problems, but they may also not have deadlines as tight as those in larger wineries.

*Respondents were asked what % of each inoculated and wild red table wine MLFs were sluggish or stuck in the last five years. They were asked to select from a drop-down box which had options of <0.01%, 0.01%, 0.05%, 0.1%, 0.5%, 1%, 2%, …etc.. Box plots were drawn using the value for inoculated or wild MLFs (whatever was most commonly used by each producer) and the median is written for each winery size.

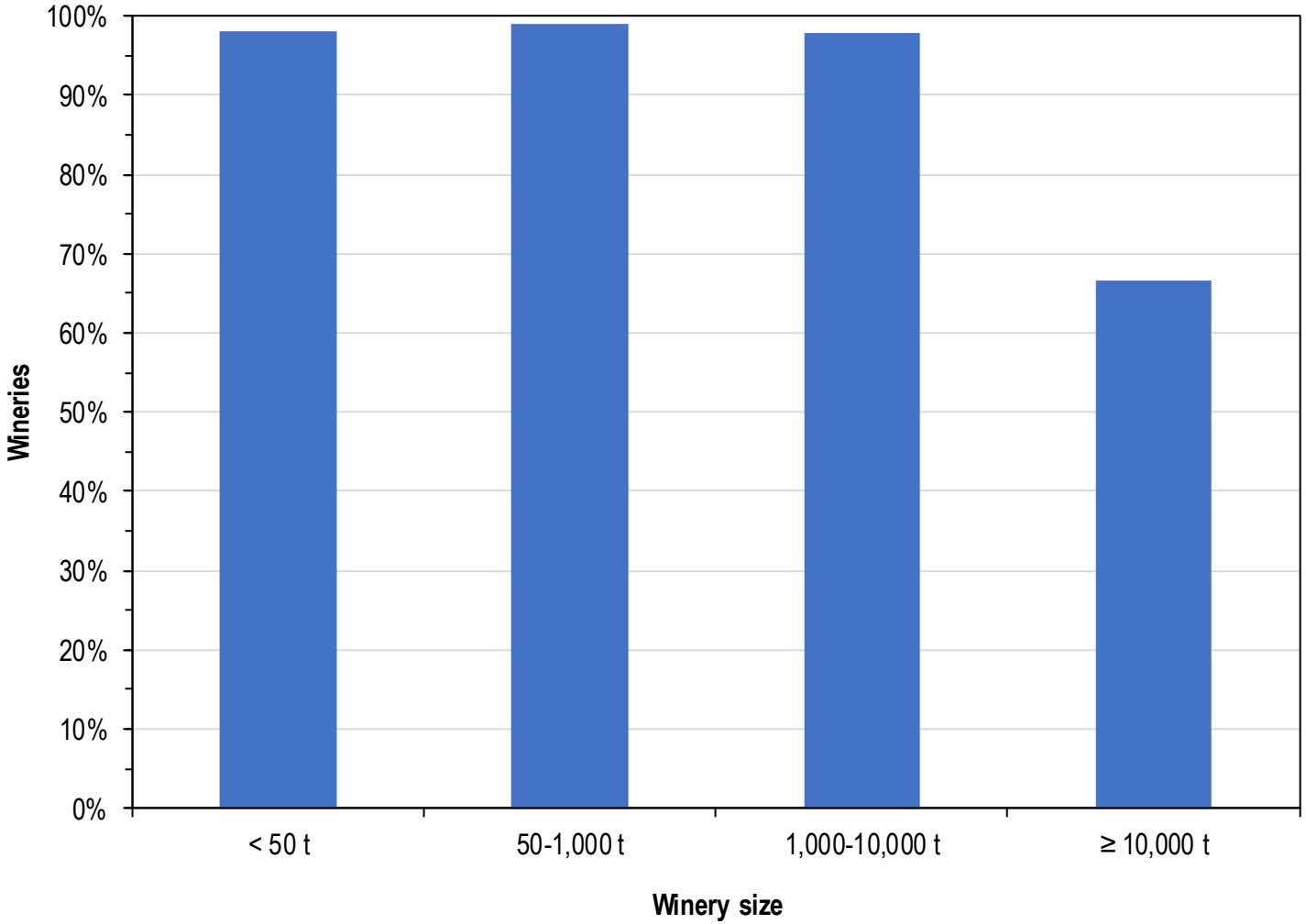
Lysozyme (ever been used)



- Few wineries had ever used Lysozyme and this was verified by suppliers.

*Respondents were asked whether Lysozyme has ever been used at the site for red or white wines or both.

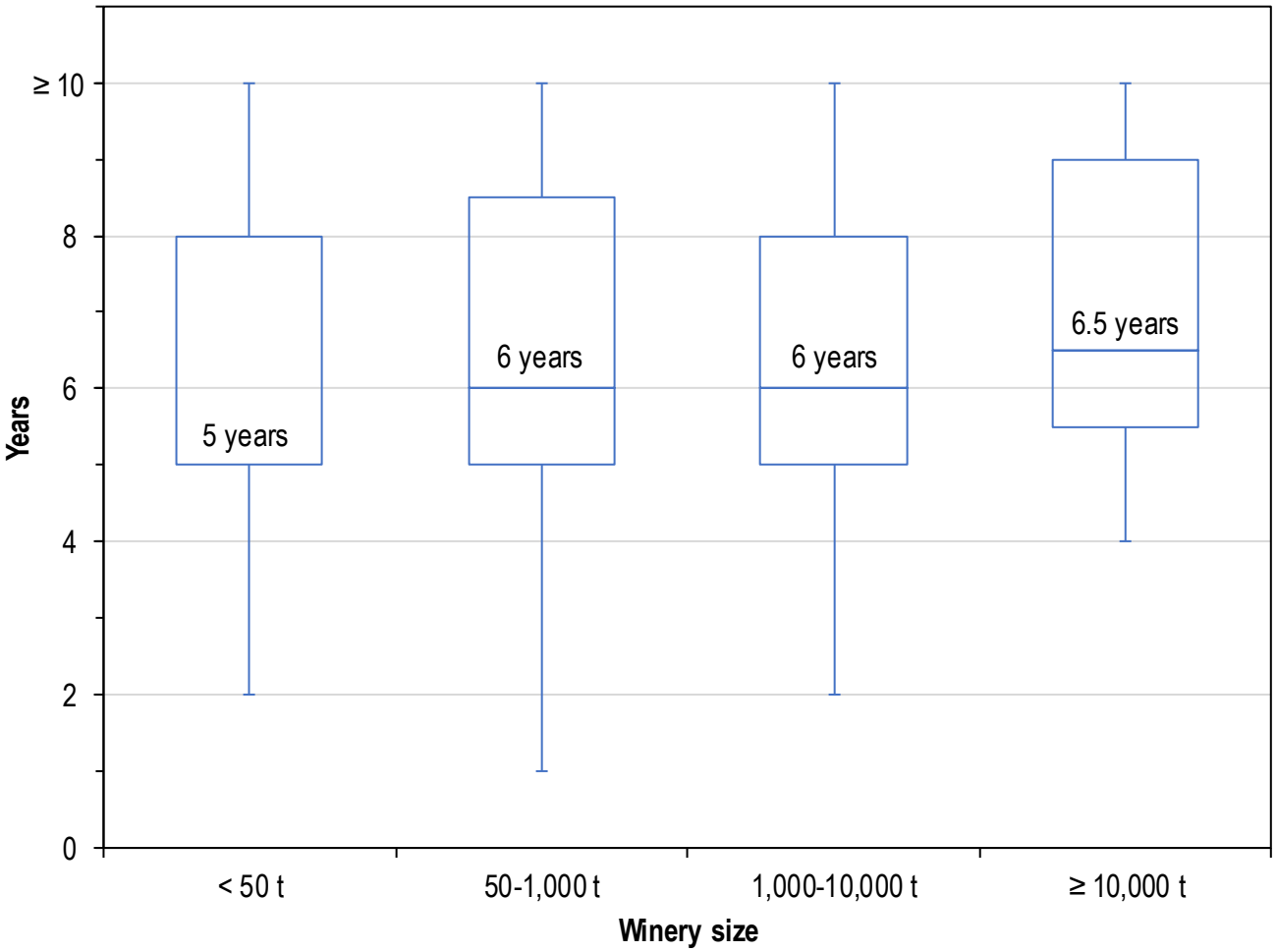
Ageing of table wine in barrels (performed at all)



- Most wineries performed barrel ageing for some table wines.

*Respondents were asked whether any table wines were aged in oak barrels at the site.

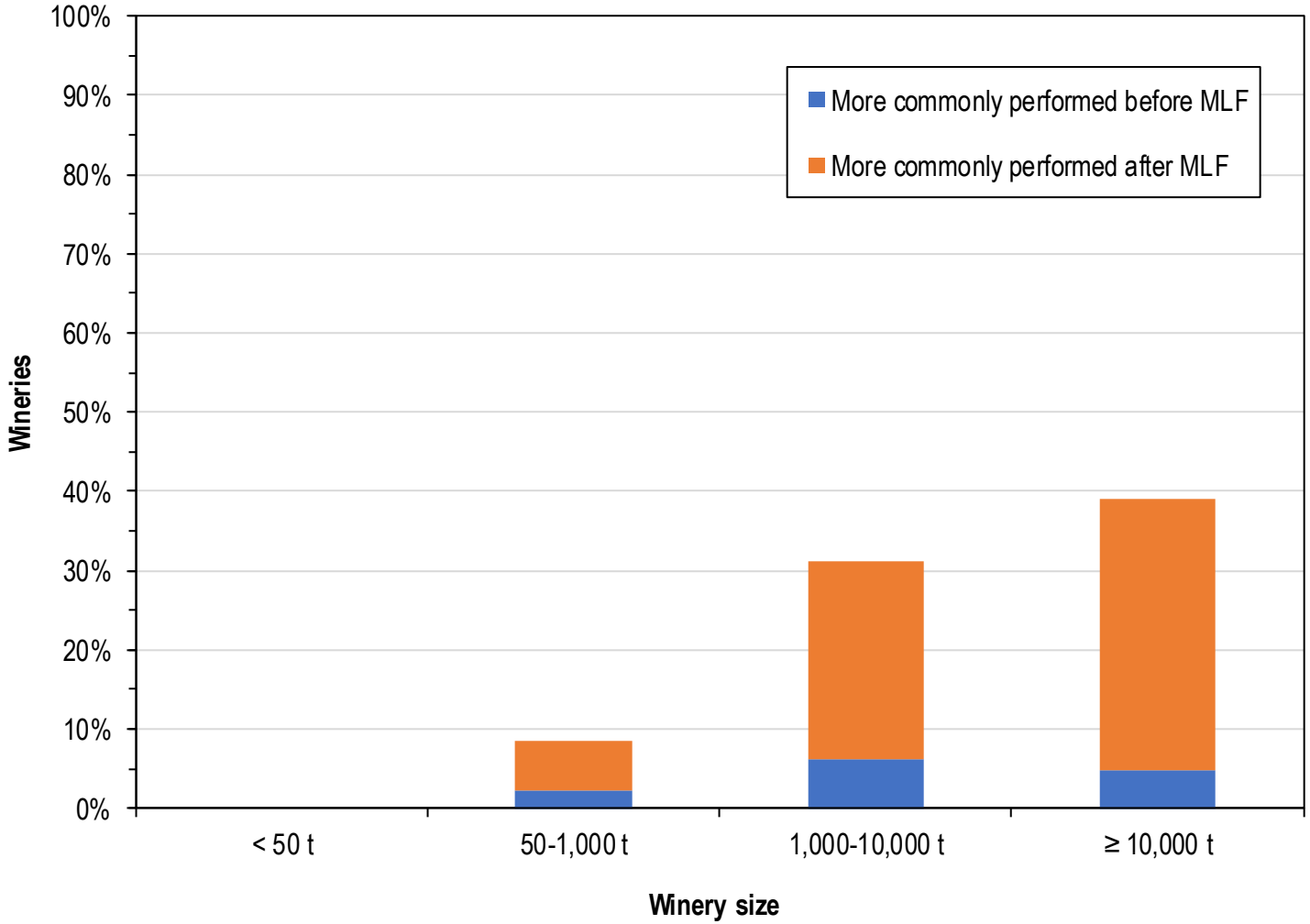
Typical barrel age at time of disposal/major rejuvenation



- Median barrel life ranged from 5 to 6.5 years across the different winery size categories.

*Respondents that performed some ferments or ageing in barrels were asked how long they were typically used at the site before discarding, selling, or performing a major rejuvenation on them. Respondents were asked to select from a drop-down menu with options of 1-10 years as well an option for >10 years.

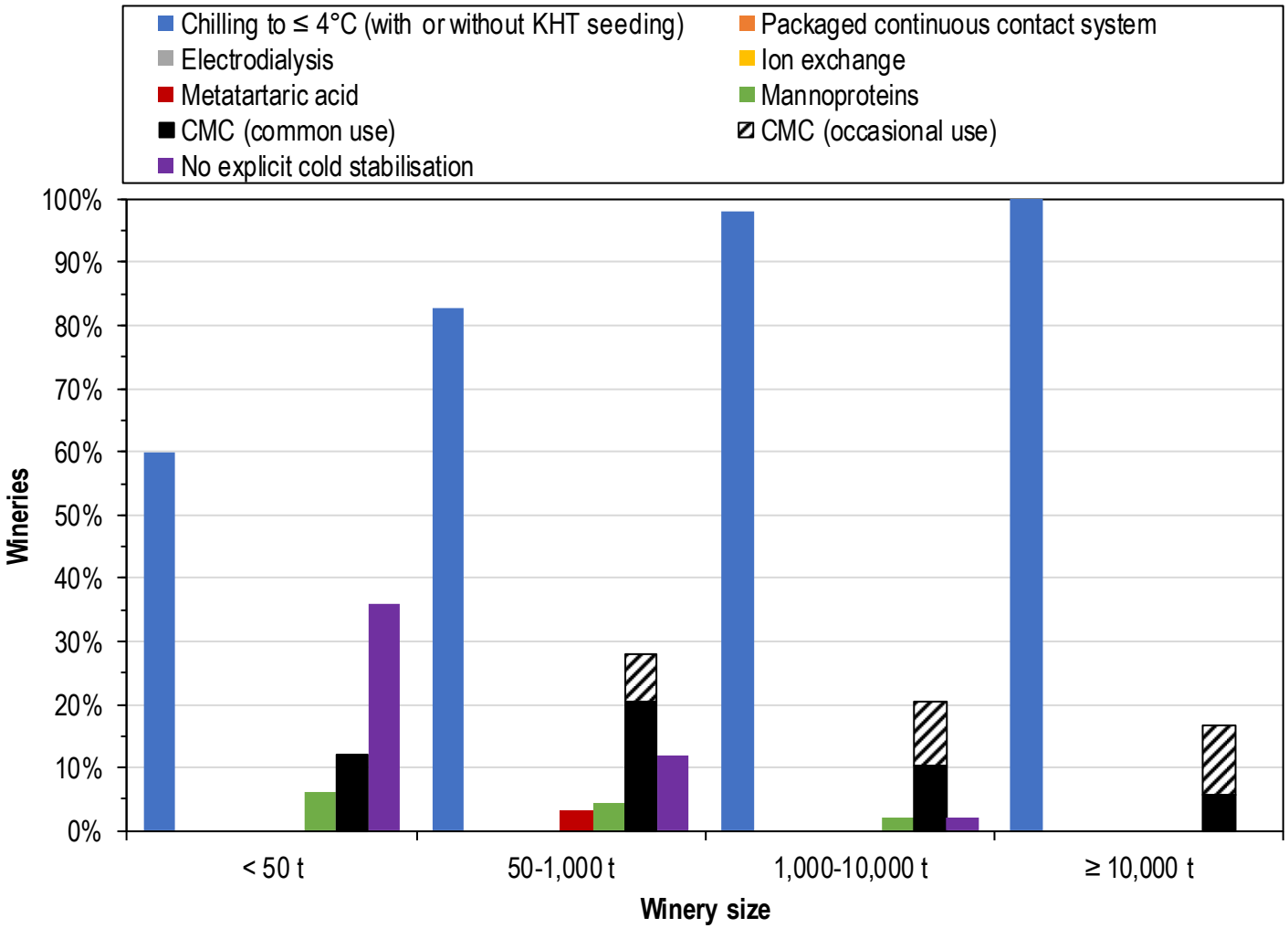
Micro-oxygenation (used at all)



- Micro-oxygenation (MOX) was more commonly performed by large wineries than small wineries, but use was low – much lower than the plot suggests at first glance.
- 9 out of 11 wineries that were visited that had reported using MOX at all said that they only used it for very small proportions of red wine (<10%, with some going years without using it at all).
- Many wineries that performed some MOX (and some that no longer performed any) mentioned that it was a technique that used to be used quite frequently, but much less so now.

*Respondents were asked whether any micro-oxygenation was performed on red table wine. If they answered yes, there was a follow-up question on whether it was more commonly performed before or after MLF.

Cold stabilisation methods (used at all)

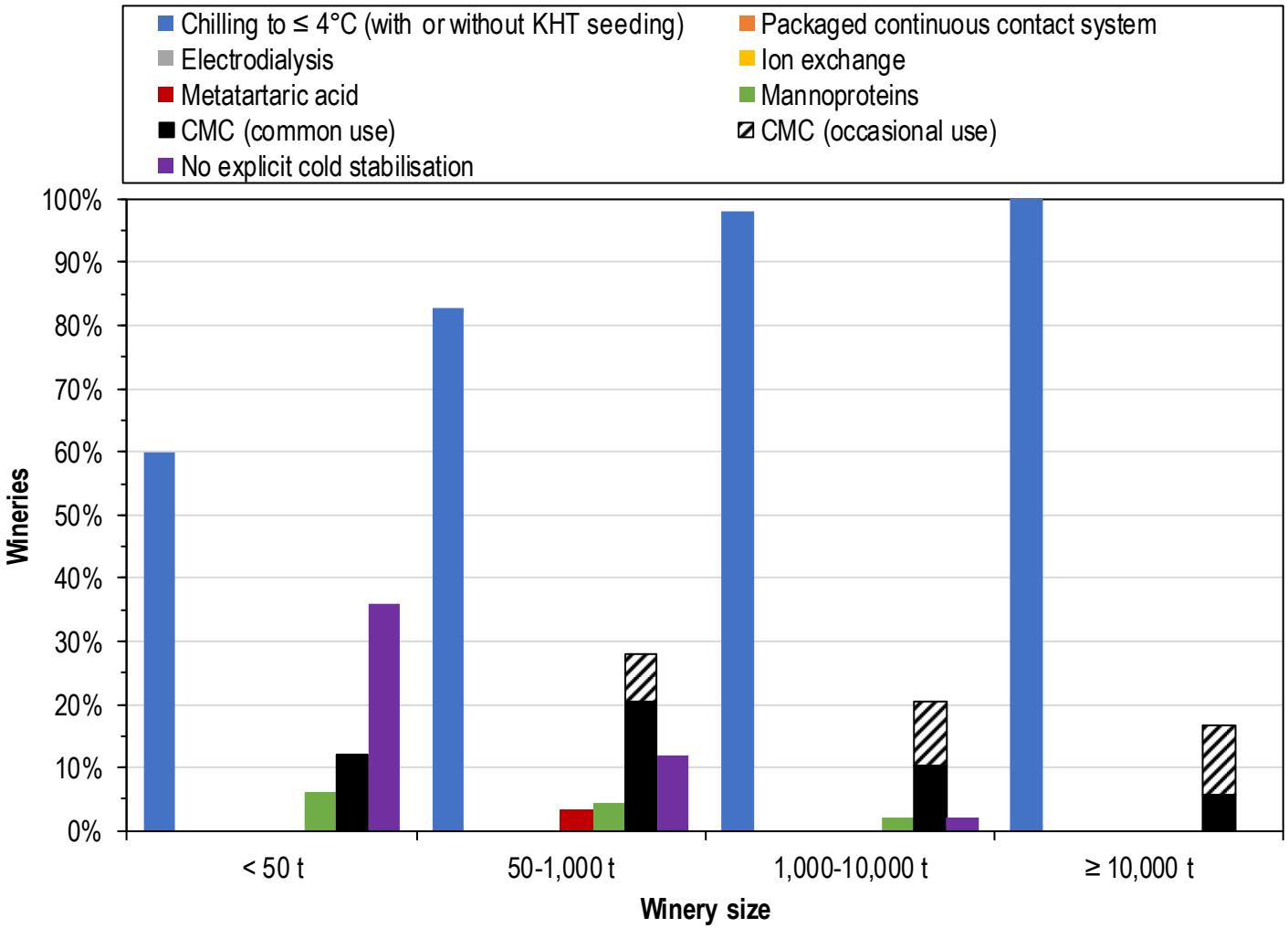


- Chilling with or without KHT seeding was the most common method of cold stabilisation.
- Some wineries seeded with KHT routinely, while others only did so when they were having issues or were under time pressure.
- 15% of Australian wineries ≥ 10,000 t performed some form of tartrate recovery and reuse (hydrocyclone recovery or pumping tartrate lees between tanks or wine onto tartrates).
- No respondents used ion exchange, packaged continuous contact systems, or electrodialysis, although the literature reports that there is one Australian winery using a packaged continuous contact system and one using electrodialysis.
- CMC was used to some extent by around 20% of wineries.
- Follow-up calls/visits were made to CMC users to understand if it was used commonly or only occasionally.

(continued next page…)

*Respondents were asked to select all methods used for cold stabilisation.

Cold stabilisation methods (used at all) – CMC continued



(…from previous page)

- A significant proportion of CMC users only used it occasionally, and only one winery ≥ 10,000 t had adopted CMC as common practice.
- Current common users were generally positive about CMC.

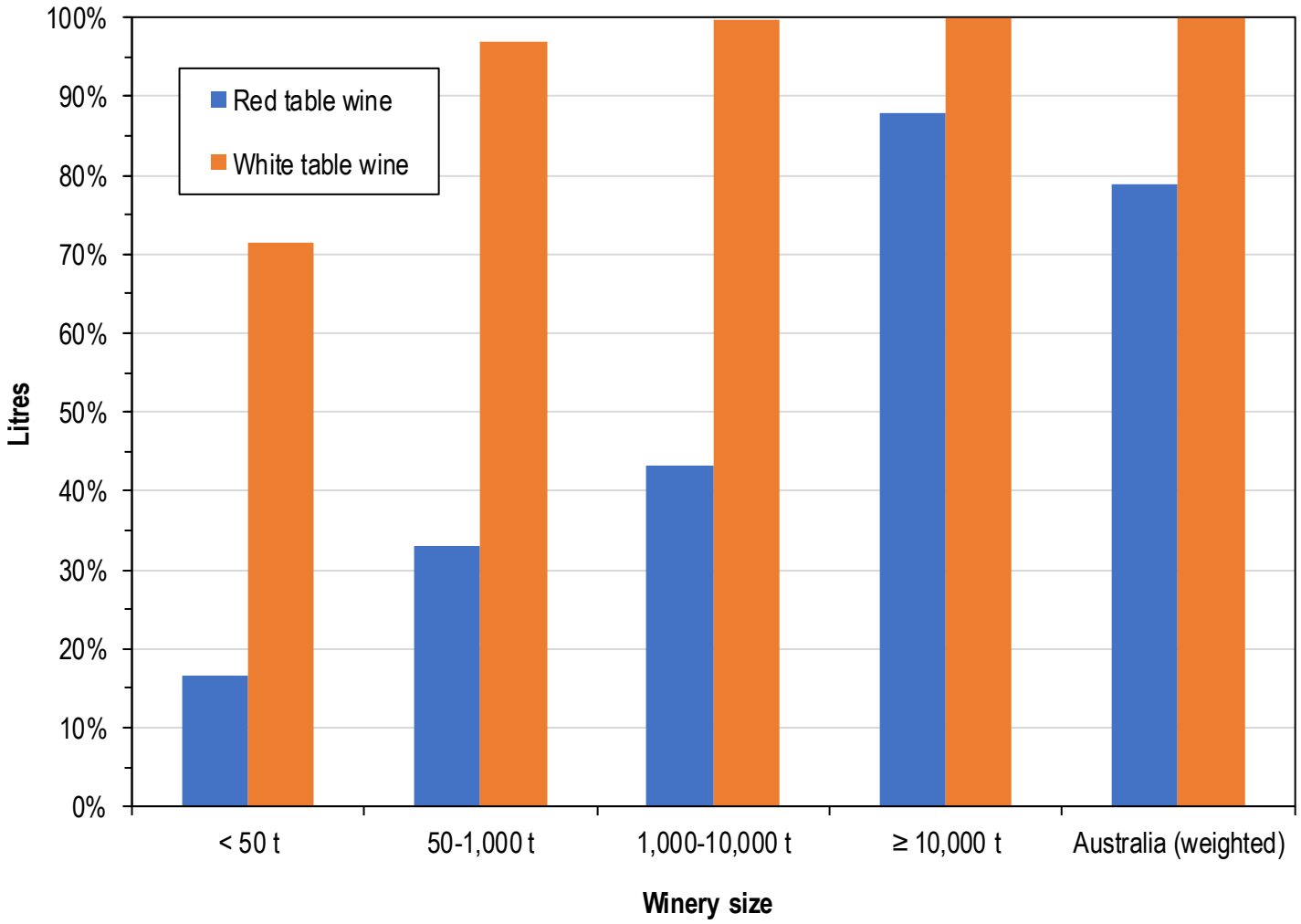
Occasional CMC user reasons given for using:

- Wine needed at short notice
- Base wines were stable but blend not
- Didn't want to drop wine acid
- Small white wine volumes.

Reasons given by CMC non-users for not using:

- Long-term stability questioned
- Might need to still pre-chill wine
- Problems if later blended.
- Clauses in sales contracts
- Not allowed in all export markets
- Filtration concerns.
- Like dropping wine acid by chilling
- Negative sensory impacts of CMC
- Haven't done enough trial work yet.

Cold stabilised (using one of the methods listed)



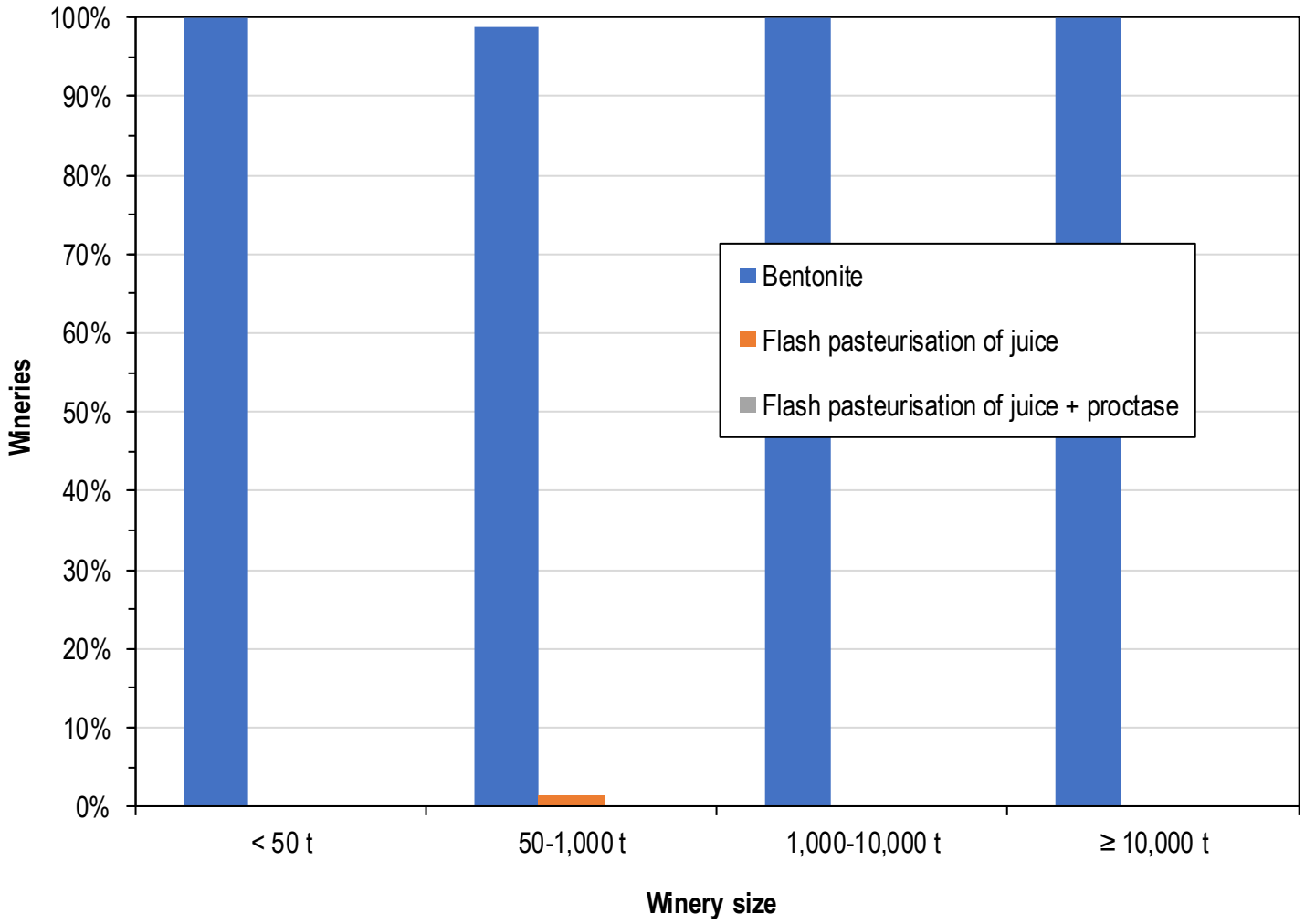
Cold stabilisation in Australia

79% red wine
100% white wine

- White table wine was more likely to be cold stabilised than red table wine.
- Smaller wineries performed relatively less explicit stabilisation of red table wine than larger wineries.
- This likely relates to the higher average price of their wine (higher-priced wine consumers seem likely to be more understanding of inert bottle deposits) and longer periods of cool ambient holding pre-bottling that achieve or near achieve cold stability anyway.
- Large wineries also often did not explicitly cold stabilise higher-priced red wines for the same reasons.

*Respondents were first asked whether all finished red and white table wines at the site were explicitly cold stabilised by treating with one of the methods listed. If they answered no, they were asked what % of the volume of red and white table wines were explicitly cold stabilised. Litres cold stabilised were estimated based on this, the winery intake tonnage and fraction of red and white grapes.

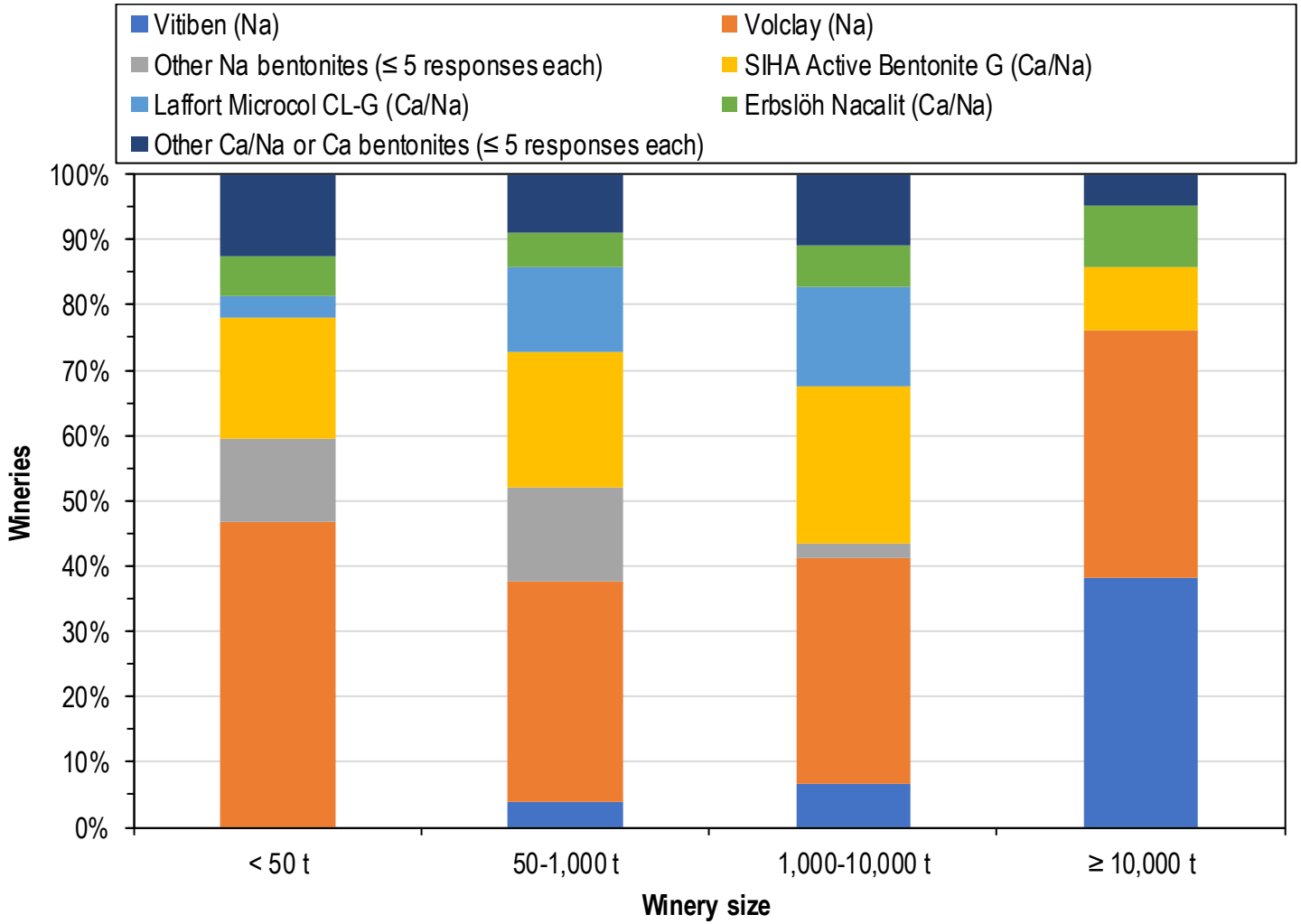
Heat stabilisation methods (used at all)



- 99% of respondents who made white wine reported using bentonite at some stage of production.

*Respondents making white wine were asked if bentonite was added to any white juice, ferments or wines at the site. They were also asked if apart from bentonite any other techniques were used to heat stabilise or partially heat stabilise white wine and were provided with a list to select from that included flash pasteurisation of juice, flash pasteurisation of juice + proctase, and other.

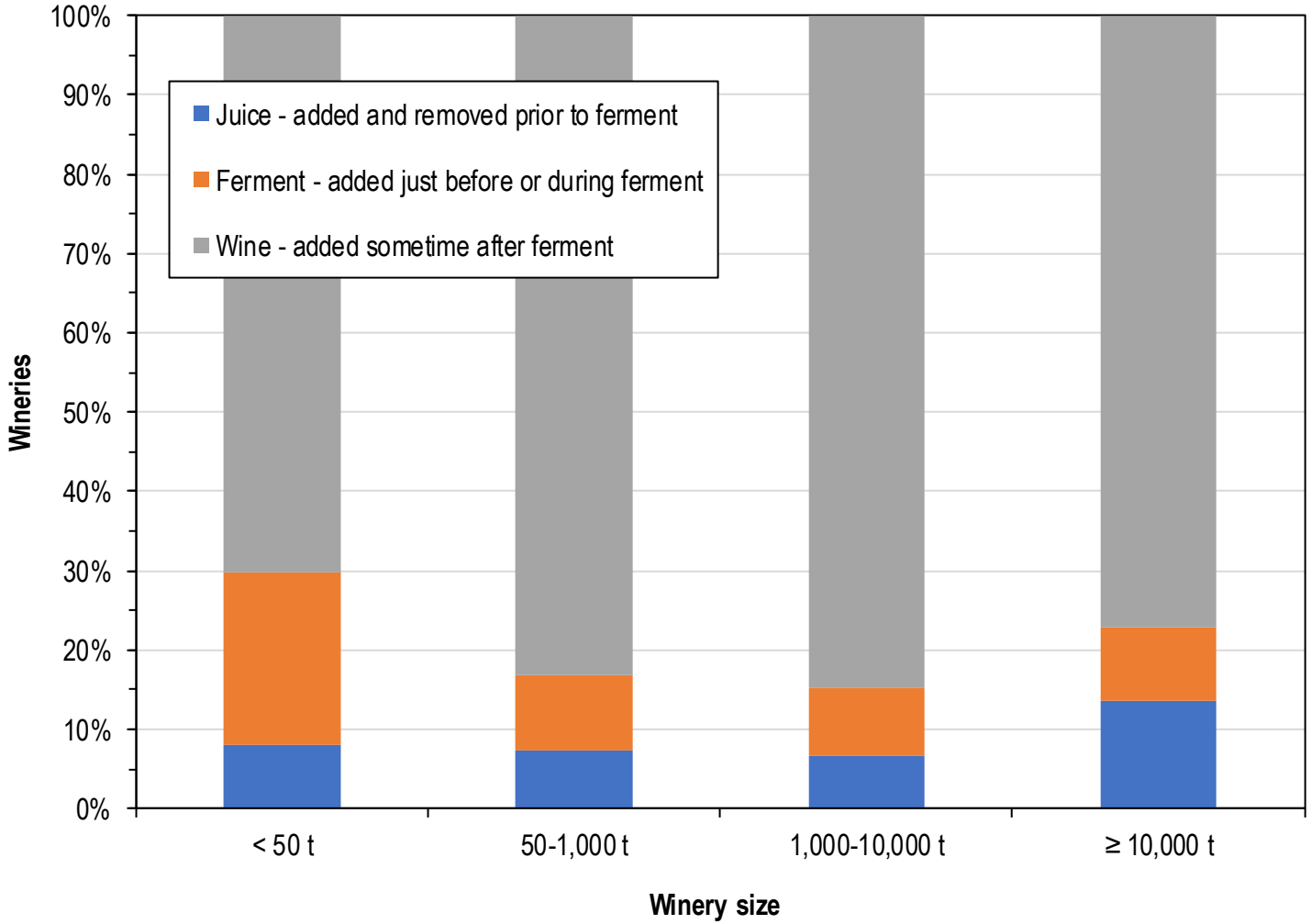
Most common bentonite type used



- Sodium (Na) bentonites are typically cheaper and require lower doses than calcium-sodium (Ca/Na) bentonites.
- Ca/Na bentonites, however, typically form smaller lees and are easier to prepare.
- These were some of the drivers in bentonite choice by wineries.
- Large wineries were more likely to commonly use Na bentonites than smaller wineries but would also sometime use Ca/Na bentonites with their higher-priced wines.
- While Na bentonites produce more lees, larger wineries usually have access to lees reprocessing equipment.
- Surprisingly, smaller wineries still quite commonly used Volclay Na bentonite despite the relatively large lees volumes it causes and absence of reprocessing equipment in some of those wineries.

*Respondents were asked to select the most common bentonite used from a drop-down list.

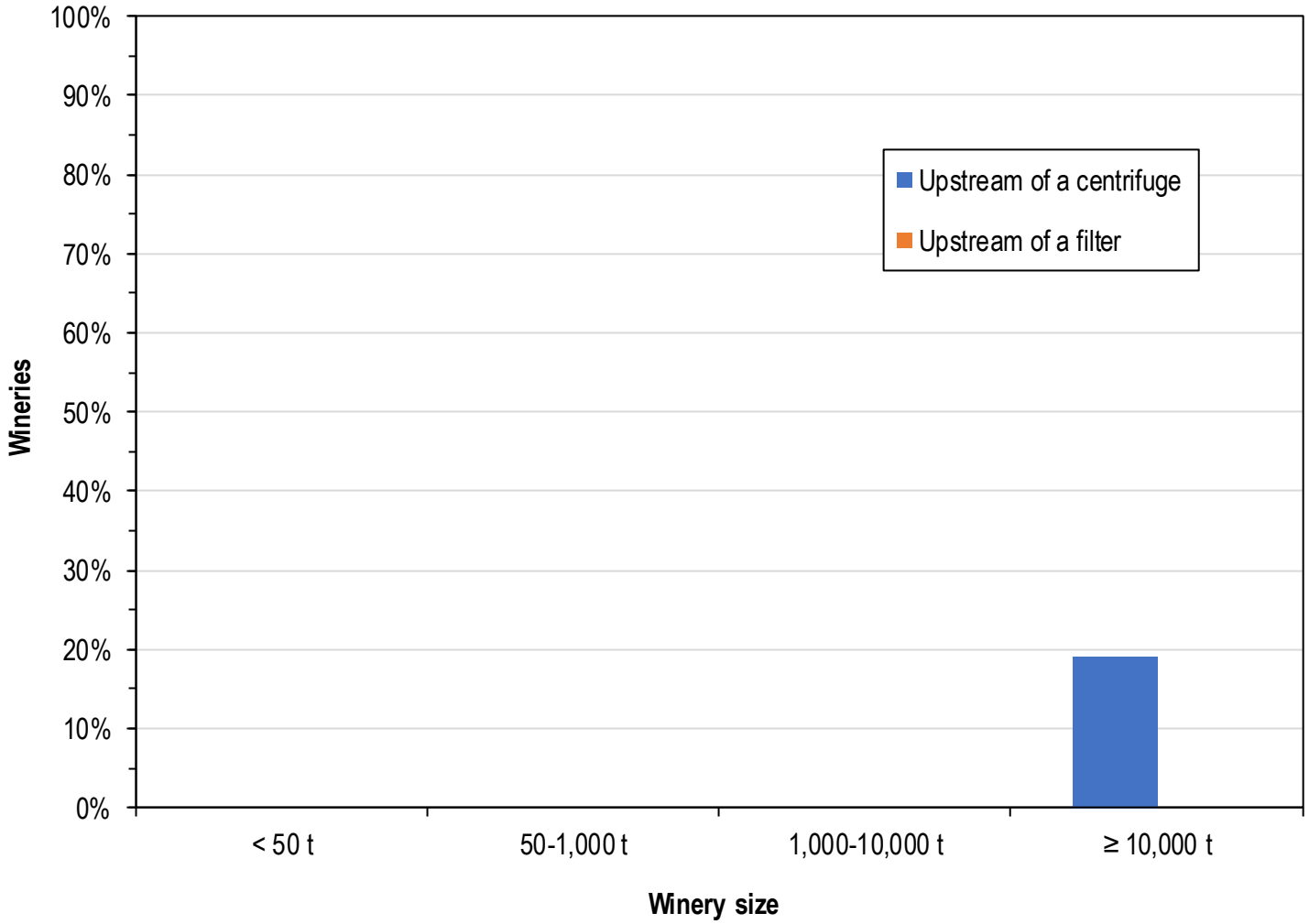
Timing of largest bentonite addition



- Bentonite was most commonly added to wine, but this does not tell the full story.
- During site visits, it was found that 50% (6 of 12) wineries ≥ 10,000 t adding their largest dose to wine, added it prior to the first separation from yeast lees (sometimes after lees mixing) rather than to near finished wine.
- 60% of wineries ≥ 10,000 t therefore appeared to be removing their largest bentonite quantity in combination with yeast lees, combining steps and possibly reducing overall lees volumes.
- The prevalence of a small bentonite dose to aid juice flotation was not explicitly captured in the survey, but increased use of flotation by wineries (page 94) may be having some influence on bentonite doses required by wines (although additions of bentonite to juice usually requires higher doses for stabilisation than additions made to ferments or wine).

*Respondents were asked at what point in the winemaking process was the largest dose of bentonite typically added.

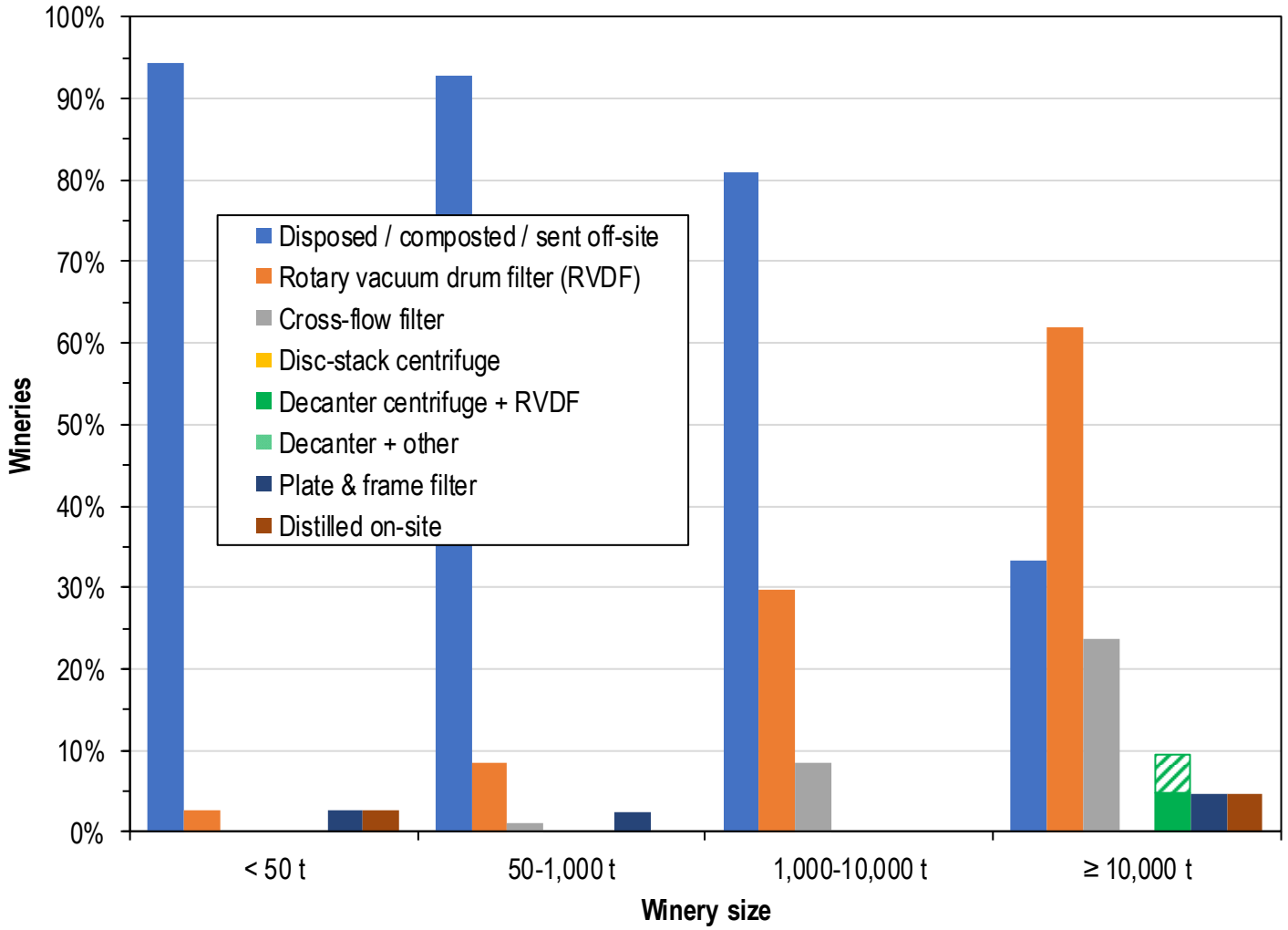
In-line bentonite dosing (used at all)



- Four wineries ≥ 10,000 t in-line dosed upstream of a centrifuge, with one doing it with juice, one after ferment, one on blends and one sometimes with juice and sometimes after ferment.
- No respondents were in-line dosing upstream of a cross-flow filter.
- The survey question also included options for centrifugation or filtration after in-tank bentonite addition.
- Based on follow-up site visits, only two additional wineries to those in-line dosing were using the centrifugation step to remove the bulk of the bentonite and therefore compacting the lees, while others were just racking off bentonite lees to the centrifuge.
- From follow-up site visits, all wineries performing filtration after in-tank bentonite additions were racking to the filter rather than using it to remove the bulk of the bentonite. Since 2016 a limited number of smaller wineries have started using filtration for bulk bentonite removal through a contract cross-flow filtration service provider.

*Respondents were asked to select which methods were used to initially remove juice/wine from bentonite solids. The options included settling and racking, in-line bentonite dosing upstream of a centrifuge or filter and centrifugation or filtration after a tank addition.

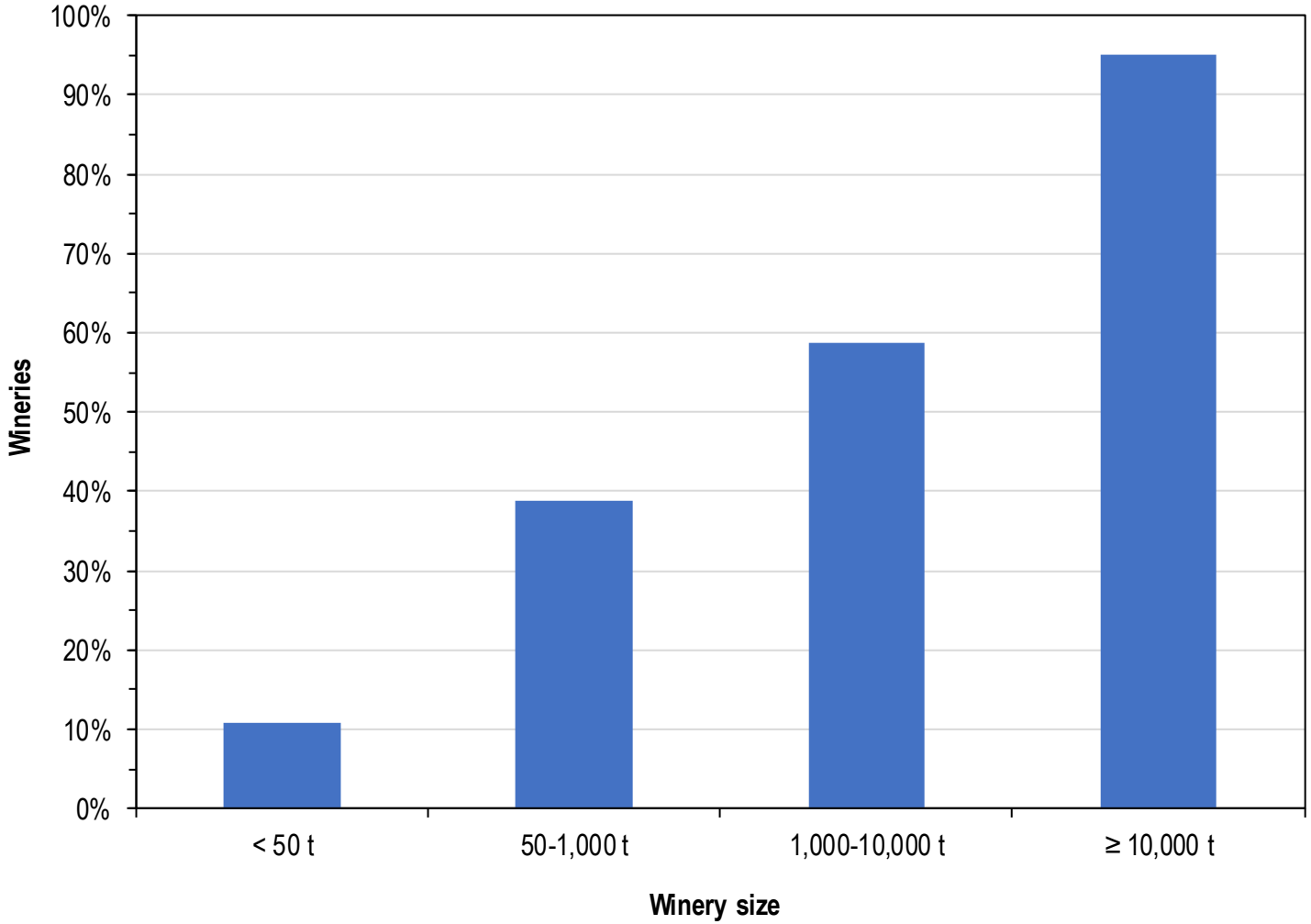
Bentonite lees/desludge management techniques (used at all)



- As with white juice and red gross lees (see pages 96 and 120), larger wineries were more likely to recover juice/wine from bentonite lees.
- An additional factor to those mentioned for other lees types is that large wineries were more likely to use Na bentonites that form more voluminous lees than with Ca/Na bentonites (see page 134).
- As with the other lees types, RVDF was most commonly used for reprocessing, with wide-bore cross-flow filtration being the next most common technique but some had concerns about flow rate.
- One winery using cross-flow noted that it is a technology that lifts wine quality across all product levels.
- For example, RVDF can reduce wine quality, and that wine is then blended into a lower-tier product, reducing its quality as well, while with cross-flow, wine often stays at the same level, maintaining the quality of both that product and the product it previously would have been downgraded into.

*Respondents were asked to select from a list all the techniques that were used to manage the lees/desludge from the clarification processes selected in the prior question.

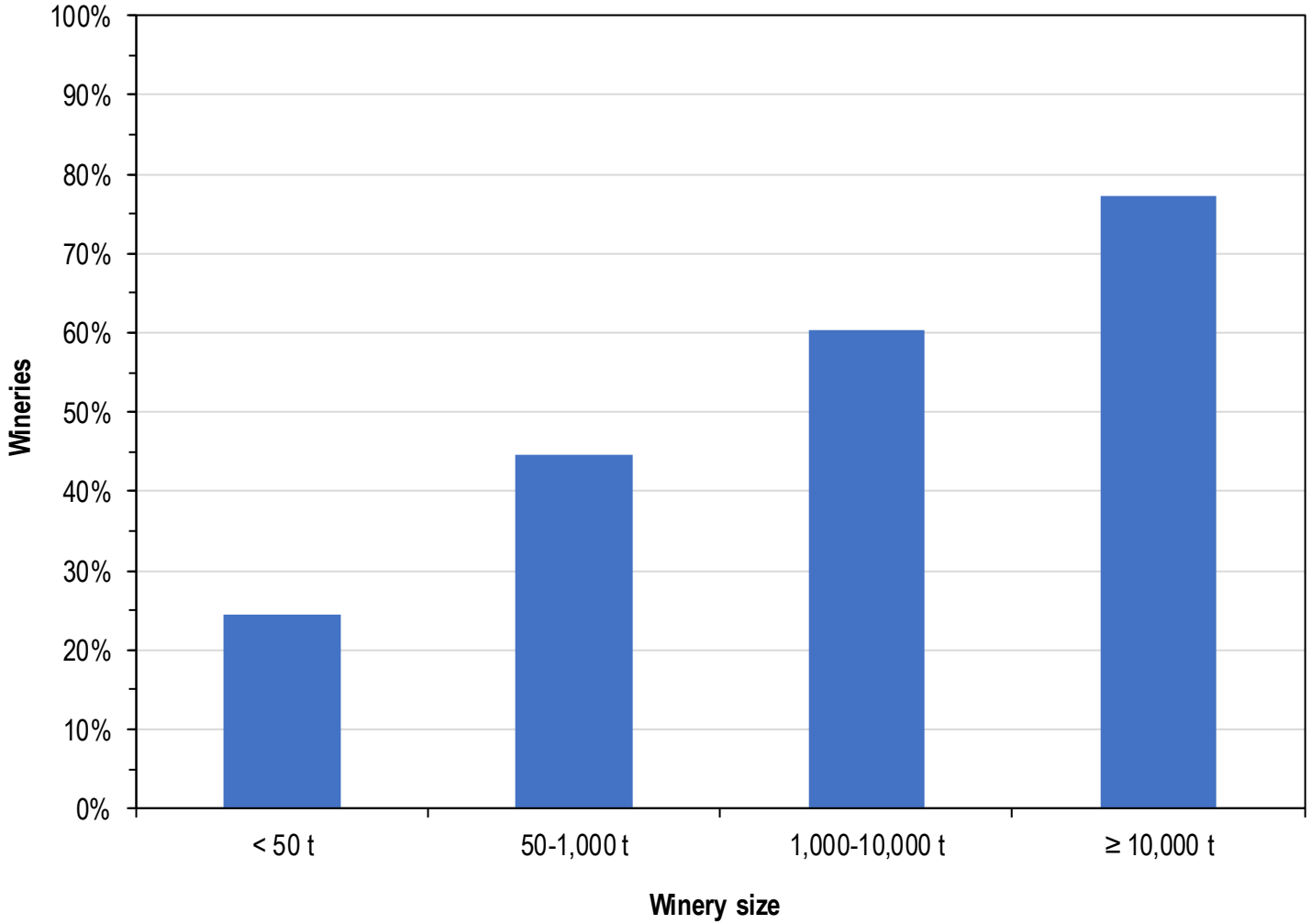
Ascorbic acid addition to white table wines (used at all)



- Large wineries were more likely to use ascorbic acid than smaller wineries.

*Respondents were asked whether they added ascorbic or erythorbic acid to any white table wine, included those added in the form of salts (e.g. sodium erythorbate).

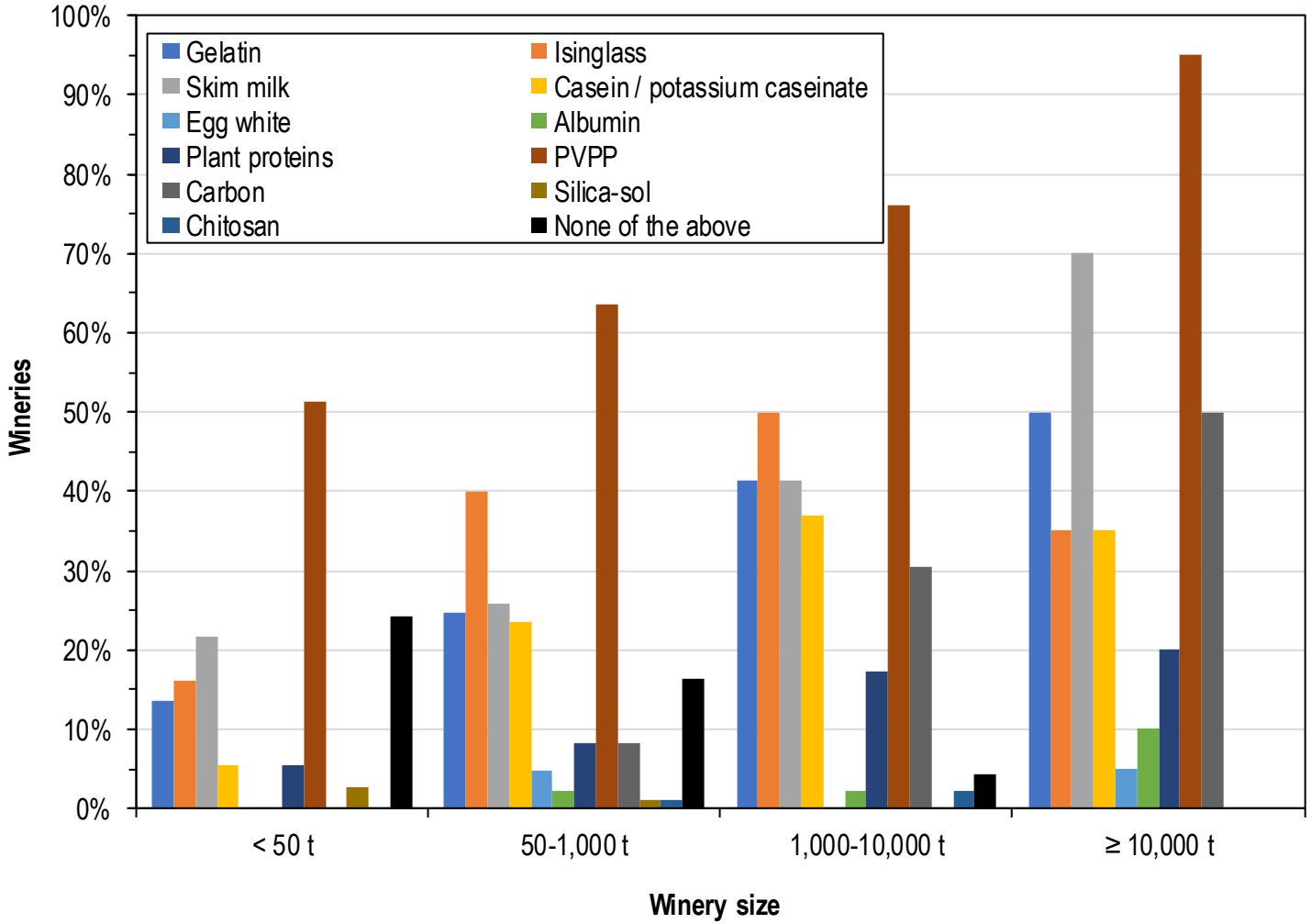
Tannin additions to red table wines – after alcoholic fermentation (used at all)



- Larger wineries were more likely to make a tannin addition to at least some wine (i.e. post-alcoholic fermentation).
- Please see page 111 for data on tannin additions before or during fermentation.

*Respondents were asked whether any red table wines received a tannin addition at some point after alcoholic fermentation.

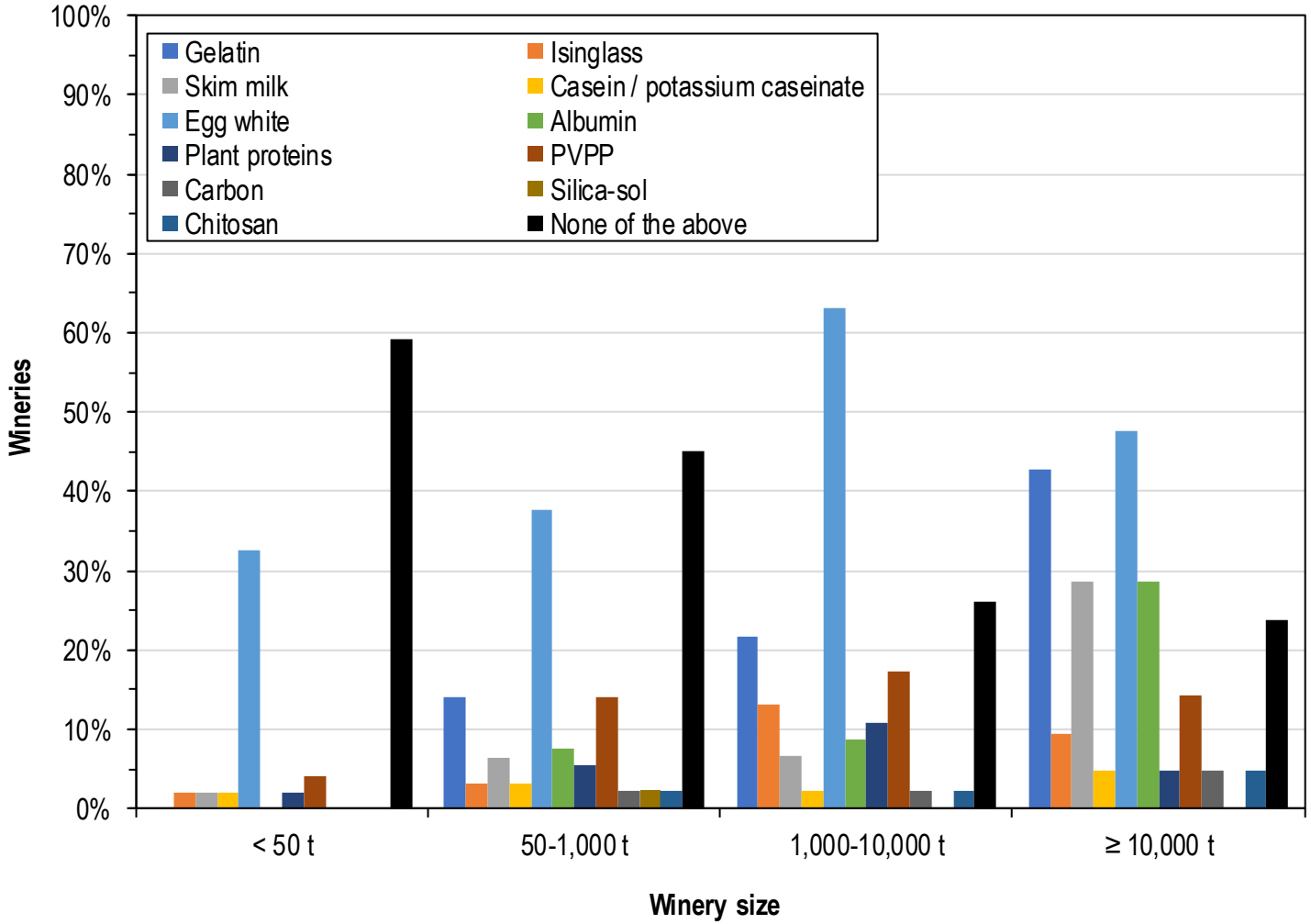
Processing aids used on white table wine (used at all in a typical year)



- As with white juice (see page 93), PVPP and bentonite (see pages 133 and 135) were the agents most commonly used at all by wineries to treat white table wines.
- In follow-up visits, some wineries expressed concerns about the use of PVPP because of it potentially damaging cross-flow filters. They were considering alternatives.
- Please see pages 93 and 141 for data on processing aids used at all for white juice and red table wine and additional general comments on the use of processing aids.

*Respondents were asked to select from a list which processing aids would be used at all in a typical year on white table wines at some point after alcoholic fermentation.

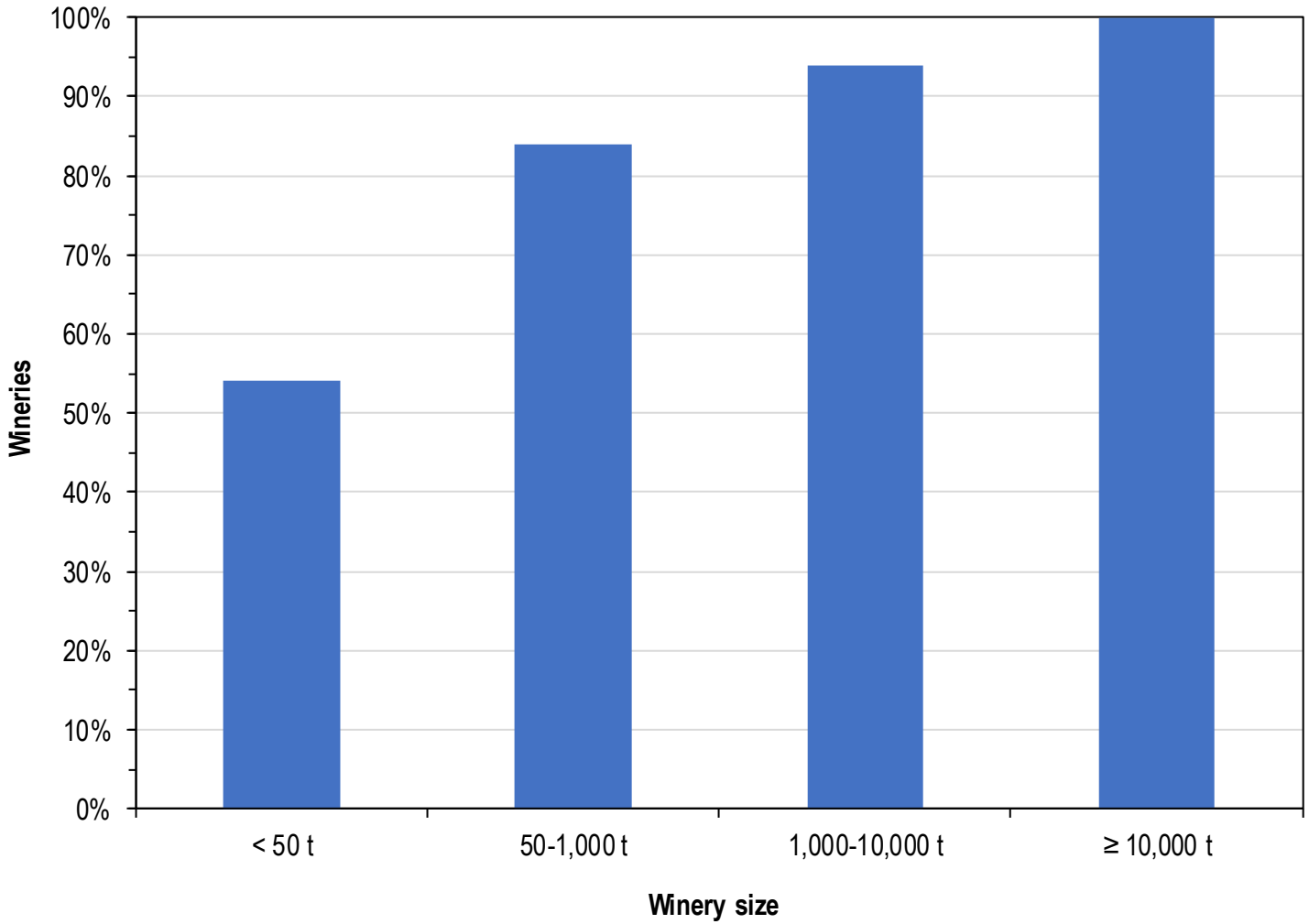
Processing aids used on red table wine (used at all in a typical year)



- Red table wine was much less likely to undergo any fining than white table wine (see page 140), with around 60% of wineries < 50 t and 25% of wineries ≥ 10,000 t using none of the listed fining agents at all on red table wine in a typical year.
- Egg whites were the most common fining agent to be used at all on red table wines in wineries of all sizes.
- Chitosan use reported in the survey was very low; however, while some suppliers agreed with this, others disputed it and said that they had sold it to many clients. This could be a reflection on the question referring to a typical year, while this product may only have been used very occasionally by wineries when they had an isolated issue with *Brettanomyces*.
- Please see pages 93 and 140 for data on processing aids used at all for white juice and white table wine and additional general comments on the use of processing aids.

*Respondents were asked to select from a list which processing aids would be used at all in a typical year on red table wines at some point after alcoholic fermentation.

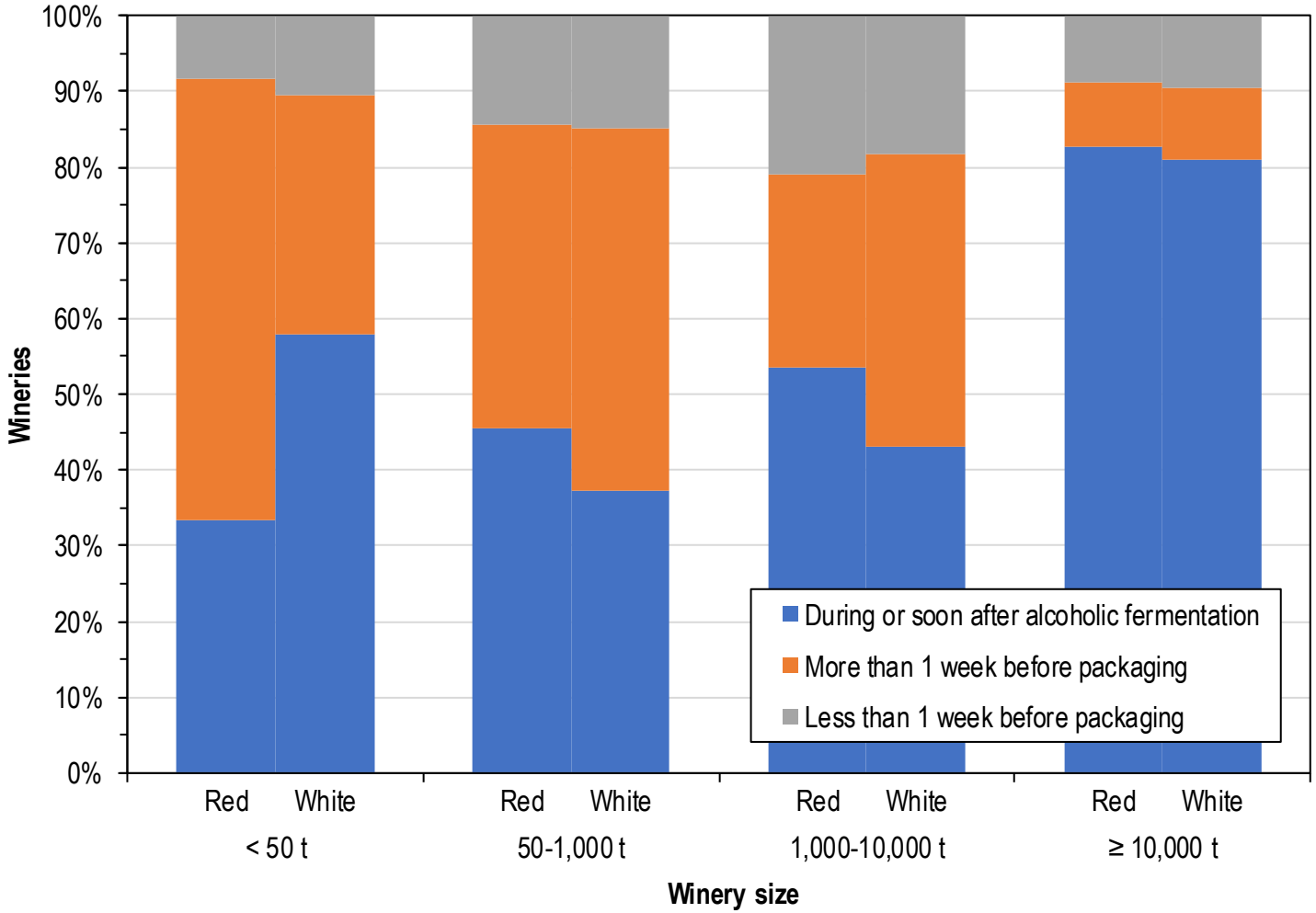
Copper additions to table wines (ever used)



- Larger wineries were more likely to ever make some copper additions to wine.

*Respondents were asked whether copper additions were ever made to table wines.

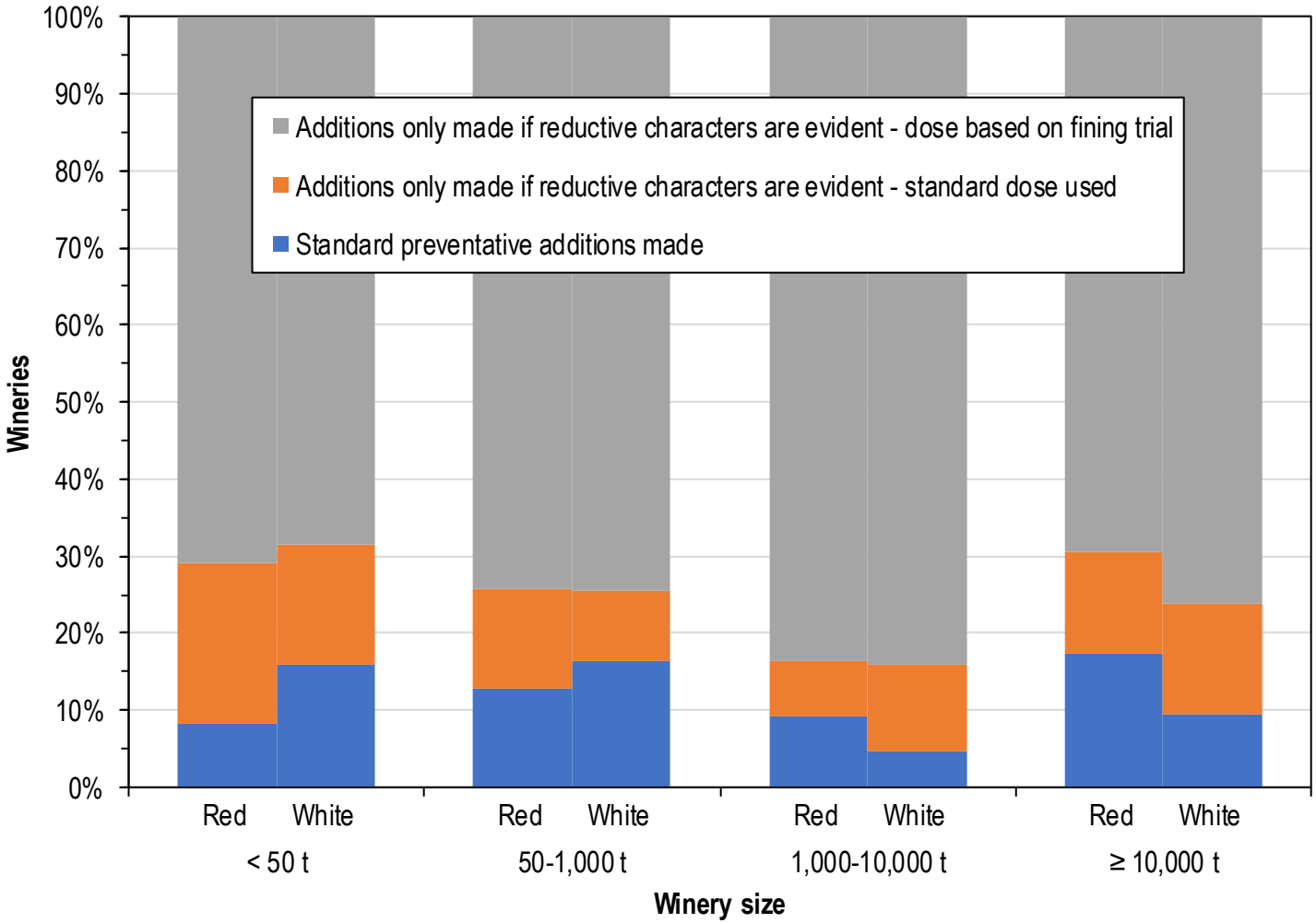
Most common timing of copper additions for table wines



- Larger wineries were more likely to make copper additions during or soon after alcoholic fermentation when yeast could mop up any residual copper.
- Several wineries noted that while their answer might reflect the most common timing of copper additions, additions are only made when required and this could be at any stage.

*Respondents that sometimes made copper additions were asked when the most common timing of additions was for red and white table wines.

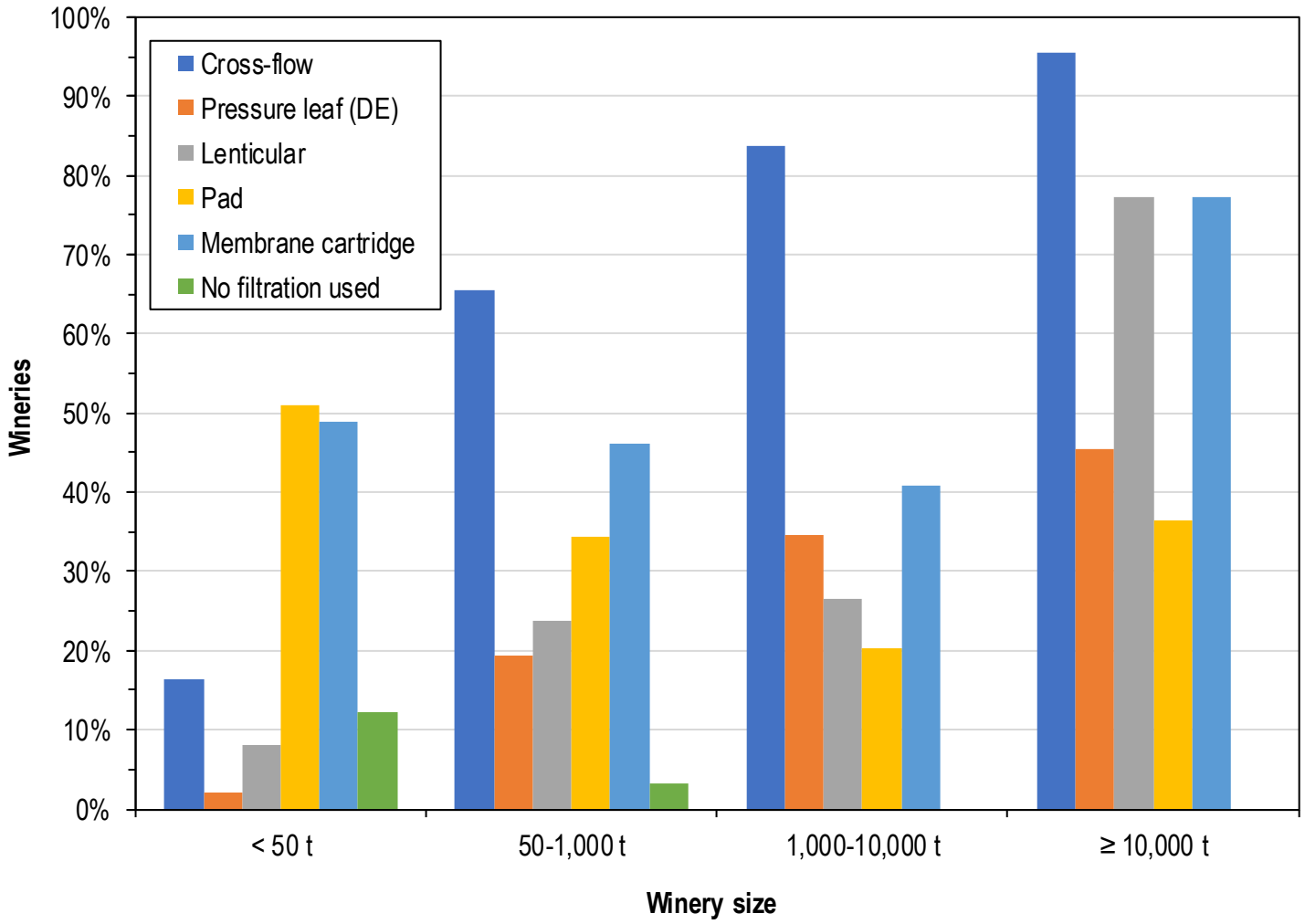
General strategies for copper additions to table wines



- Copper additions were most commonly only made if reductive characters were evident and the dose used was based on a fining trial.

*Respondents that sometimes made copper additions were asked what strategies were generally used for copper additions to red and white table wines.

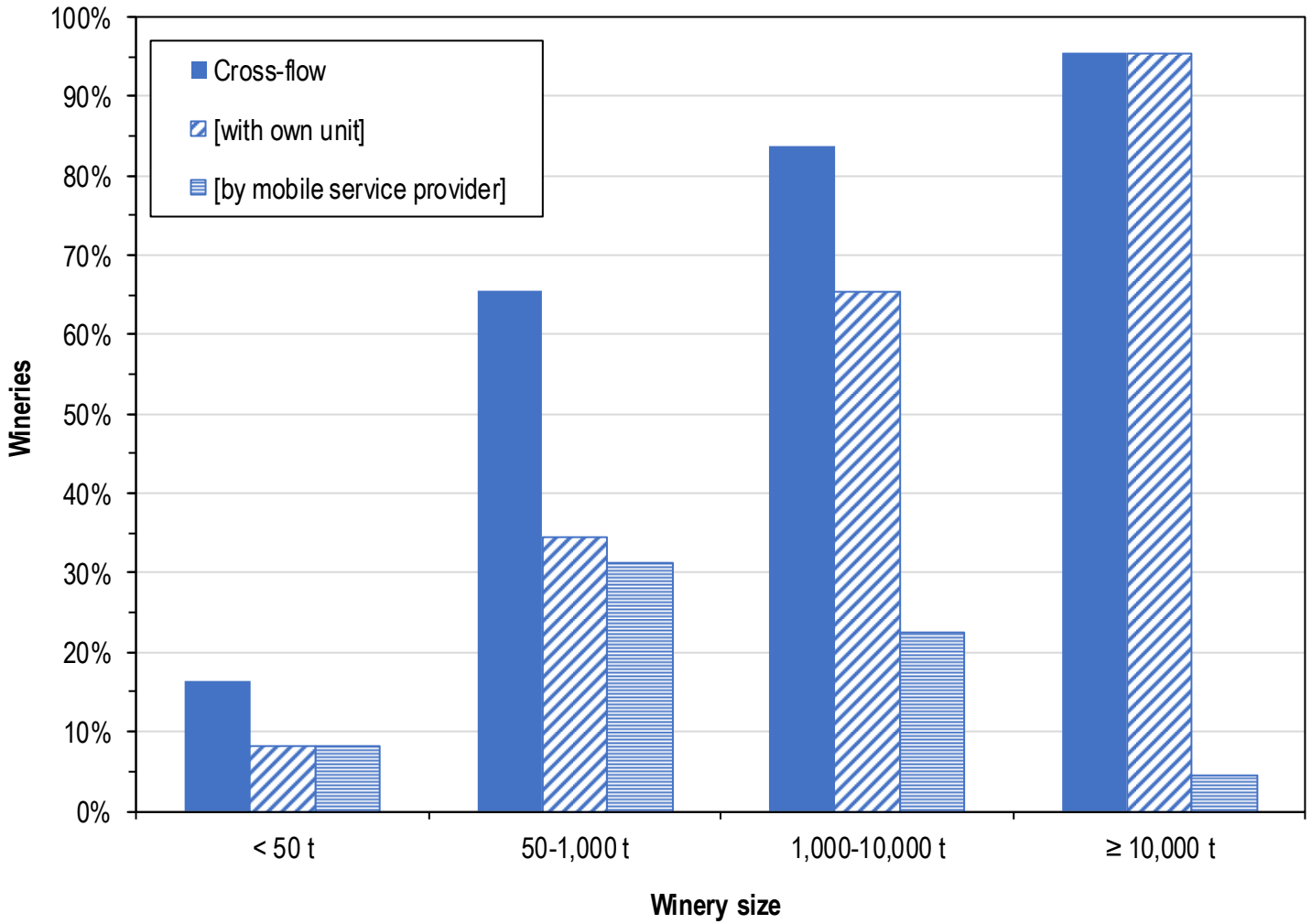
Wine filtration techniques (used at all)



- Cross-flow filtration was commonly used by wineries > 50 t, and only one responding winery ≥ 10,000 t did not use it at all.
- Please see page 146 for a detailed discussion on cross-flow filtration.
- Final filtration varied with product.
- In larger wineries, white wines appeared commonly to be final-filtered through a 0.45 μm membrane.
- Moderately priced red table wines were also often filtered through 0.45 μm membranes, but at high price points red wines sometimes received a coarser final filtration or just a sieve.
- However, several wineries mentioned that more and more high priced red wines are undergoing 0.45 μm membrane filtration.

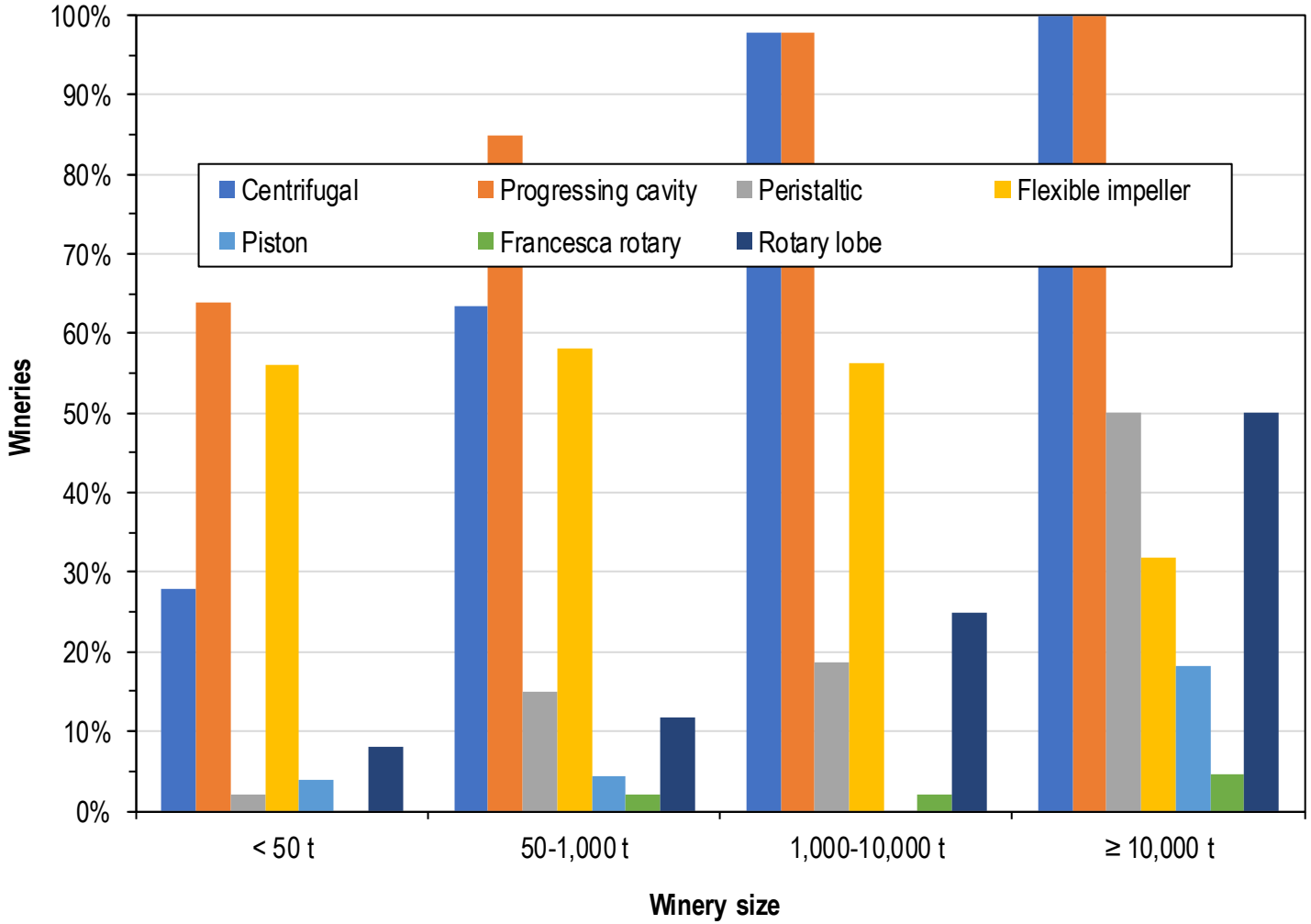
*Wineries were asked to select from a list which filtration methods are used to filter wine (not lees). A separate question asked respondents to select what final filtration steps were used for red and white table wines bottled at the site. Data from these two questions have been aggregated in the plot. Quantitative data on final filtration has not been included because the data was judged not to be sufficiently accurate based on follow-up site visits.

Cross-flow wine filtration (used at all)



- **Cross-flow filtration was by far the most commonly nominated new practice to have a positive impact in the last five years (see page 154).**
- One winemaker described it as: *"the biggest single advance we have made in quality improvement in the last 25 years".*
- Apart from quality, respondents noted the health and safety and waste reduction benefits of eliminating diatomaceous earth (DE) and the reduced number of filtration stages now required.
- Automation was another positive aspect of cross-flow filtration systems, allowing them to run for long periods unsupervised – including overnight.
- While most wineries praised cross-flow filtration, this was not universal, with some criticising the high price of cross-flow systems and of replacement membranes, and the low flow rates compared with DE filtration.
- As wineries increased in size they were more likely to use cross-flow filtration, firstly through a mobile service provider, and then with their own unit.

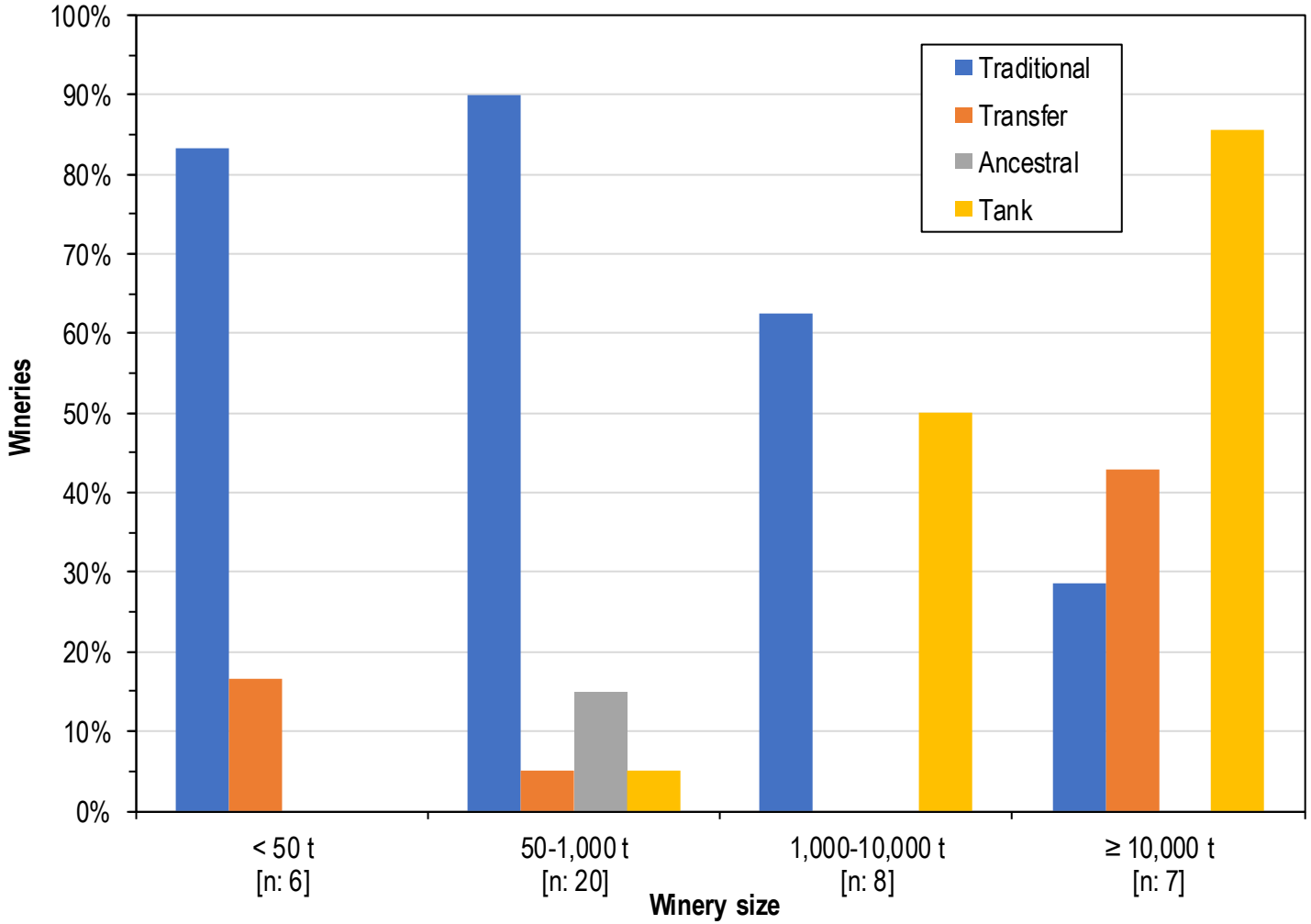
Winery pumps (used at all – including for must)



- Progressing cavity pumps were the most common type of pump to be used at all, with centrifugal and flexible impeller pumps also being common.
- It is likely that the rotary lobe pump responses also include external circumferential piston (ECP) pumps, since they appear similar but have a different rotor design.

*Respondents were asked to select all pump types used at the winery.

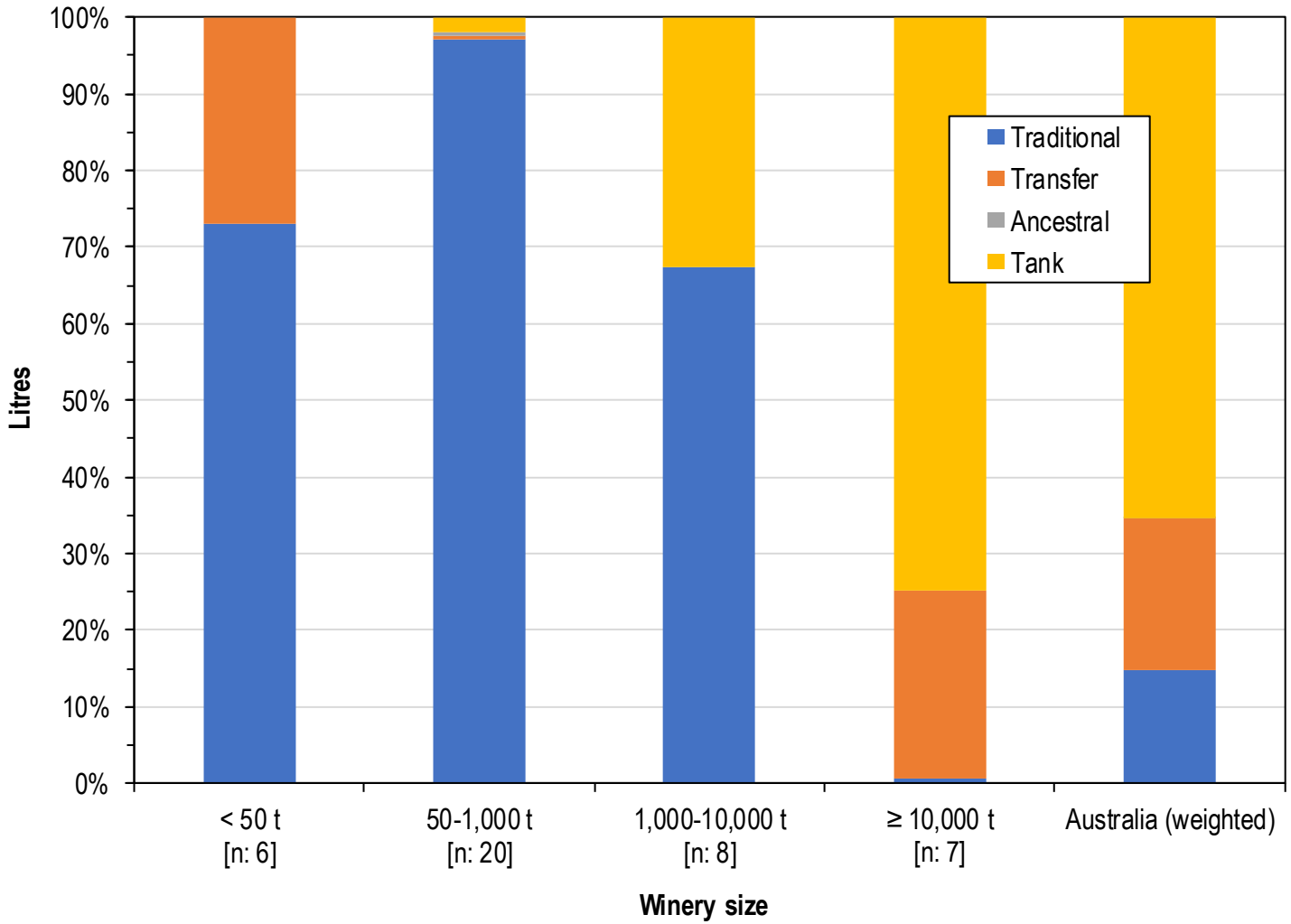
Sparkling wine producers finishing wine made with technique (used at all)



- Sparkling wine was as defined by FSANZ standard 4.5.1 (i.e. ≥ 5 g/L of CO_2 from fermentation, not carbonation).
- Forty-one survey respondents finished sparkling wine on-site in the 2015 calendar year.
- The traditional process was used in the largest number of small wineries, while many larger wineries also used tank secondary fermentations and 3 out of 7 wineries ≥ 10,000 t made sparkling wine using the transfer method.

*Respondents making sparkling wine and finishing the wine in 2015 on-site were asked which techniques were used to make it.

Finished sparkling wine made by technique



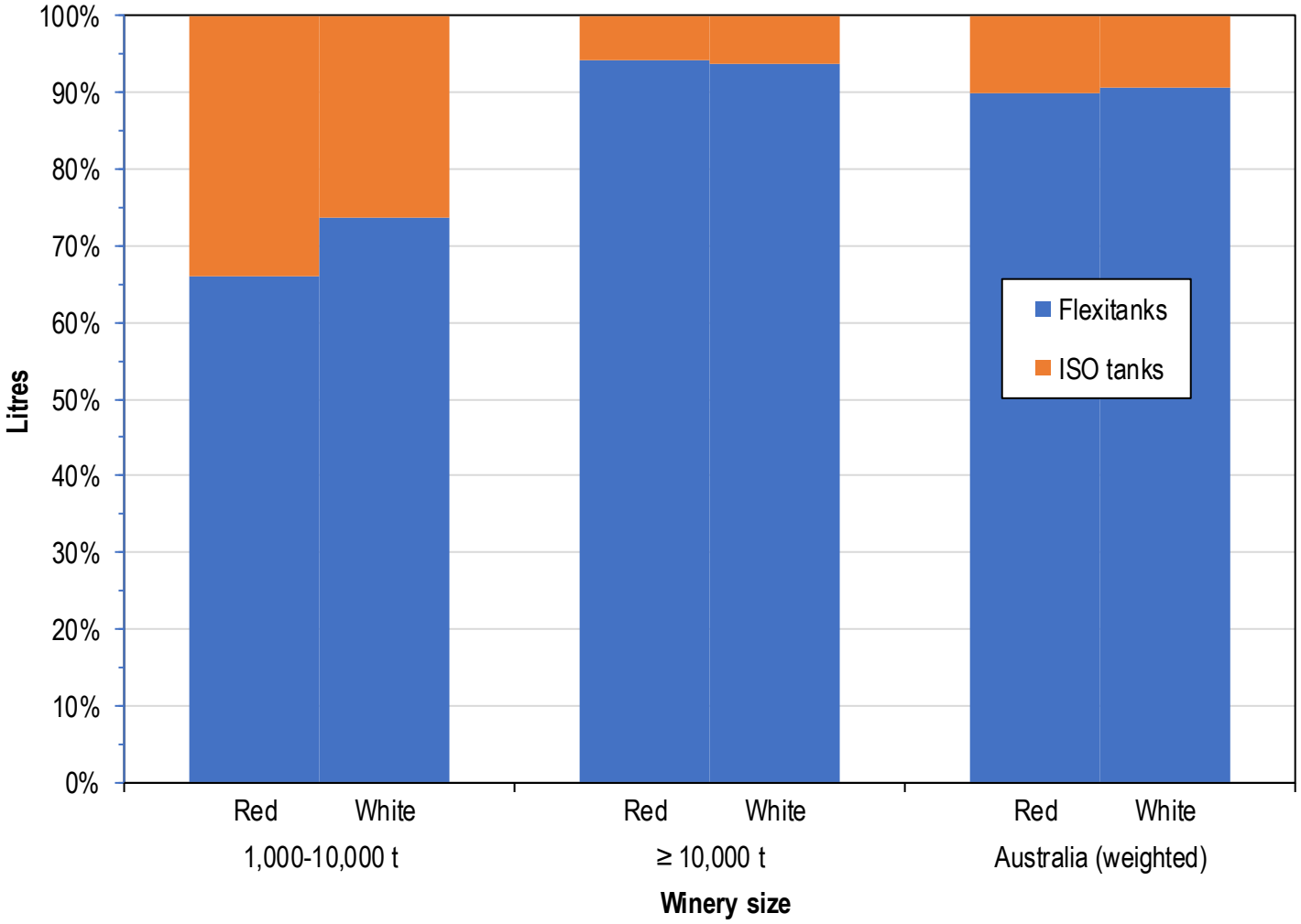
Sparkling wine production methods in Australia

15% Traditional
20% Transfer
65% Tank

- Volumetrically, the most sparkling wine was made by the tank method, but considerable sparkling wine was also made using the transfer and traditional methods.

*Respondents were asked what volume of sparkling wine was produced in 2015. After selecting which methods were used to make this sparkling wine at all, respondents were asked to enter the % made with each method and based on this aggregate industry data was calculated.

Bulk export container types for table wines



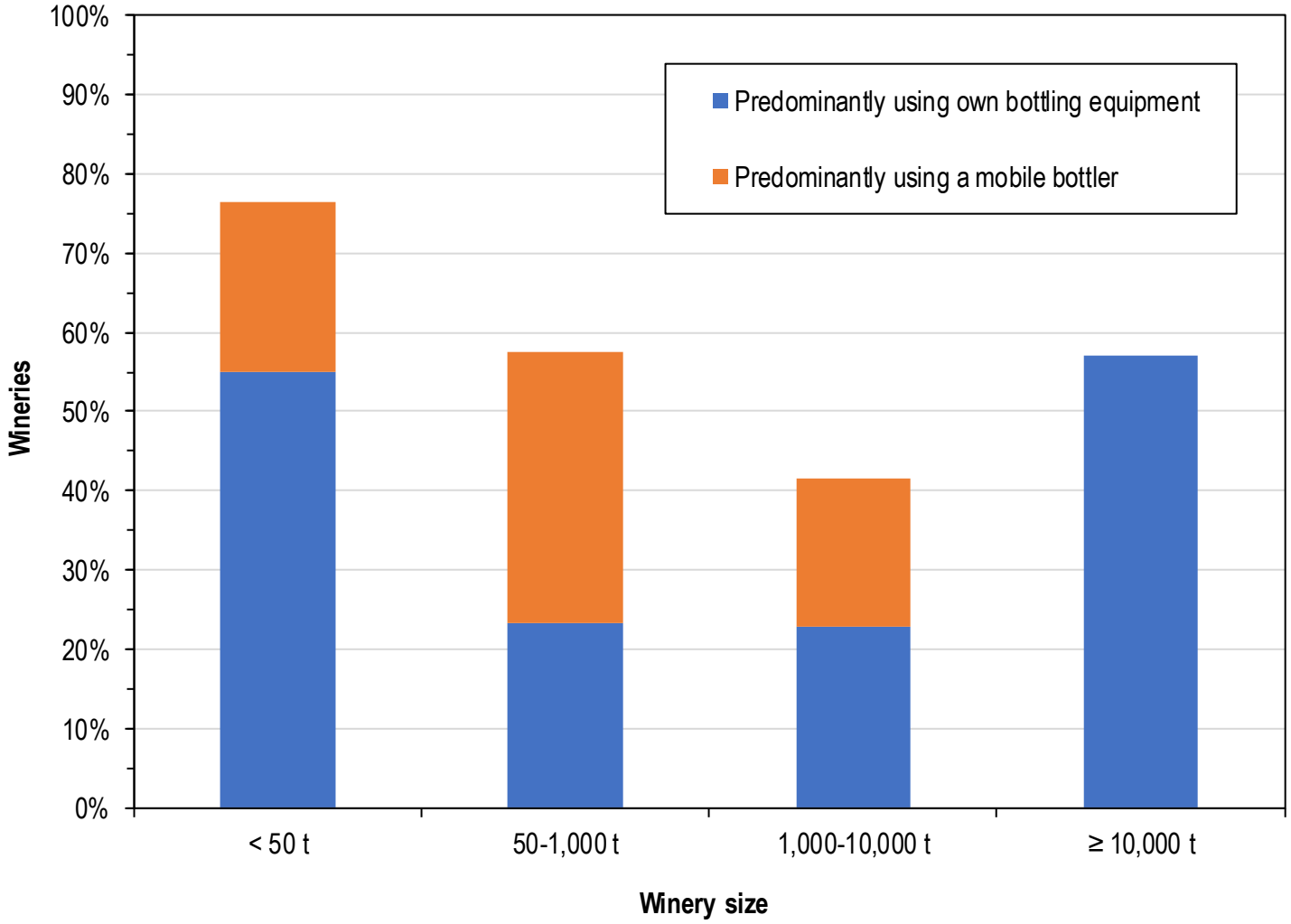
Bulk export containers from Australia

90% flexitanks
10% ISO tanks

- In 2015, 49% of red table wine exports and 57% of white table wine exports were in bulk, according to Wine Australia data.
- Flexitanks were the main bulk container type used for exports.
- Wineries noted that container type was usually chosen by the customer.

*Respondents were first asked whether any wine was exported in bulk (flexitanks or ISO tanks) in 2015. If they answered yes, they were asked what volume of red and white table wines was exported and then were asked to select what container type was used to the nearest 10% to export each wine type. Aggregate data was calculated based on this. Wineries < 1,000 t are excluded from the plot because the volumes they exported in bulk were very small.

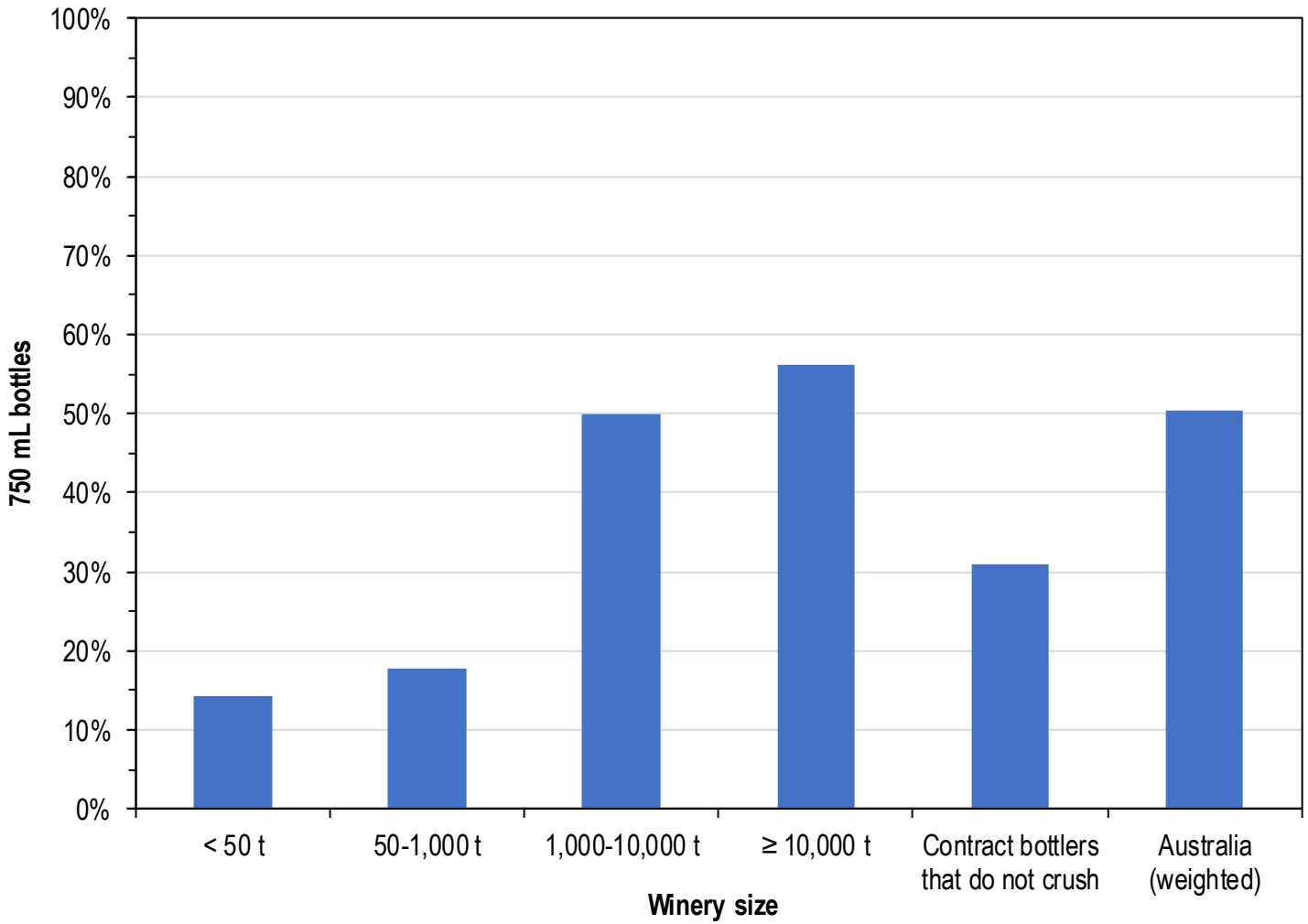
Bottle table wines on site



- Small wineries were the most likely to bottle wine on-site, most commonly using their own equipment – presumably in a fairly manual manner.
- Mid-sized wineries were less likely to bottle wine on-site, possibly because they often use off-site contract bottlers, and when mid-sized wineries did bottle on-site it was commonly using a mobile bottler.
- Large wineries that bottled on-site did so using their own equipment.

*Respondents were asked whether they bottled table wine on-site in 2015 and whether it was predominantly performed by a mobile bottler or using their own bottling equipment.

Light-weight bottles (< 450 g) used



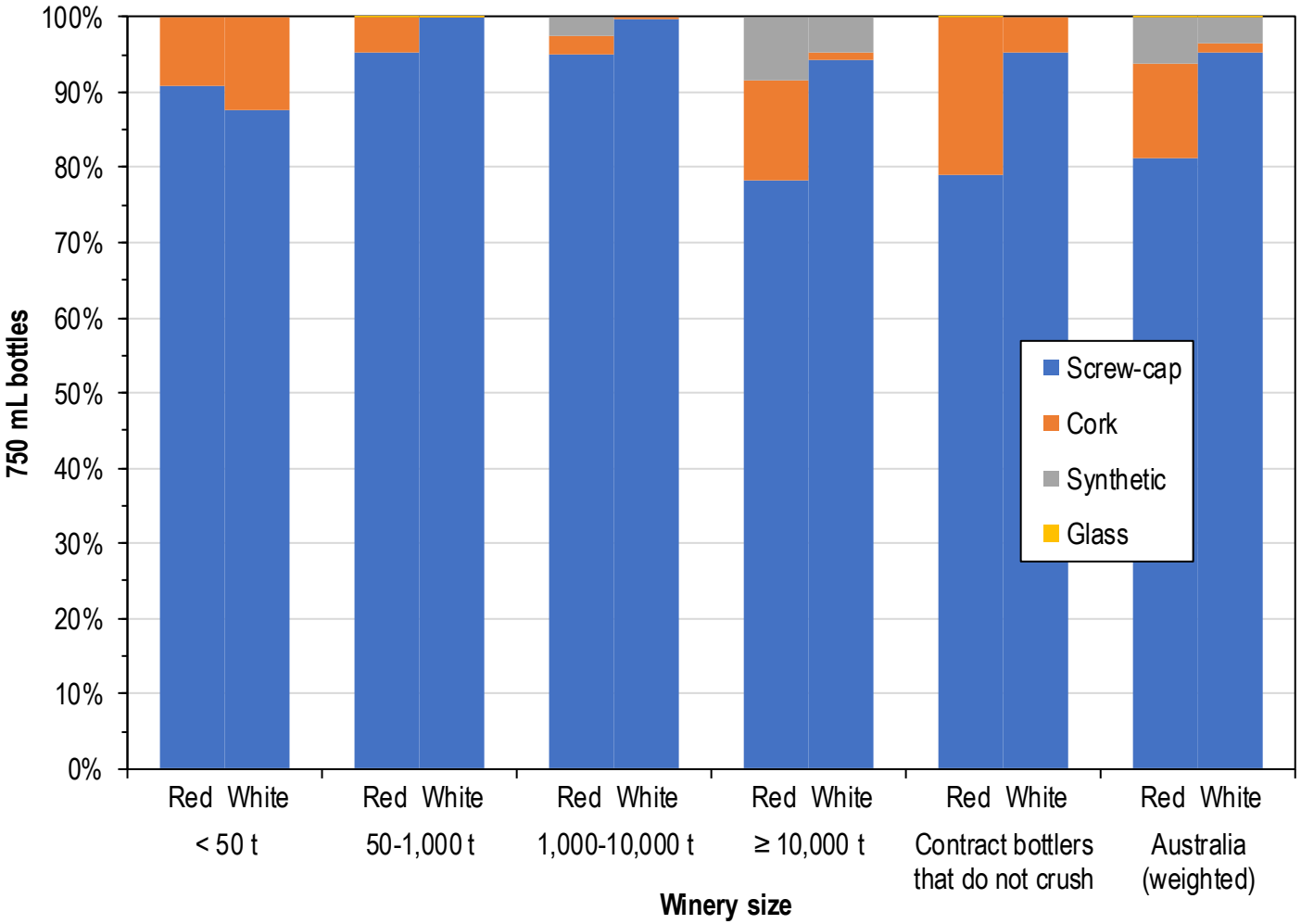
Wine bottles used in Australia

50% light-weight

- Larger wineries used a greater proportion of light-weight bottles, likely due to their lower average wine price point.
- The intermediate light-weight bottle fraction for contract bottlers likely relates to them servicing many mid-sized wineries (see previous page).
- Australian bottle manufacturers were contacted for data on their light-weight bottle production and their data was consistent with the industry-wide value of 50% in 2015.
- Data is only for wine bottled in Australia, not wine exported in bulk and bottled overseas (see page 150).

*Respondents were asked to select the % of 750 mL table wine in light-weight bottles in 2015. Aggregates were calculated based on this and entries for volumes of red and white table wines in 750 mL bottles.

Closures for table wines in 750 mL bottles



Closures used in Australia

	Red	White
Screw-cap	81%	95%
Cork	13%	1%
Synthetic	6%	3%

- Screw-caps were the most common closure.
- One of the reasons for using cork or synthetic closures mentioned was that these closures were preferred by consumers of some products in some markets (e.g. China and/or USA).
- Data is only for wine bottled in Australia, not wine exported in bulk and bottled overseas (see page 150).

*Respondents were asked to enter what % of 750 mL red and white table wines were packaged using screw-cap, corks, synthetic and glass closures in 2015. Aggregates were calculated based on this and entries for volumes of red and white table wines in 750 mL bottles.

New winery products/techniques that had the biggest positive impact in the last five years

1. Cross-flow filtration
2. Flotation for juice clarification

Cross-flow filtration and flotation were listed far more often than anything else

3. CMC for cold stabilisation
4. New destemming and sorting equipment in-winery or on-harvester
5. Co-inoculation for MLF
6. Refrigeration upgrades
7. Choice of yeasts available
8. Pulsair for red ferment management
9. New membrane presses
10. Plant-derived fining proteins
11. Oenofoss

*Respondents were asked which new products or techniques had the biggest positive impact on their operations in the last five years. Themes are listed in decreasing order of responses – 67% of survey respondents wrote at least one item for this optional free-text question.

Methodology and interpretation

Reference period (unless otherwise stated)

- Vineyard questions refer to grapes grown for the 2016 vintage.
- Winery questions refer to 2016 vintage for pre-ferment operations, 2015 for bottling and a typical year for post-ferment operations.

Reference point

- Results are presented relative only to the number of respondents relevant for each question (e.g. for questions on white wine bentonite fining, only respondents who made white wine are included).

Used at all?

- Many questions asked whether a practice was used at all (even if it is was just on one block, one batch, etc.).
- The fact that a piece of equipment/additive was used at all should not be interpreted as saying that all production was made with this technique.
- Larger sites sometimes have a greater chance of using a technique or encountering an issue simply because they are processing more blocks or batches.

A used X % / B used Y%

- Some questions asked for % processed in different manners; for example, machine-harvested vs hand-picked, with a drop-down box with % options (0% MH/100% HP, 1/99, 10/90, 20/80, etc.).
- From this and the site size entered at the start of the survey (ha for vineyards and t for wineries), quantitative data could be calculated (e.g. % hectares machine-harvested in a whole region).

Size-weighting

- Practices are heavily influenced by size; for example, it is more likely to be economic for larger sites to substitute labour with capital.
- Regional vineyard results are presented without size-weighting, except for the warm inland and cool/temperate aggregate categories, which have been weighted assuming that the size distribution below for SA winegrowers applies nationally.

Property size	Share of ha
< 10 ha	11%
10 – 50 ha	34%
50 – 100 ha	15%
≥ 100 ha	40%

- Australian aggregate vineyard data was calculated by weighting the results for warm inland and cool/temperate categories according to ABS area data.

Classification	Share of ha
Cool/temperate	59%
Warm inland	41%

- Australian aggregate winery data was calculated by weighting winery results according to ABS grape intake data.

Winery size	Share of t
50 – 1,000 t	4%
1,000 – 10,000 t	15%
≥ 10,000 t	81%

- Bottling is also performed by contract bottling facilities that do not process grapes.
- Australian aggregate bottling characteristics (e.g. closures) were calculated by weighting results from sites that both crush grapes and bottle wine vs specialist contract bottling facilities, according to the relative volumes bottled in their responses.

*SA vineyard size distribution data from the 2016 South Australian Winegrape Crush Survey. ABS vineyard data from 1329.0.55.002, 2014-2015. ABS winery data from 1329.0, 2010-2011.

Methodology and interpretation (continued)

Ensuring questions were answered and 'other'

- To ensure respondents had considered each question, there was usually a 'none of the above' option.
- There was also generally an 'other' option, which the respondent could select and then fill out a textbox, but this option has generally been excluded from results plots unless the responses add value to the analysis.
- Each page of the survey also had an optional general comments box where respondents could add further details if they wished.

Data presentation by region and size

- Vineyard responses are typically presented on a regional basis and sometimes on a vineyard size basis, particularly in relation to mechanisation.
- Winery responses are based just on size because there were insufficient responses for most regions, wineries may receive grapes from multiple regions and because size is correlated with region in many cases.

Hectares or acres

- Vineyard survey respondents were able to choose to answer in hectares or acres.

Site visits

- Resourcing only allowed visits to some sites.
- Sites of all size categories were visited but there was a bias towards visiting larger wineries because they typically have the greatest diversity and complexity in practices and are the earliest adopters of new technologies.
- Face-to-face meetings were held with 60 people, phone calls were made to a further 30 and email communications had with another 50.

Most accurate vineyard data

- Vineyard data for the aggregated weighted categories warm inland, cool/temperate and Australia are likely the most accurate because they are based on the largest number of responses and have the most correct weighting of operational sizes.
- Accuracy of data for individual regions depends on the number of responses from those regions.

Contractor use on vineyards

- The survey was based on the site, so equipment and operations are counted for that site even if they are performed by a contractor.

Validation against other survey data

- Reputable data are not available for comparison on most practices, but it was possible to compare yield, red/white and varietal grape mix against the ABS data, and a reasonable agreement was found (pages 159-161).

Low practice use

- The relative errors are likely to be highest for practices used to a very small extent.
- Where there are only one or two vineyards or wineries using a practice, the apparent use of a practice can double/half based on whether a particular vineyard/winery completed the survey.

Small producers using other wineries

- The winery survey was based on all operations on a site but it is likely that in a few instances some very small producers filled out the survey even though they are making that wine at a much larger winery site and this may lead to their apparent use of technologies that would not normally be suitable for a producer of that size.

Methodology and interpretation (continued)

Engaged respondent bias

- Surveys usually tend to exaggerate the level of adoption of new techniques and technology because the people that are willing to voluntarily spend time filling out a survey are also those that are the most engaged with the latest technologies and are willing to try new things.
- There will be some element of this with the current survey, but it is likely to be more representative than most prior industry surveys because it is not a single topic survey (which tend to attract people passionate about that single topic) and it was distributed via many different channels to reach as broad a range of producers as possible.

Spectrum of practices and definitions

- A quantitative survey of this nature has to make practices black and white to some extent in order to allow categorisation and analysis but for many practices there is a spectrum and the definitions of when one practice becomes another can be unclear.
- This has been managed as best as possible by follow-up site visits, but inevitably some nuances will have been missed.

Average versus aggregates within size categories

- When results are organised on a size basis, each size category still contains a range of site sizes.
- Within each size category, the average of the results could be used, or alternatively the hectares or tonnes for all sites in the size category could be aggregated.
- The second approach is more biased towards the larger producers in the size category; however, the first approach could be said to be biased towards the smaller producers in the category.
- The second approach was used in this final report, but calculations were made by both techniques for winery data and showed similar results.

Focus on red and white table wines

- The survey captures information on some other wine styles, but winery data is primarily focused on red and white table wine production because these are the wines made by the most producers.

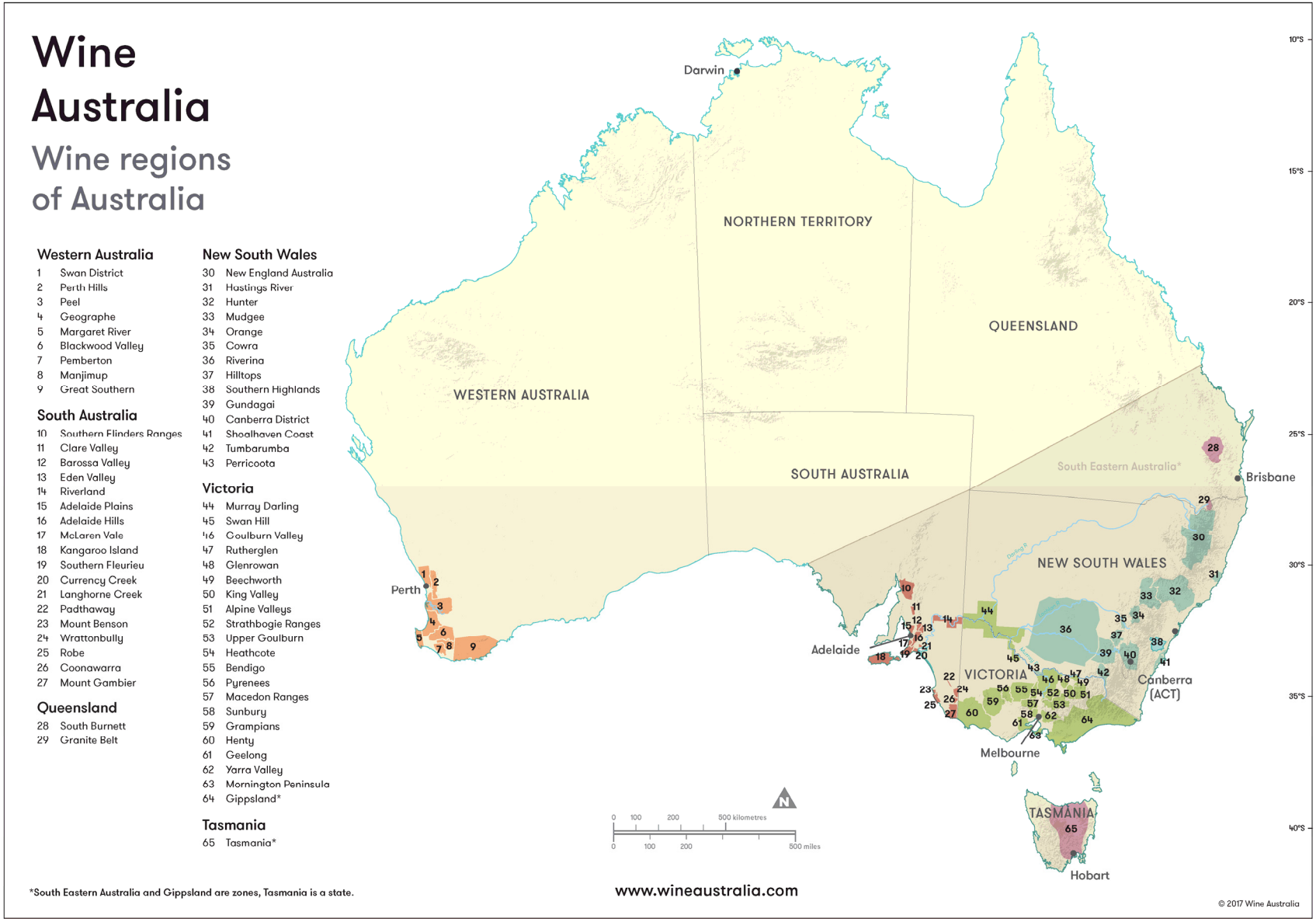
Partial processing

- Fractions of wine produced in different manners (e.g. wild vs inoculated ferments) were calculated assuming that the grapes going into the winery go through alcoholic and malolactic fermentation at the same winery.
- While juice is sometimes transferred between sites, the above strategy is believed to be a reasonable simplification when taken at an aggregate industry level across many wineries.
- For statistics relating to bottling and sparkling wine production, however, the specific volumes bottled and undergoing secondary fermentation were requested for use in aggregation statistics, so partial processing is not relevant.

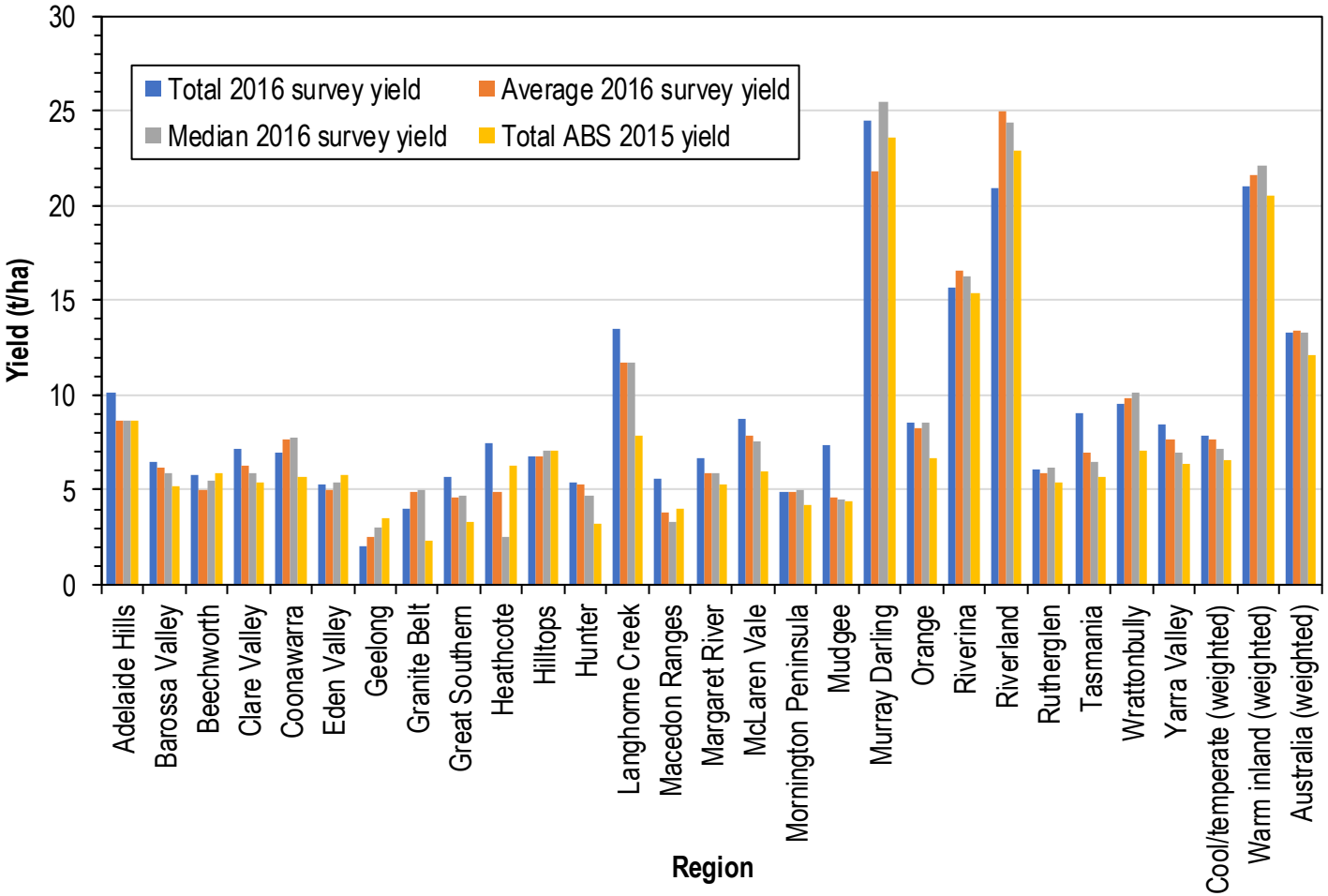
Footnotes in this document

- An asterisk (*) is used to denote comments relevant to each page.

Map of Australian wine regions - courtesy of Wine Australia



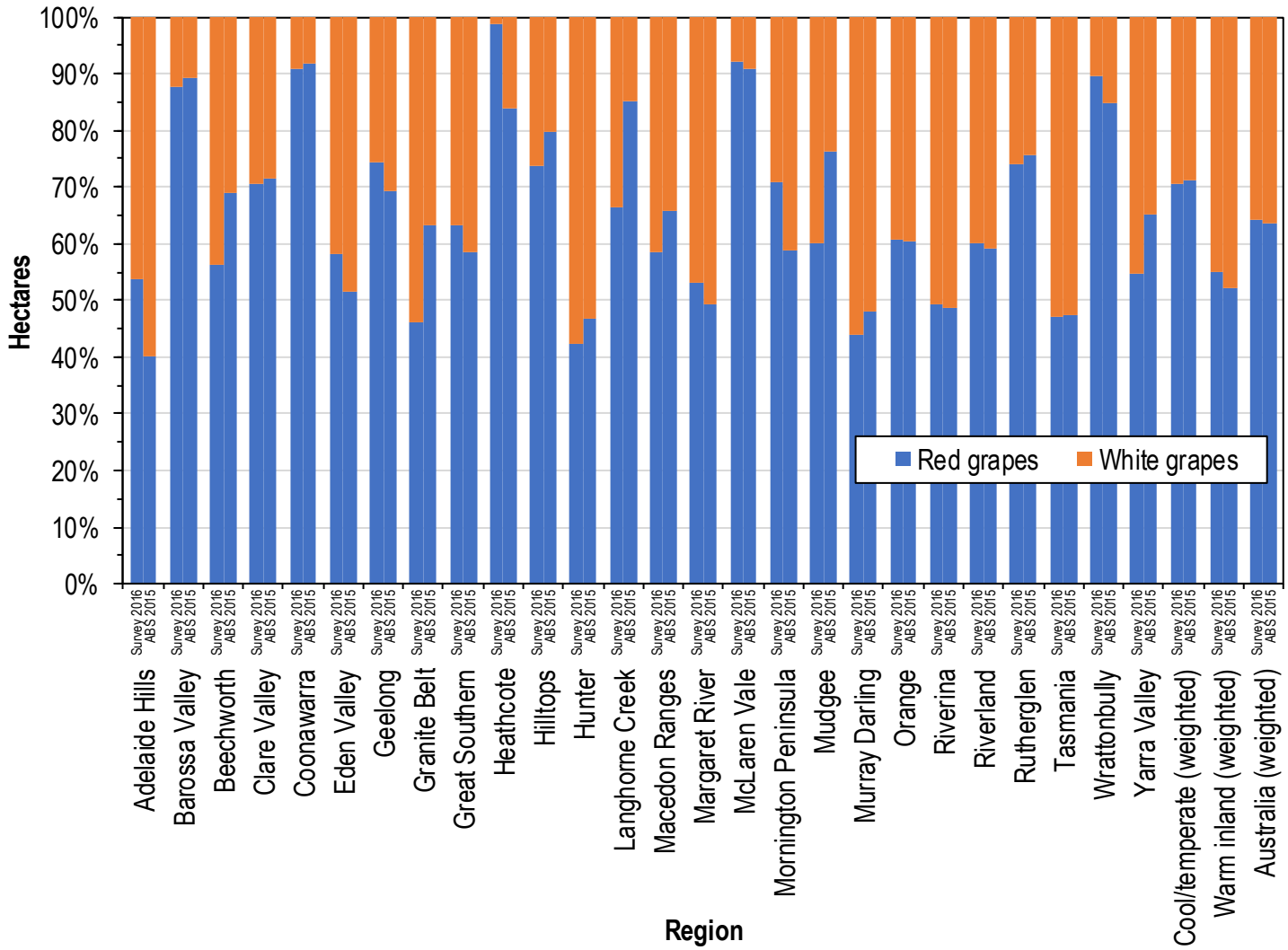
Practices Survey regional yield and comparison with ABS data



- 2016 survey yields calculated in different manners followed similar regional trends to 2015 ABS data.
- The weighted Australian 2016 average survey yield was 10% higher than the 2015 Australian ABS yield.
- Wine Australia reported in its vintage reports that the national grape crush was 8% higher in 2016 than 2015.
- The survey appears representative with regards to yield.

*Total yield is the total regional yield, average and median yields are the average and medians of respondent yields for the region. Survey yields relate to harvested area, while ABS (1329.0.55.002, 2014-2015) yield relates to bearing area. Wine Australia reported data is from its 2016 and 2017 national vintage reports, using final tonnages for 2015 and 2016 from the Department of Agriculture and Water Resources.

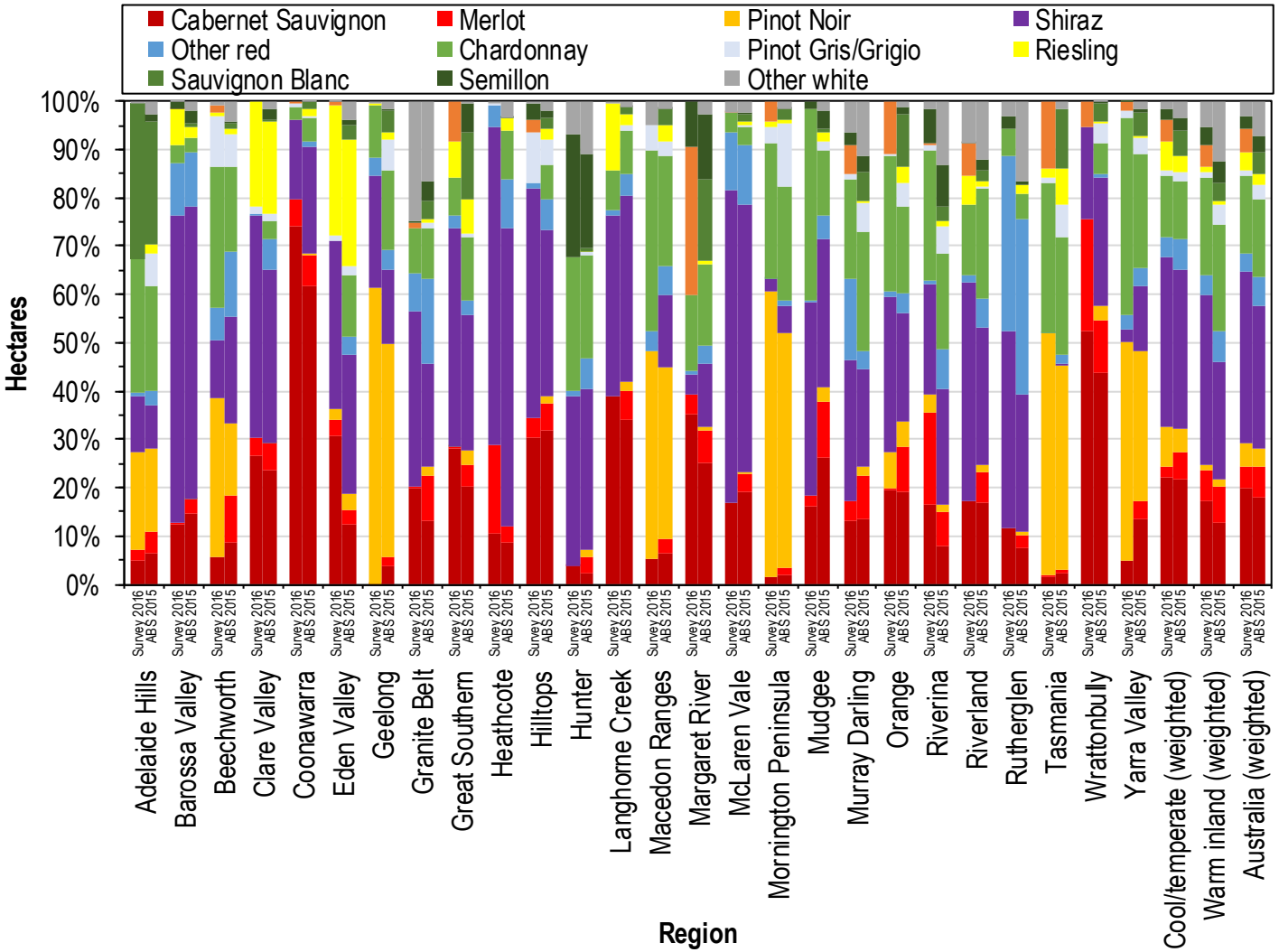
Practices Survey regional colour mix and comparison with ABS data



- The 2016 survey red-white grape mix (first column in each pair) followed similar regional trends to 2015 ABS data (second column in each pair).
- The red-white grape mix survey question was only a drop-down box selection with 10% increments, but despite this the agreement is reasonable.
- The survey appears representative with regards to the mix of red and white grapes.

*Areas of red and white grapes were calculated for each respondent from the area harvested and the red/white mix ratio in 10% increments selected from a drop-down box. These were added across all responses from each region and the regional red/white mix ratio calculated.

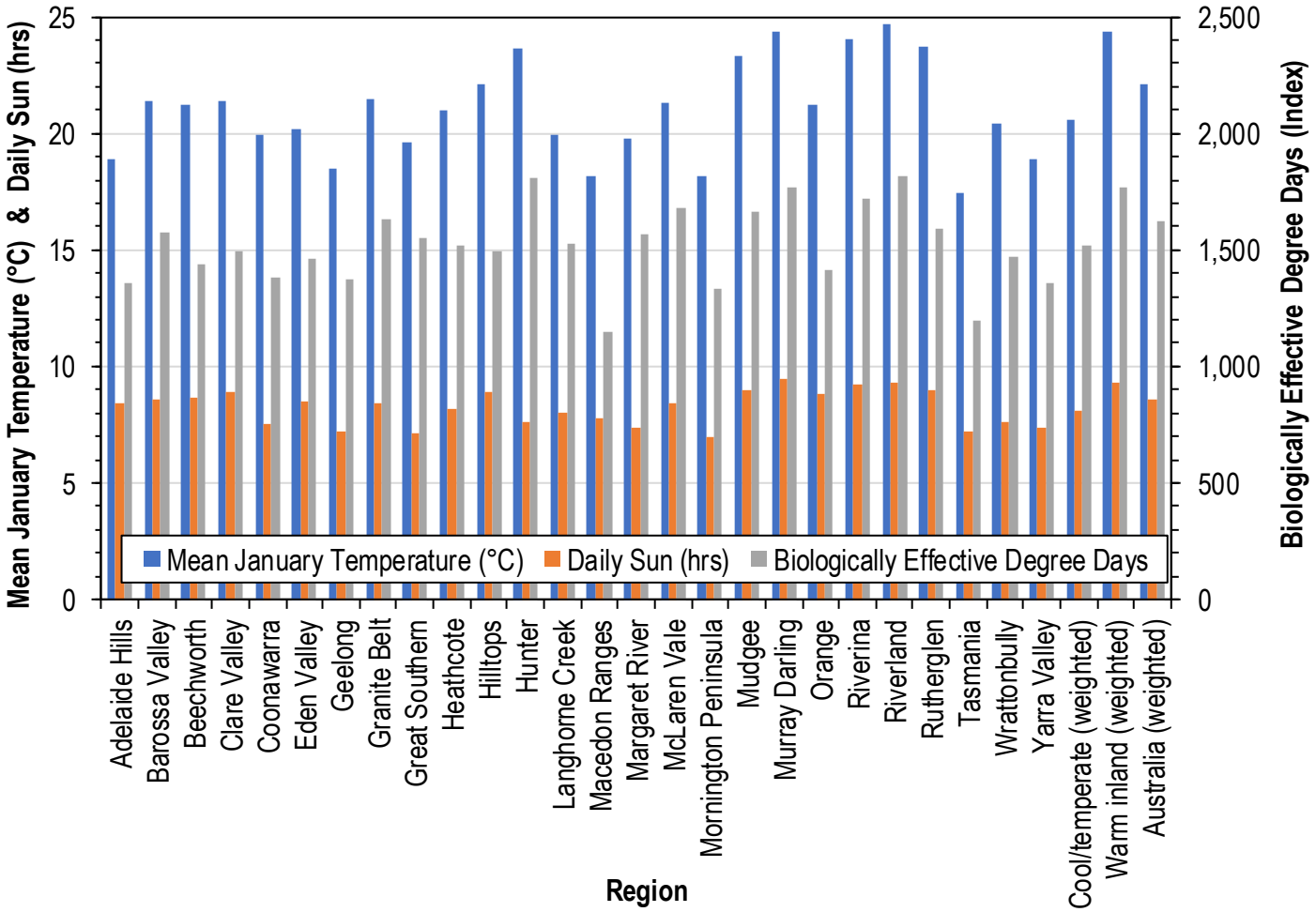
Practices Survey regional varietal mix and comparison with ABS data



- 2016 survey grape varietal mix (first column in each pair) followed similar regional trends to 2015 ABS data (second column in each pair).
- Varietal data was only collected in the survey for the top three varieties and the question was only a drop-down box in 10% increments, but despite this the agreement is reasonable.
- The survey appears representative with regards to grape varietal mix.

*Areas of each variety were calculated for each respondent from the area harvested and their top three varieties in 10% increments selected from drop-down boxes. These were added across all responses from each region and the regional mix calculated.

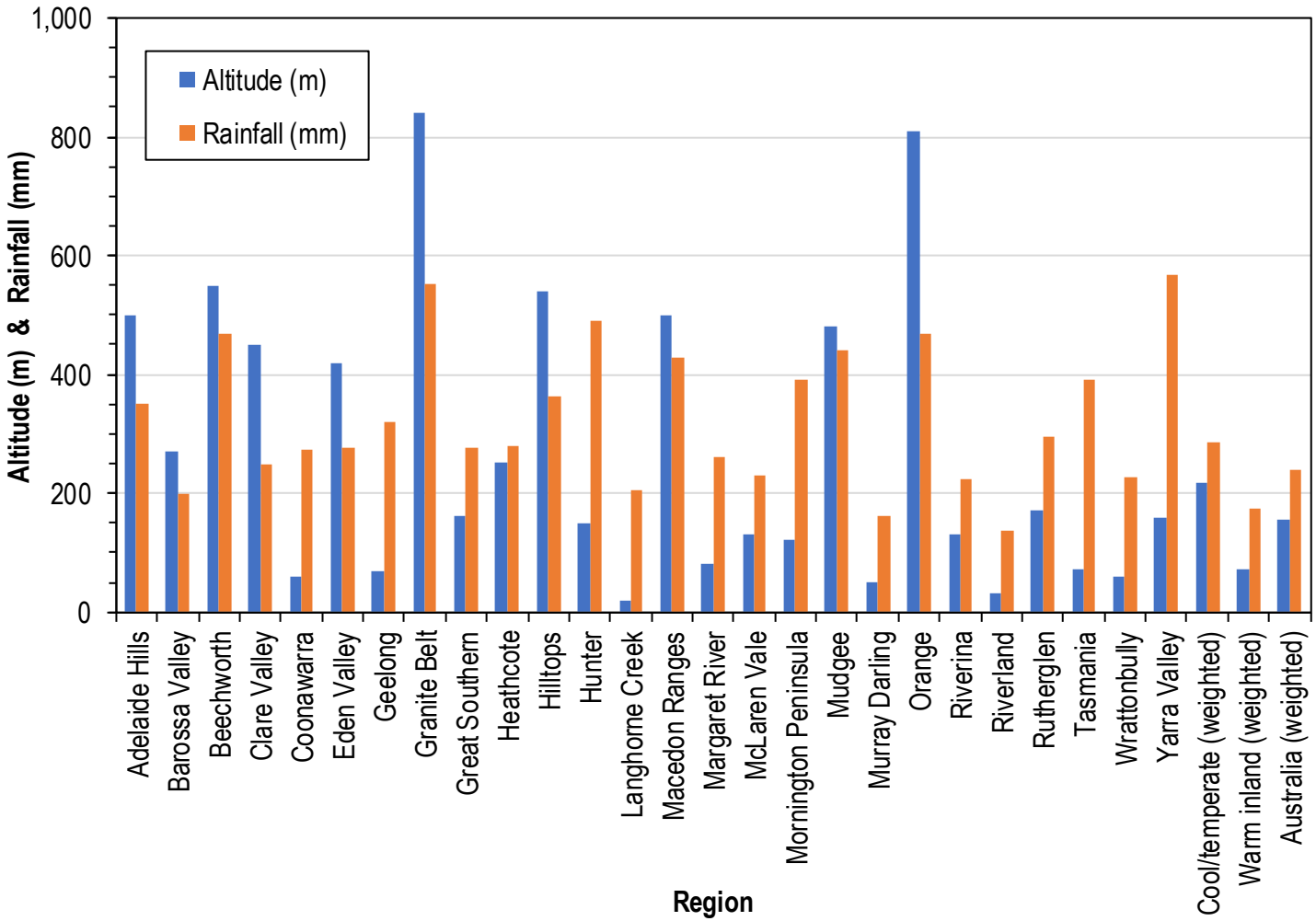
Mean January Temperature, Daily Sun and BEDD - derived from Halliday (2014)



- Weighted aggregate values are area and producer size-weighted values, calculated in the same manner as practices statistics and may have little physical meaning.

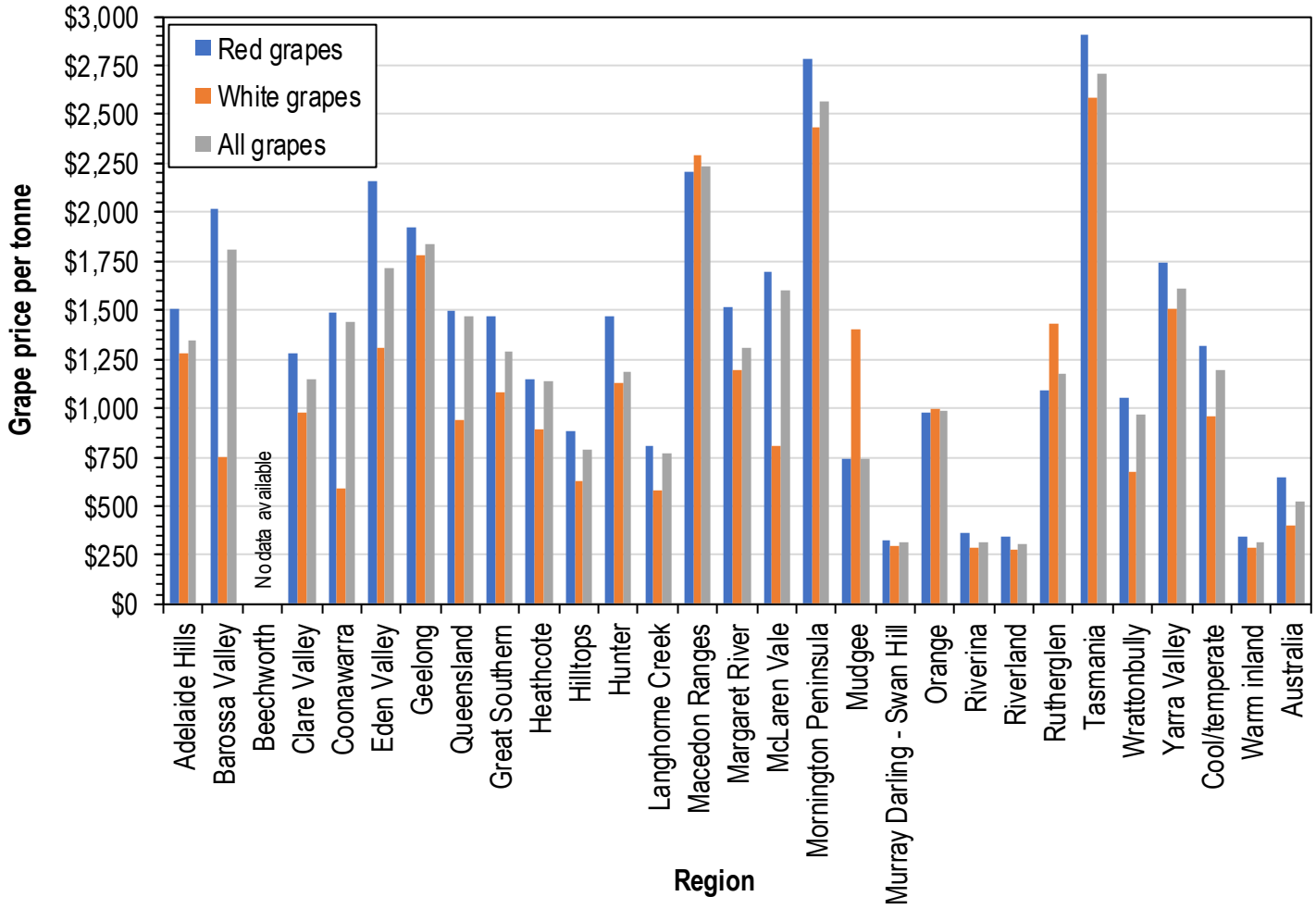
*Climate data derived from Dr John Gladstone's tables in James Halliday's *Wine Atlas of Australia* (2014) Hardie Grant books. Averages have been taken for eight regions that Gladstone classified in sub-regions. BEDD: Biologically Effective Degree Days.

Altitude and Rainfall - derived from Halliday (2014)



- Weighted aggregate values are area and producer size-weighted values, calculated in the same manner as practices statistics and may have little physical meaning.

Grape prices - data from Wine Australia (2016)

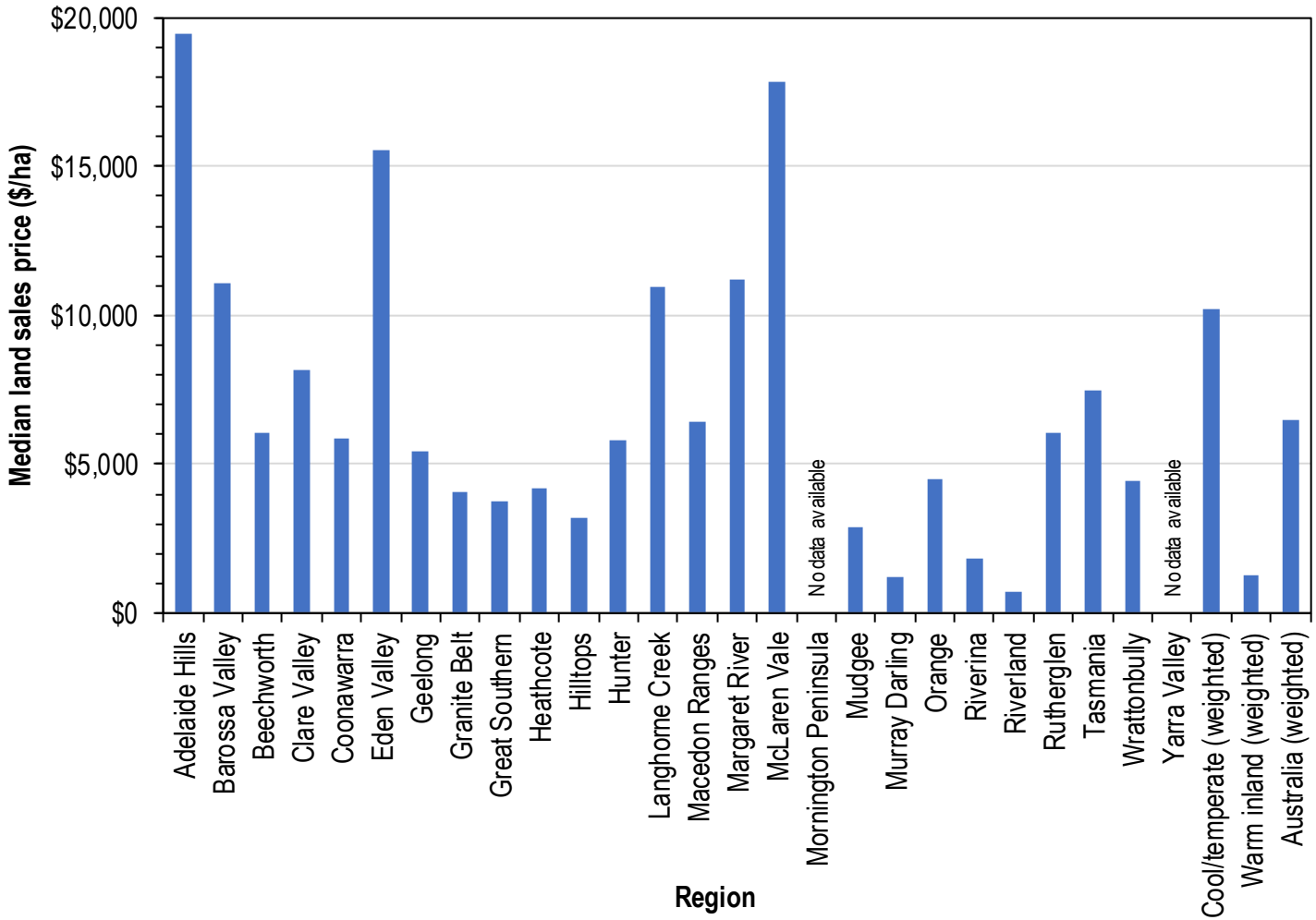


Mean grape price in Australia in 2016

$526 per tonne

*Wine Australia (2016) Vintage report 2016. https://www.agw.org.au/assets/vintage-reports/Vintage-Report-2016.pdf.

Median land value based on 2011-2015 sales >30 ha (not vineyards) – data from Rural Bank



- Data based on 8,000 property sales >30 ha over five years in municipalities overlapping the listed regions.
- The land is not necessarily suitable for viticulture, but the data gives a very general indication of underlying land value (at least for the weighted aggregate categories).
- During follow-up visits, several people asked for some information to be included in the report on land value. The data shown has kindly been supplied by Matt Ough from Rural Bank.

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