

AWRI Vineyard & Winery Practices Survey

2nd Edition

AWRI Australian
Wine
Research
Institute

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Preface

This report presents the results of the second edition of the AWRI Vineyard and Winery Practices Survey. This survey was performed in 2022, six years after the first edition. It provides an independent source of aggregated information on grape and wine production practices and how they are changing over time.

Several questions were added to the 2022 survey to capture information on newer practices and topics that had emerged since the 2016 survey. Data from both the 2022 and 2016 surveys are included in this report. Where no year is specified, the data is from the 2022 survey.

I was able to conduct more follow-up site visits after the 2016 survey than has been possible since the 2022 survey. As a result, the first-edition report includes more detailed discussion of the factors influencing some practice choices. The first-edition report is available on the AWRI website.

We are indebted to the many grapegrowers and winemakers who took the time to complete the web-based survey, as well as to the industry suppliers who provided information and the regional and national industry organisations that assisted with survey distribution. I also thank Eric Wilkes, Con Simos, Anna Hooper and Jo Hargreaves for their input on topics for inclusion in the 2022 survey, together with my AWRI colleagues who provided advice, reviewed the survey and assisted with promotion.

I would like to thank Affinity Labs for supporting the time I spent working on this project. I also thank Vinitech-Sifel for sponsoring a prize that enabled one survey respondent to attend the 2022 edition of its biennial vineyard and winery equipment exhibition in Bordeaux.

Dr Simon Nordestgaard
Principal Engineer
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Sponsors



Executive summary of key practice changes between 2016 and 2022

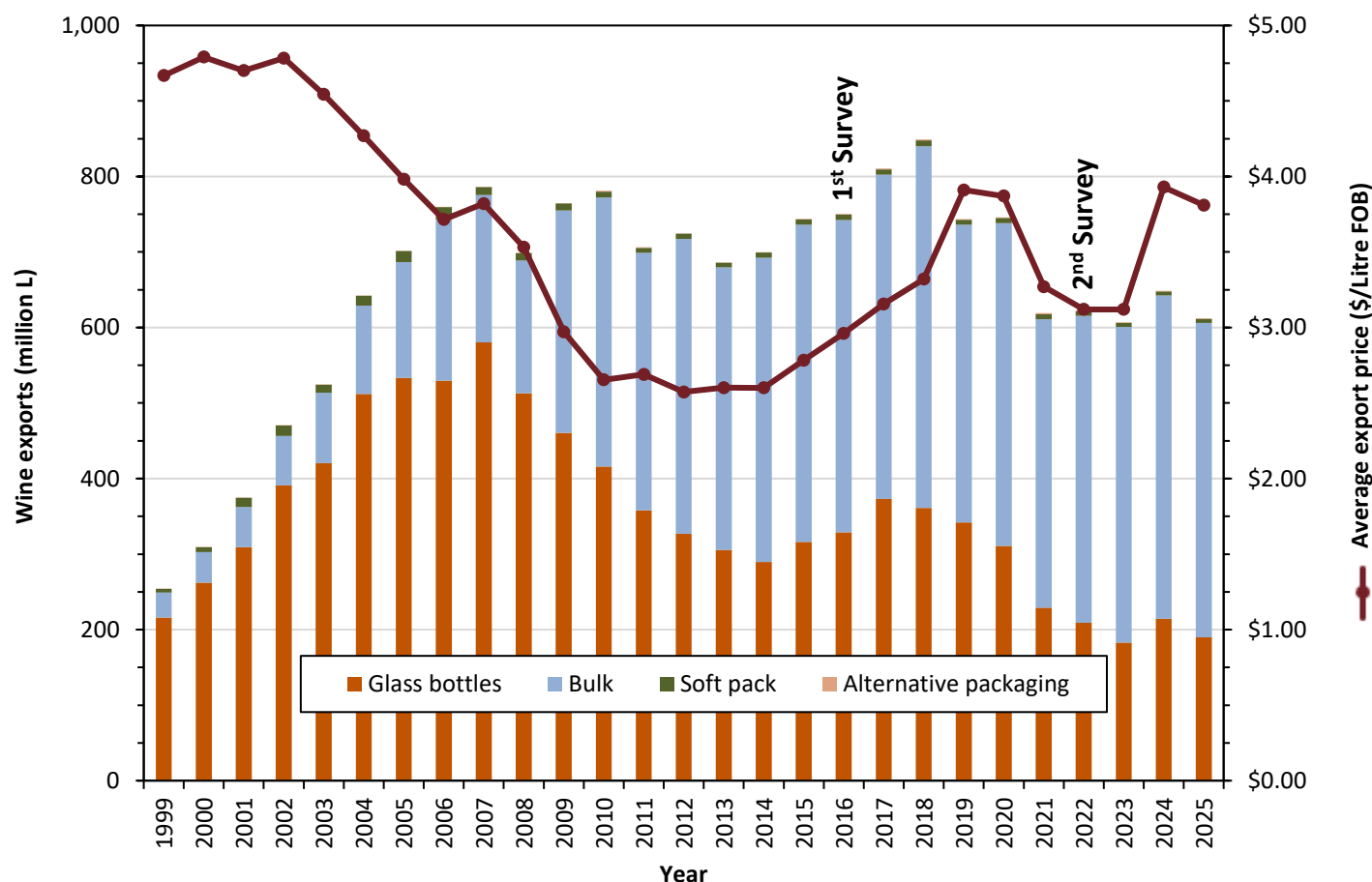
Vineyard Practices

- Biological fungicides for botrytis management were the new product most highly ranked as having a positive impact in the survey, with a significant number of growers starting to use them (page 36).
- There was a trend towards using metal vineyard posts, but only around 20% of total vineyard posts are metal (page 19).
- Larger vineyards increased their use of multi-row sprayers, particularly 3-row sprayers (page 31).
- The area of vineyards where herbicide is the main under-vine weed management technique decreased, but it is still the most common technique (page 49).
- Many respondents indicated that under-vine weed management was an area that they wanted more technical assistance with (page 78).
- The use of harvesters with integrated destemmers increased to around 20% of harvested area (page 73).

Winery Practices

- Cross-flow filtration was the new product or technique that had the biggest positive impact in the 2022 survey, just like it was in the 2016 survey (page 187).
- An increasing number of wineries used cross-flow filtration for processing juice lees (page 98) and to a lesser extent bentonite lees (page 142) but adoption was much lower for processing red wine lees (page 127).
- The use of flotation for juice clarification continued to increase (page 93).
- The choice to use plant-derived fining agents increased dramatically between 2016 and 2022, with many sites becoming exclusively vegan (pages 100, 148-150).
- The percentage of wineries adapting ferment nitrogen addition rates based on YAN measurements increased markedly between 2016 and 2022 (page 106).
- The prevalence of roller sorting of destemmed grapes increased between 2016 and 2022 (page 84).

2nd Practices Survey timing in relation to Australian wine export volumes and prices

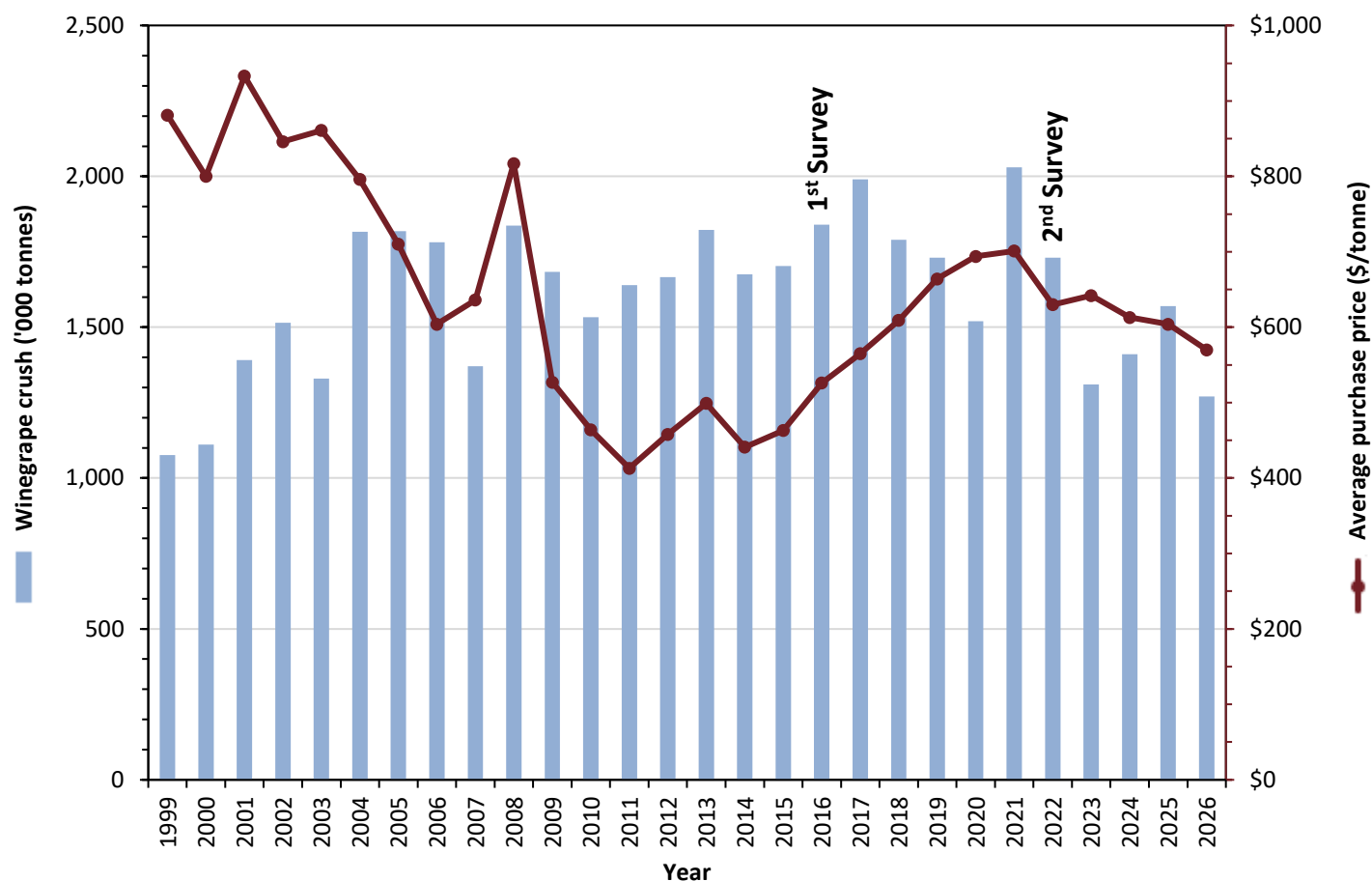


- Many advances in practices involve the purchase of equipment, which is easiest during times of profitability.
- It is therefore important to consider the timing of surveys in relation to industry cycles.
- Export volumes and prices and grape crush tonnage and prices are key metrics.
- The 1st edition of the survey was performed in 2016, and this 2nd edition was performed in 2022.
- Between 2016 and 2022, export volumes dropped 17% with bottled exports dropping 36%.
- Exports to China had a major impact on overall trends, continuing to increase after the 1st survey in 2016, but then dropping dramatically following China's imposition of tariffs in late 2020, and rising again after the tariffs were removed in 2024.

(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.

2nd Practices Survey timing in relation to grape crush size and prices



(...from previous page)

- Nominal grape prices rose for the 7 years to 2021 but then dropped in the survey year of 2022 and have dropped further since.
- The size of the grape crush was slightly lower in 2022 than in 2016 but dropped much more significantly in subsequent years, with 2026 being the smallest crush since 2000.
- Overall, this 2nd edition of the survey was performed during a more challenging period for the sector than the 1st edition, although nominal average grape prices were slightly higher.
- 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.

2nd Practices Survey structure

One survey for each GI region
you grow your own grapes



**AWRI Vineyard
Practices Survey**

One survey for each
winery site you run



**AWRI Winery
Practices Survey**

- Like the 1st edition of the survey, there were 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.
- The survey was not compulsory.
- Detailed methodologies and notes on data interpretation are provided in the Appendix.

2nd Vineyard Practices Survey response rate

Response rate comparison

	1 st Edition (2016)	2 nd Edition (2022)
Number (n)	463 (9%)	261 (5%)
Area (ha)	25,289 (19%)	19,131 (14%)

Response rate by region

GI Region	ABS 2015 (n)	2016 survey (n)	2022 survey (n)	ABS 2015 (ha)	2016 survey (ha)	2022 survey (ha)
Adelaide Hills	192	21 (11%)	15 (8%)	2,967	468 (16%)	522 (18%)
Barossa Valley	369	41 (11%)	18 (5%)	8,899	2,172 (24%)	1,218 (14%)
Canberra District	50	< 5	9 (19%)	335	N/A	62 (18%)
Clare Valley	159	16 (10%)	7 (5%)	4,200	2,013 (48%)	999 (24%)
Coonawarra	90	16 (18%)	6 (7%)	4,726	2,478 (52%)	468 (10%)
Eden Valley	95	12 (13%)	7 (8%)	1,799	558 (31%)	432 (24%)
Geelong	33	10 (31%)	5 (15%)	284	76 (27%)	30 (11%)
Granite Belt	37	7 (19%)	4 (12%)	237	194 (82%)	14 (6%)
Great Southern	61	11 (19%)	4 (7%)	1,886	697 (37%)	474 (25%)
Hilltops	23	6 (26%)	5 (22%)	566	300 (53%)	399 (71%)
Hunter	145	17 (12%)	8 (5%)	2,309	544 (24%)	459 (20%)
King Valley	58	< 5	6 (10%)	1,336	N/A	217 (16%)
Langhorne Creek	71	7 (10%)	8 (11%)	5,282	1,535 (29%)	1,487 (28%)
Margaret River	209	16 (8%)	13 (6%)	4,816	800 (17%)	848 (18%)
McLaren Vale	357	42 (12%)	17 (5%)	5,995	1,505 (25%)	715 (12%)
Mornington Peninsula	94	8 (9%)	5 (5%)	775	70 (9%)	91 (12%)
Murray Darling	427	15 (4%)	15 (4%)	15,511	1,510 (10%)	3,272 (21%)
Orange	44	11 (25%)	12 (28%)	1,098	906 (82%)	1,288 (117%)
Pyrenees	27	< 5	6 (20%)	493	N/A	170 (35%)
Riverina	341	12 (3%)	13 (4%)	18,610	1,554 (8%)	3,634 (20%)
Riverland	711	28 (4%)	11 (2%)	18,774	1,948 (10%)	587 (3%)
Rutherglen	19	6 (32%)	5 (26%)	398	159 (40%)	80 (20%)
Tasmania	117	27 (23%)	13 (11%)	1,442	641 (44%)	579 (40%)
Yarra Valley	126	13 (11%)	10 (8%)	2,116	358 (17%)	249 (12%)
Cool/temperate	3,662	408 (11%)	222 (6%)	79,540	20,277 (25%)	11,638 (15%)
Warm inland	1,479	55 (4%)	39 (3%)	52,895	5,013 (9%)	7,493 (14%)
Australia	5,141	463 (9%)	261 (5%)	132,436	25,289 (19%)	19,131 (14%)

- Responses covered approximately 5% of growers and 14% of Australian winegrape vineyard area.
- Response rates were lower than in 2016, but still very good.
- Data is reported for regions where there were ≥ 4 respondents in 2022.
- Canberra District, King Valley and Pyrenees were added since 2016, because of increased responses, while Beechworth, Heathcote, Macedon Ranges, Mudgee, and Wrattenbully were removed because of lower numbers of responses.
- Two aggregated regional production type categories are included:
 - Warm inland:** Riverland, Murray Darling, and Riverina
 - Cool/temperate:** Other regions
- Data quality should be considered in the context of response rates. Data for the aggregated cool/temperate, warm inland and Australia categories is more accurate than for individual regions.

*ABS data from 1329.0.55.002, 2014-2015. Harvested areas are used in the survey, while ABS data is bearing areas. 2015 was the last year that a comprehensive census of Australian vineyards was performed. Most but not all respondents completed all sections of the survey. Partially complete responses were counted relative to the fraction of the survey completed.

2nd Winery Practices Survey response rate

Response rate comparison

	1 st Edition (2016)	2 nd Edition (2022)
Number (n)	227	120
Crush (t)	1,340,000 (73%)	983,000 (57%)

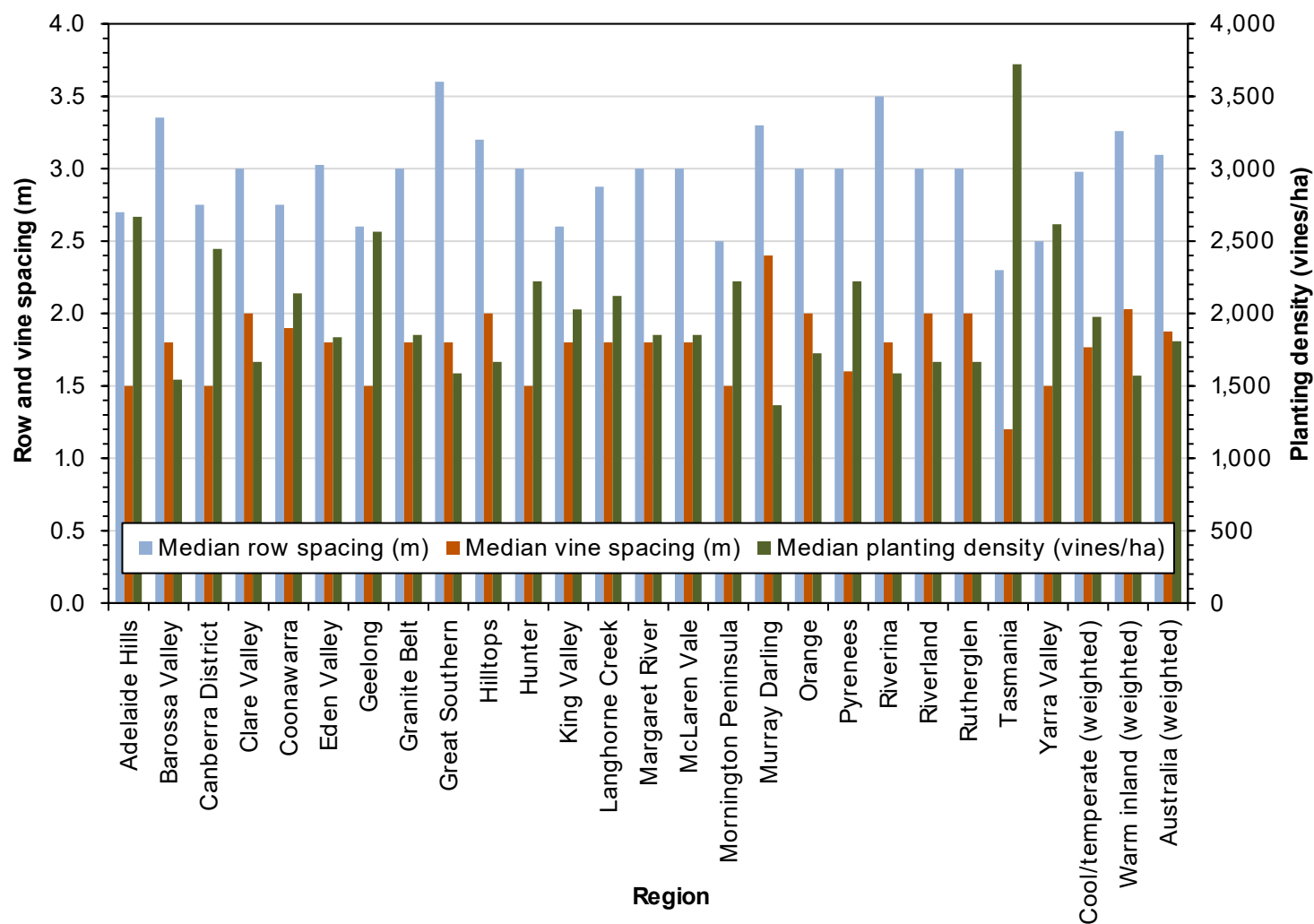
Response rate by winery crush size

	1 st Edition (2016)	2 nd Edition (2022)
< 50 t	54	27
50-1,000 t	99	46
1,000-10,000 t	50	33
≥ 10,000 t	24	14

- 120 winery responses covering 57% of the Australian grape crush were received.
- Good distribution of winery sizes.
- Response rates were lower than in 2016, but still very good.
- 2 key factors in the lower response rates to both the vineyard and winery surveys were likely:
 1. Fewer project resources were available, meaning that phone calls were not made in the lead-up to the survey to advise businesses it was coming and verify contact details.
 2. More challenging wine sector conditions leading to people having less time and interest in surveys.

*Most but not all respondents completed all sections of the survey. Partially complete responses were counted relative to the fraction of the survey completed.

Planting density



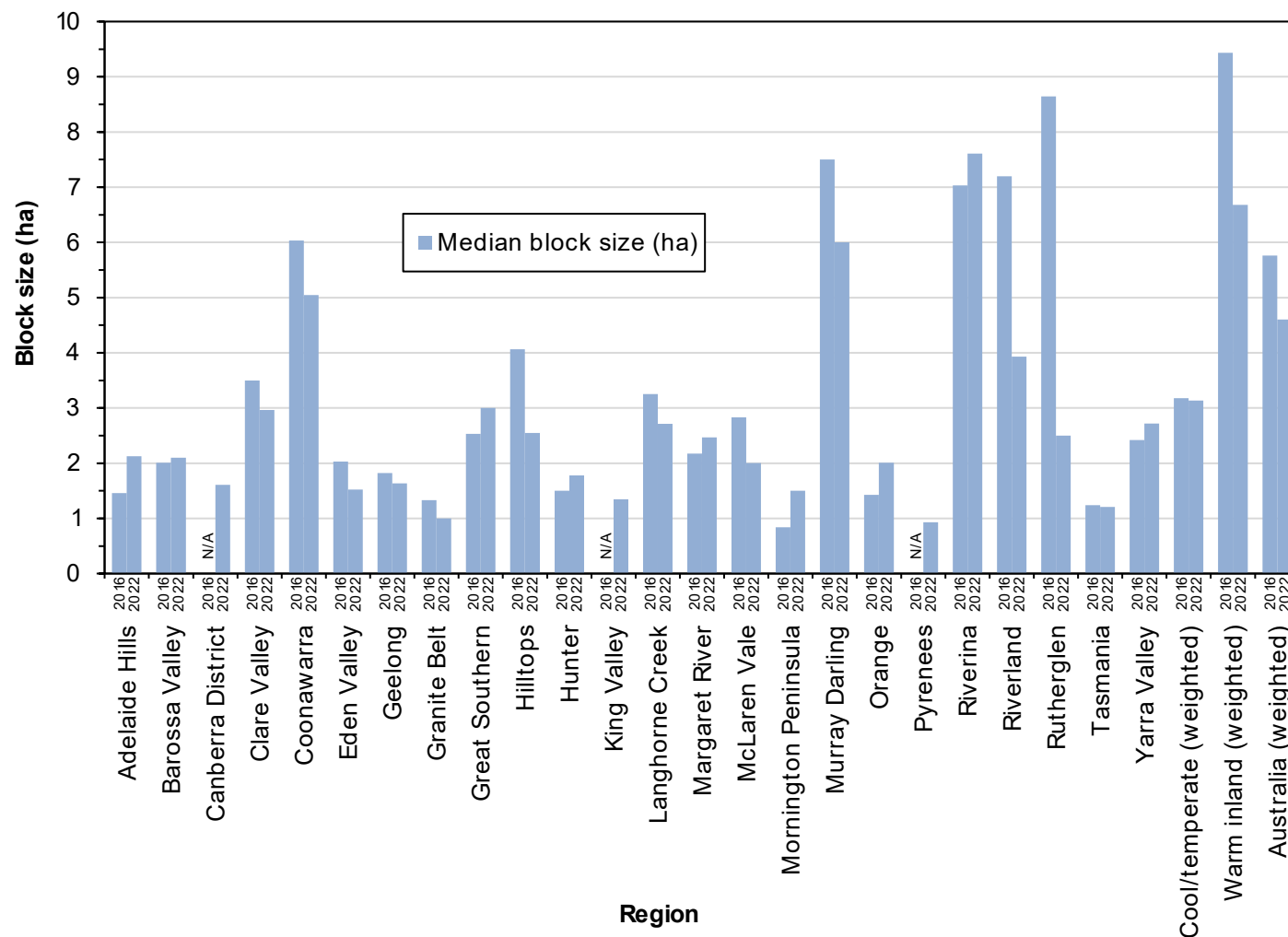
Weighted values for Australia

	2016	2022
Row spacing	3.1 m	3.1 m
Vine spacing	1.9 m	1.9 m
Vines/ha	1,760	1,810

- Weighted Australian values were similar in the 2022 and 2016 surveys.
- 2022 regional data is shown. Please refer to the 1st survey report for 2016 regional data.

*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.

Block size



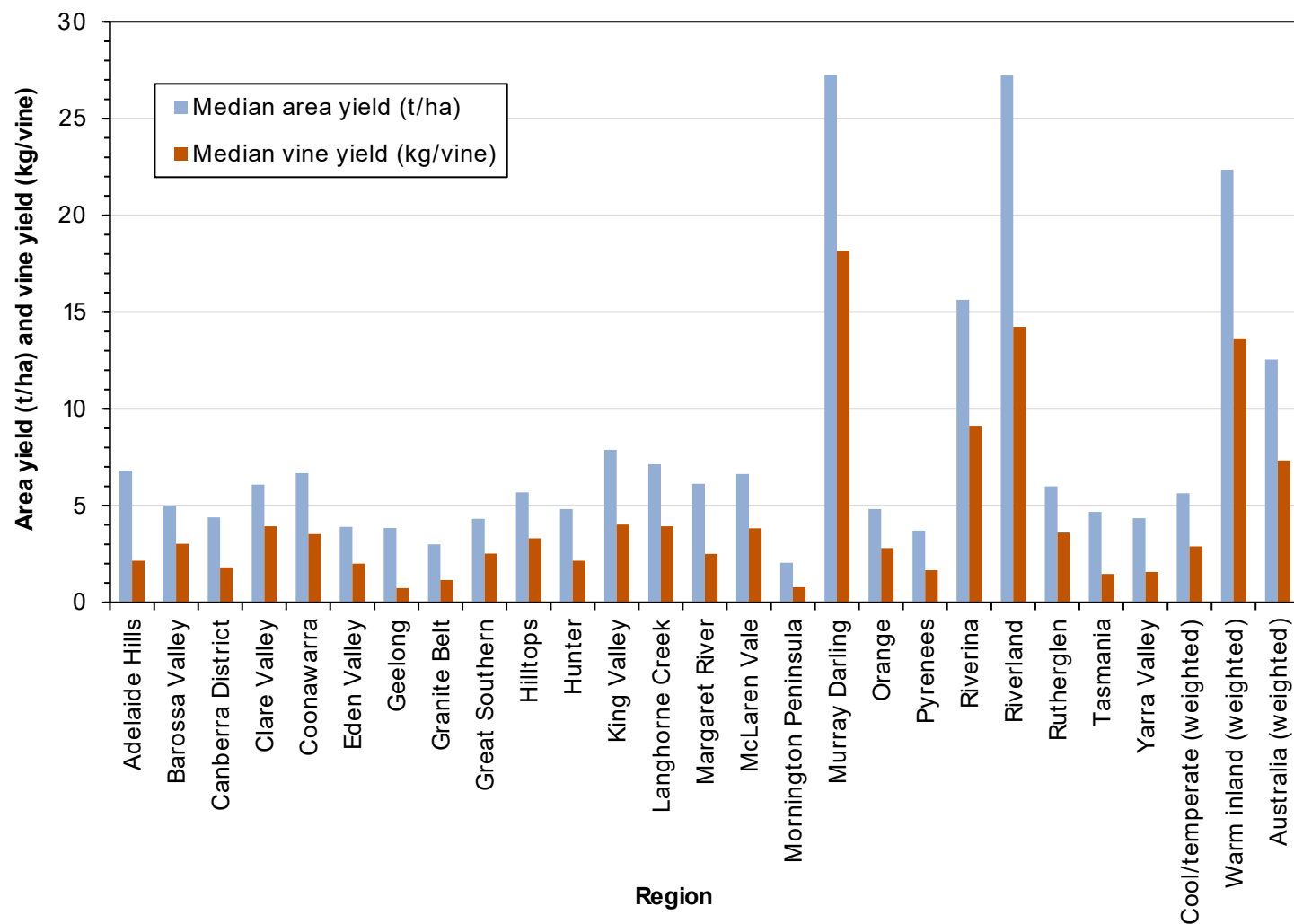
Weighted values for Australia

	2016	2022
Block size	5.8 ha	4.6 ha

- Weighted Australian block size was slightly lower in 2022 than in 2016, driven by the responses from the Riverland and Murray Darling.

*Block size was calculated by dividing the harvested vineyard area by the number of separate blocks for each respondent. Median values were then calculated for each region.

Yield per hectare and per vine



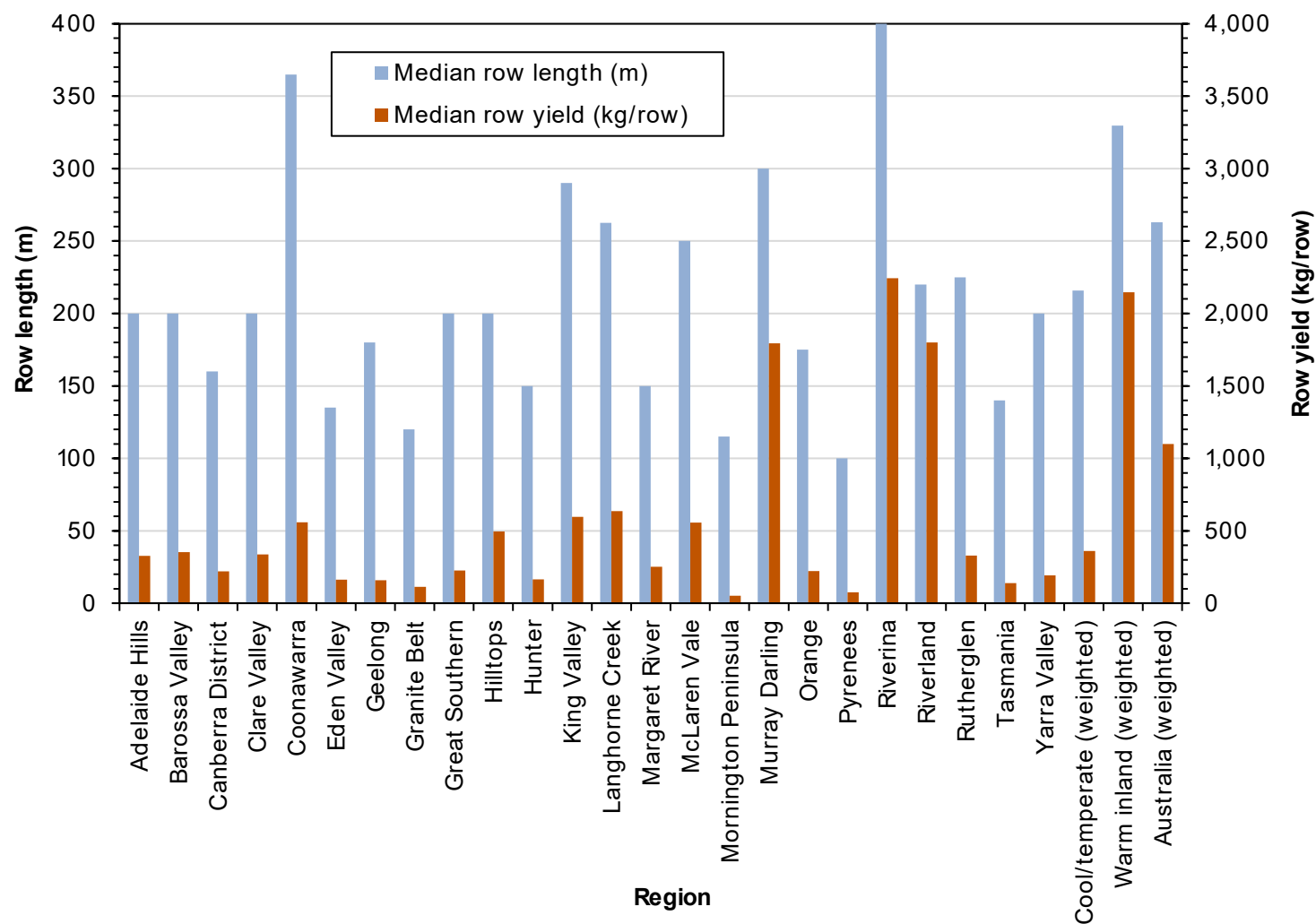
Weighted values for Australia

	2016	2022
Area yield	13.3 t/ha	12.5 t/ha
Vine yield	8.4 kg/v	7.3 kg/v

- Weighted Australian yield was 6% lower in 2022 compared with 2016, consistent with the national crush that was also 6% lower (see page 7).
- 2022 regional data is shown. Please refer to the 1st survey report for 2016 regional data.

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

Row length and yield



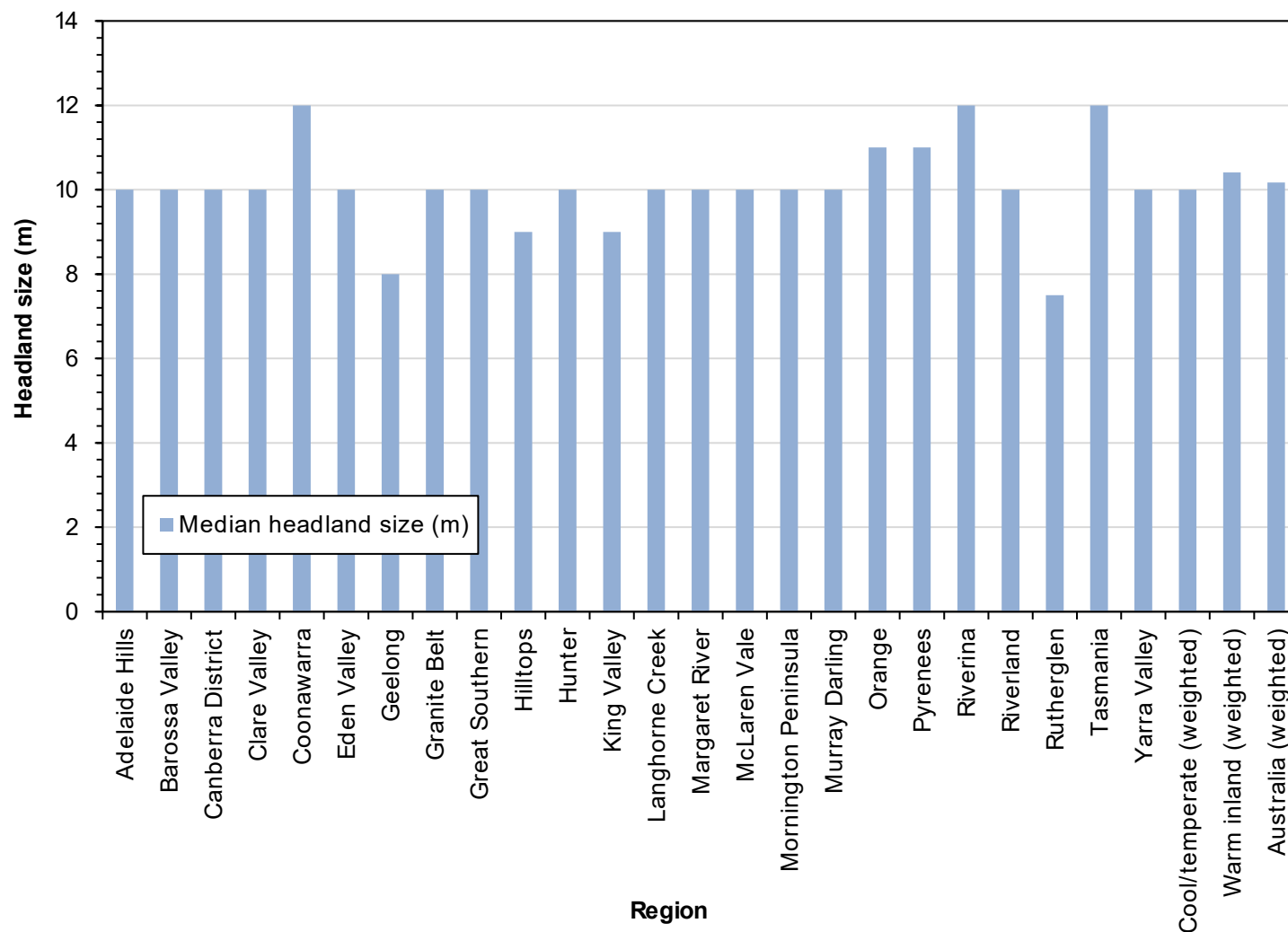
Weighted values for Australia

	2016	2022
Row length	253 m	263 m
Row yield	1,150 kg/r	1,100 kg/r

- Weighted Australian data was similar in the 2022 and 2016 surveys.
- 2022 regional data is shown. Please refer to the 1st survey report for 2016 regional data.

*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. Median values were then calculated for each region.

Headland size



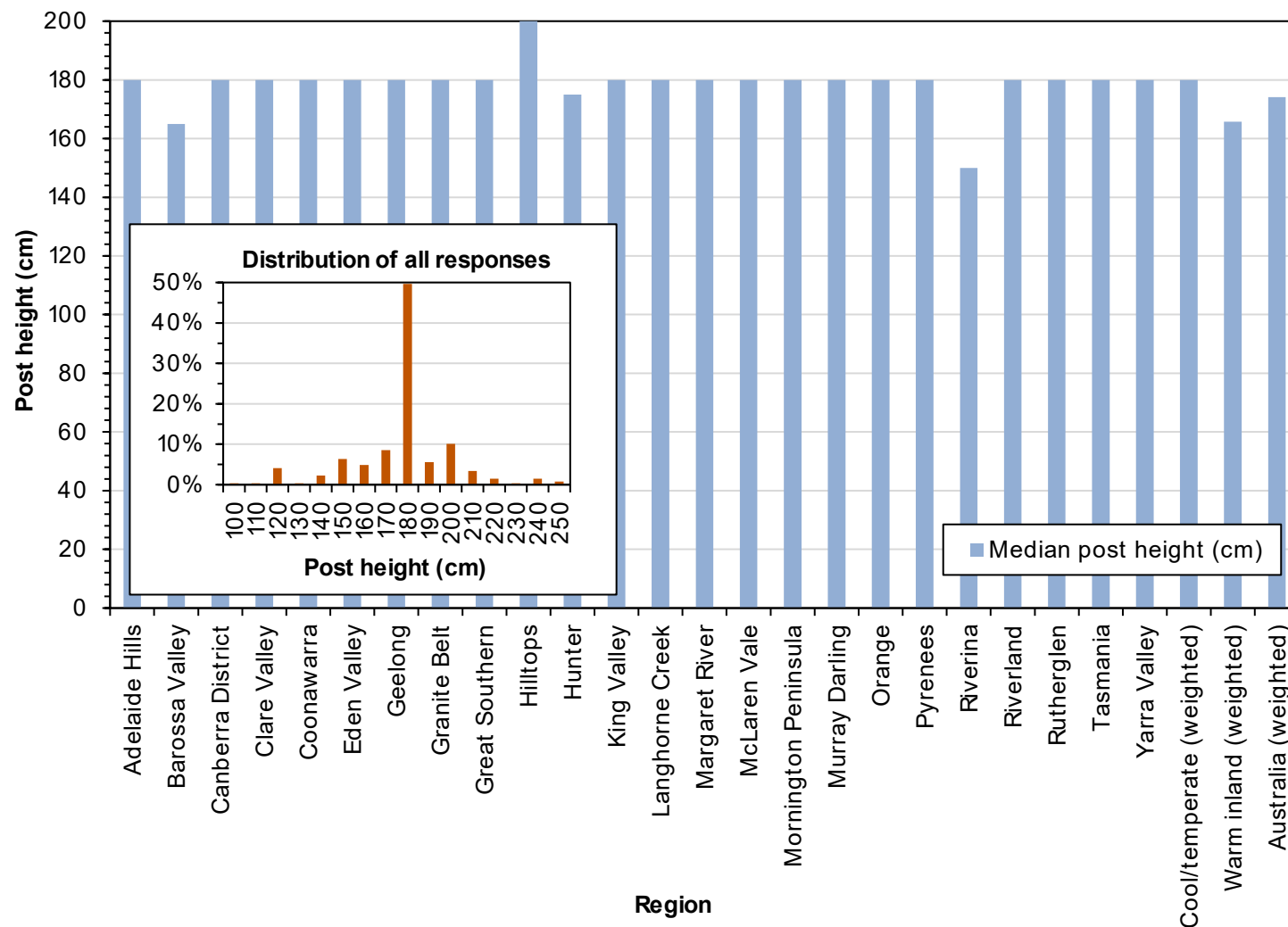
Weighted values for Australia

	2016	2022
Headland	N/A	10.2 m

- Median data was similar across regions, possibly reflecting the use of similar equipment that needs to turn on headlands (tractors, etc.).
- There are likely smaller gaps between blocks and tight points in many vineyards.

*The question asked for the most common headland size. Median values were then calculated for each region. This question was not asked in 2016.

Post height



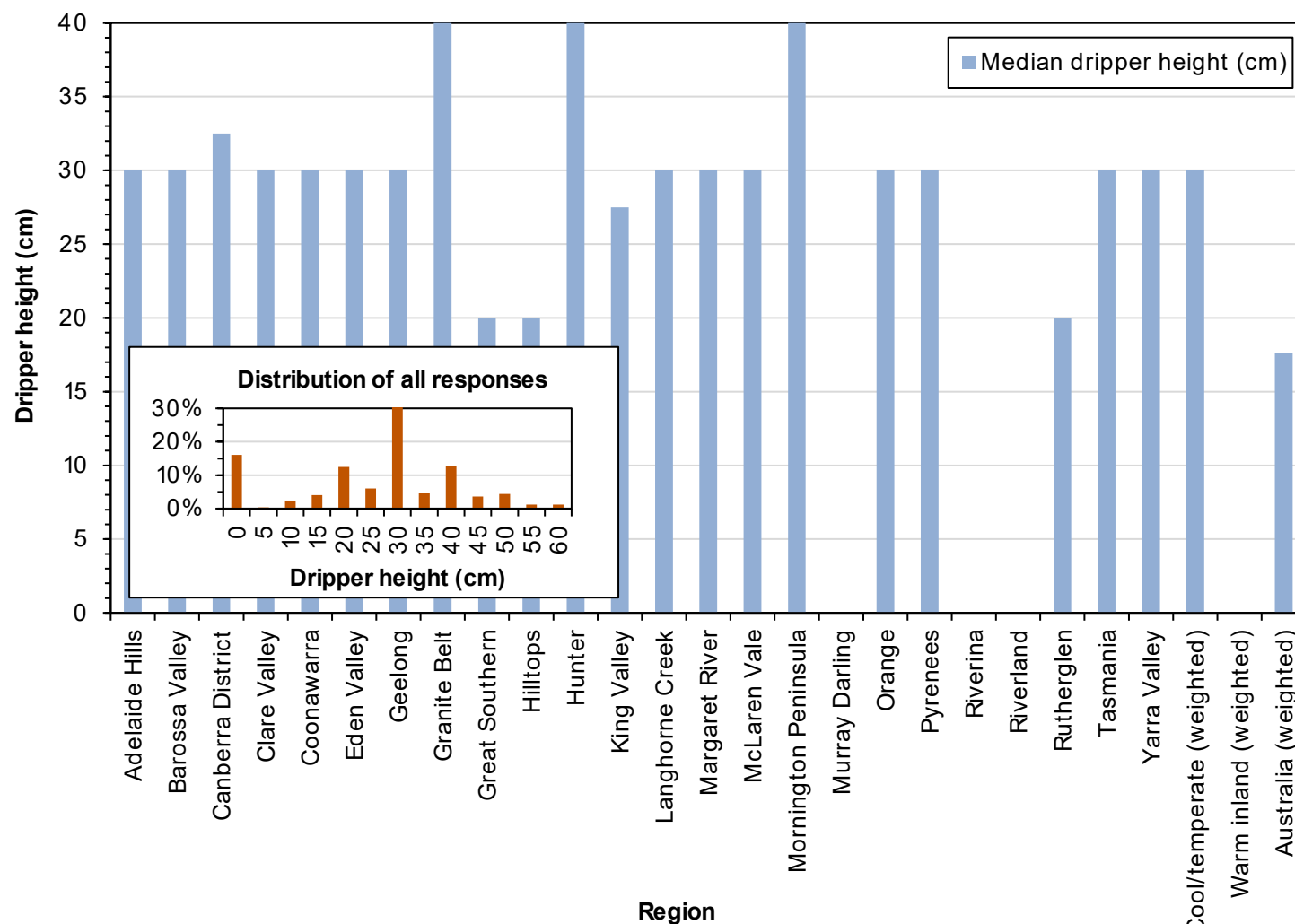
Weighted values for Australia

	2016	2022
Post height	N/A	174 cm

- Most common post height was around 180 cm.
- Post height has implications for over-the-row machinery.

*The question asked for the most common post height in cm from the ground, including any extensions. Users selected from a drop-down in 10 cm intervals. Median values were calculated for each region. This question was not asked in 2016.

Dripper height



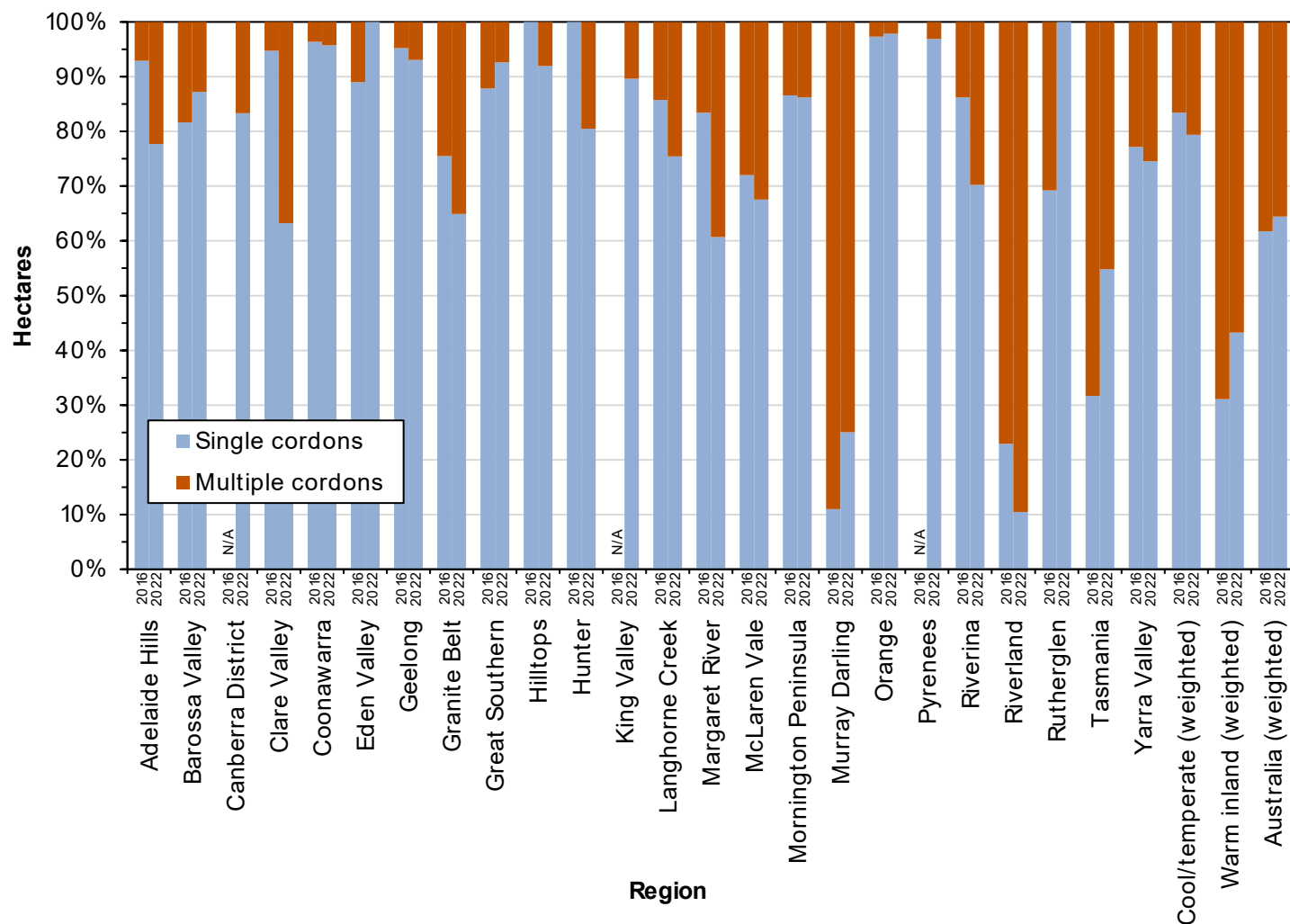
Weighted values for Australia

	2016	2022
Dripper height	N/A	18 cm

- Most common dripper height was around 30 cm.
- In warm inland regions, it was most common for drippers to be on the ground (i.e. 0 cm).

*The question asked for the most common dripper height in cm from the ground. Users selected from a drop-down in 5 cm intervals. Median values were calculated for each region. This question was not asked in 2016.

Single or multiple cordons



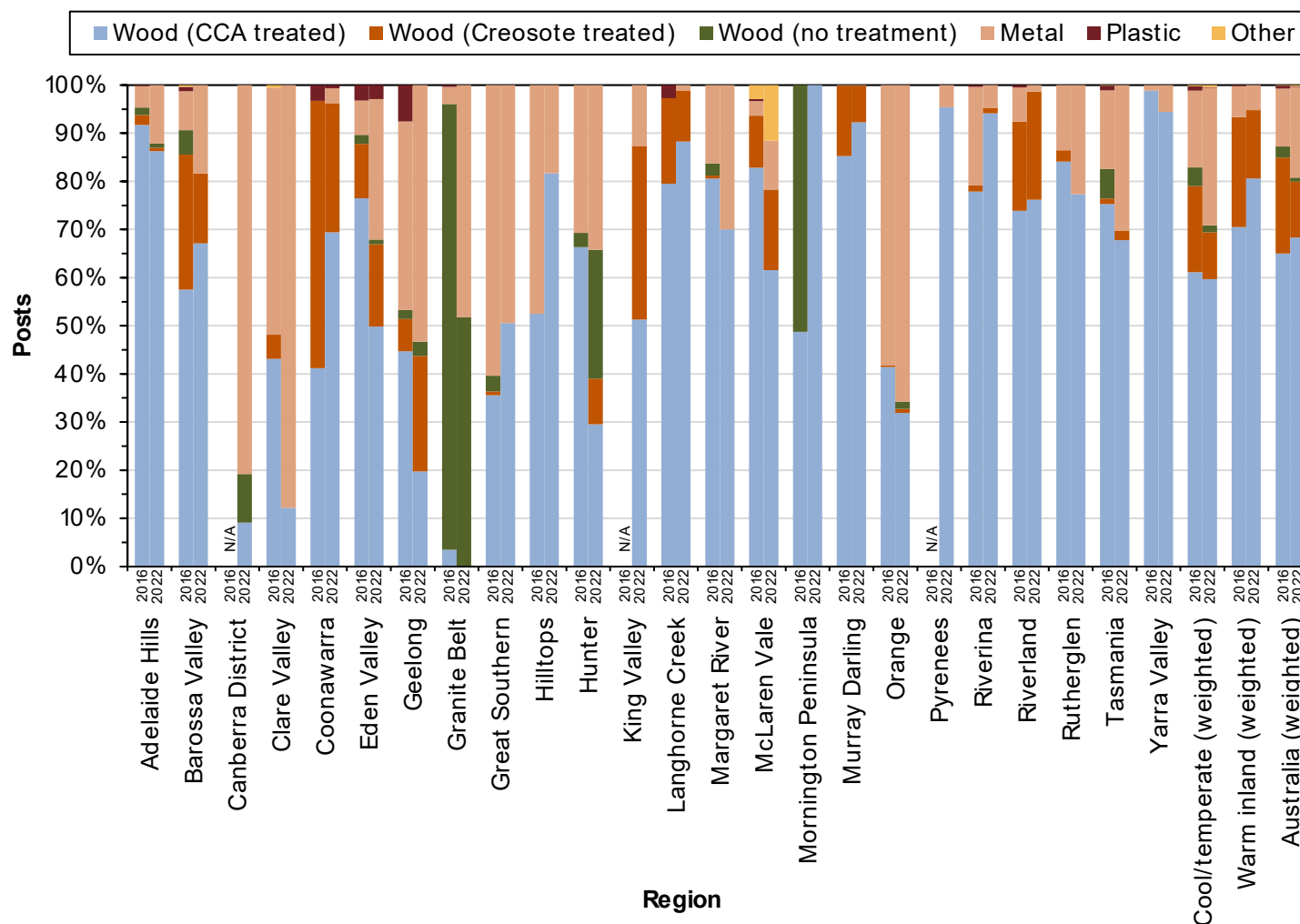
Weighted values for Australia

	2016	2022
Single cordons	62%	64%
Multiple cordons	38%	36%

- Aggregate data was similar in the 2022 and 2016 surveys.
- Variability between surveys in some regions may be due to some large producers completing one survey but not the other.

*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.

Vineyard post materials (excluding end assemblies and post extensions)



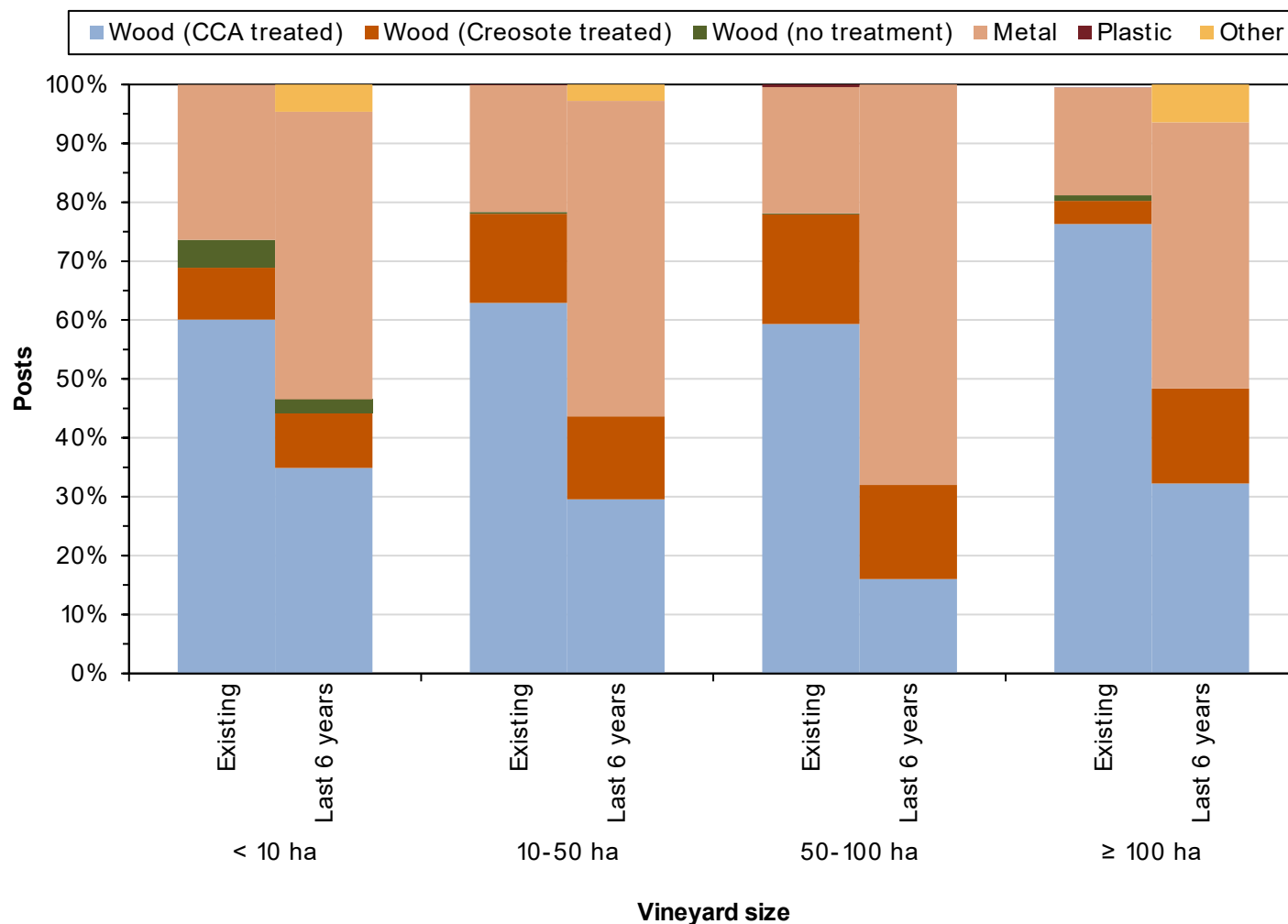
Weighted values for Australia

	2016	2022
CCA-wood	65%	68%
Creosote-wood	20%	12%
Metal	12%	19%

- Similar proportions between 2016 and 2022, with fewer respondents reporting Creosote and more reporting metal in 2022.
- Variability between surveys in some regions may be due to some large producers completing one survey but not the other.
- The response to the next question reinforces that there is a trend towards metal posts, even though they are still be in the minority.

*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.

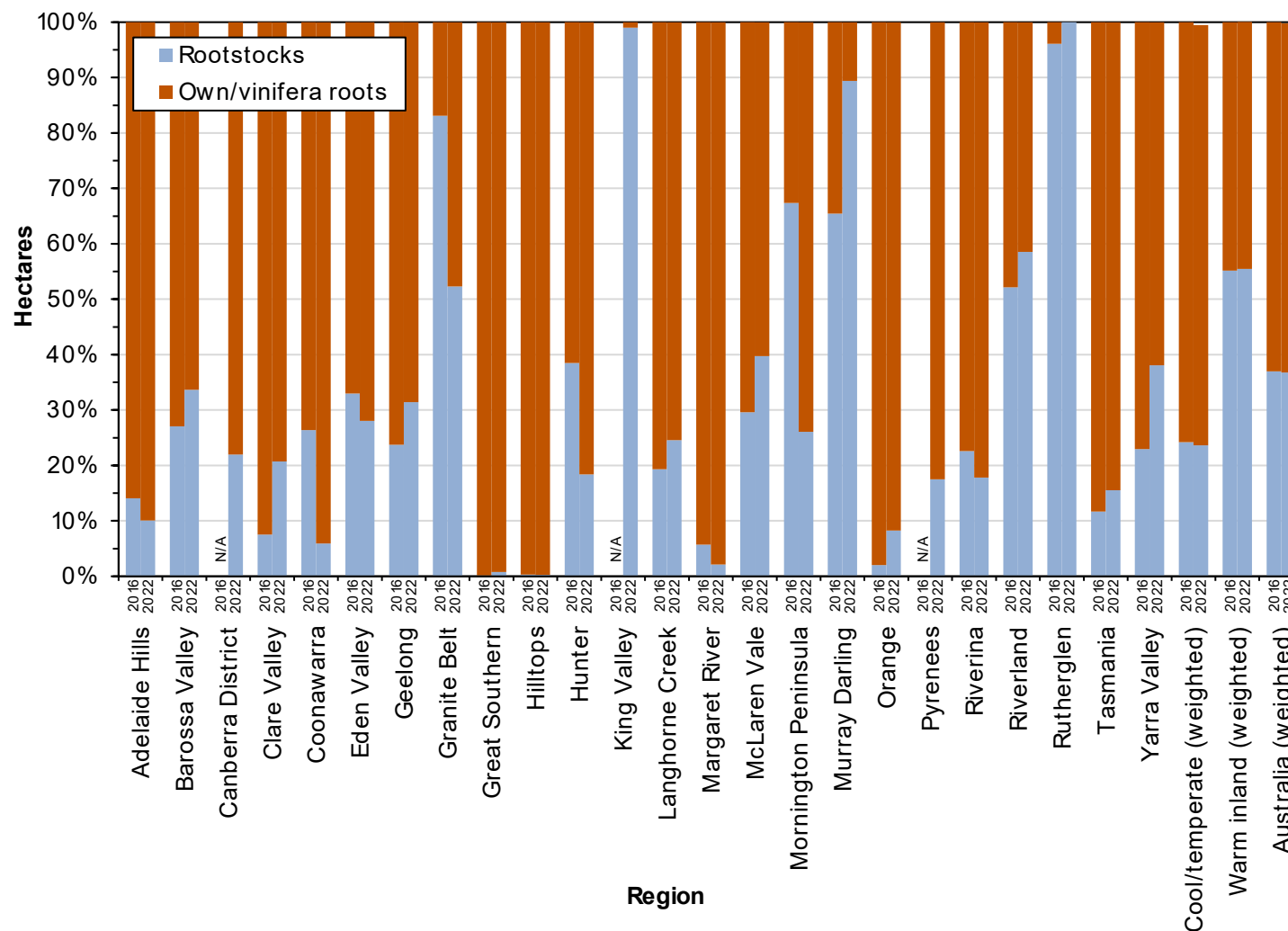
Vineyard post materials - Existing vs. most recent major install in < 6 years prior



- For the 170 of 244 respondents whose most recent time putting posts in for all or much of a block was less than 6 years prior, metal was a much more common post material than it has been in the past.

*In addition to the prior question on existing vineyard posts, respondents were asked for the most recent time that they put new posts in for all or much of a block, what post material did they use predominantly and approximately how many years ago this was. They had to select one option from a drop-down menu. While the percentage for existing posts has been applied on an area basis, the percentages for new stock have been calculated on a number of responses basis.

Rootstocks



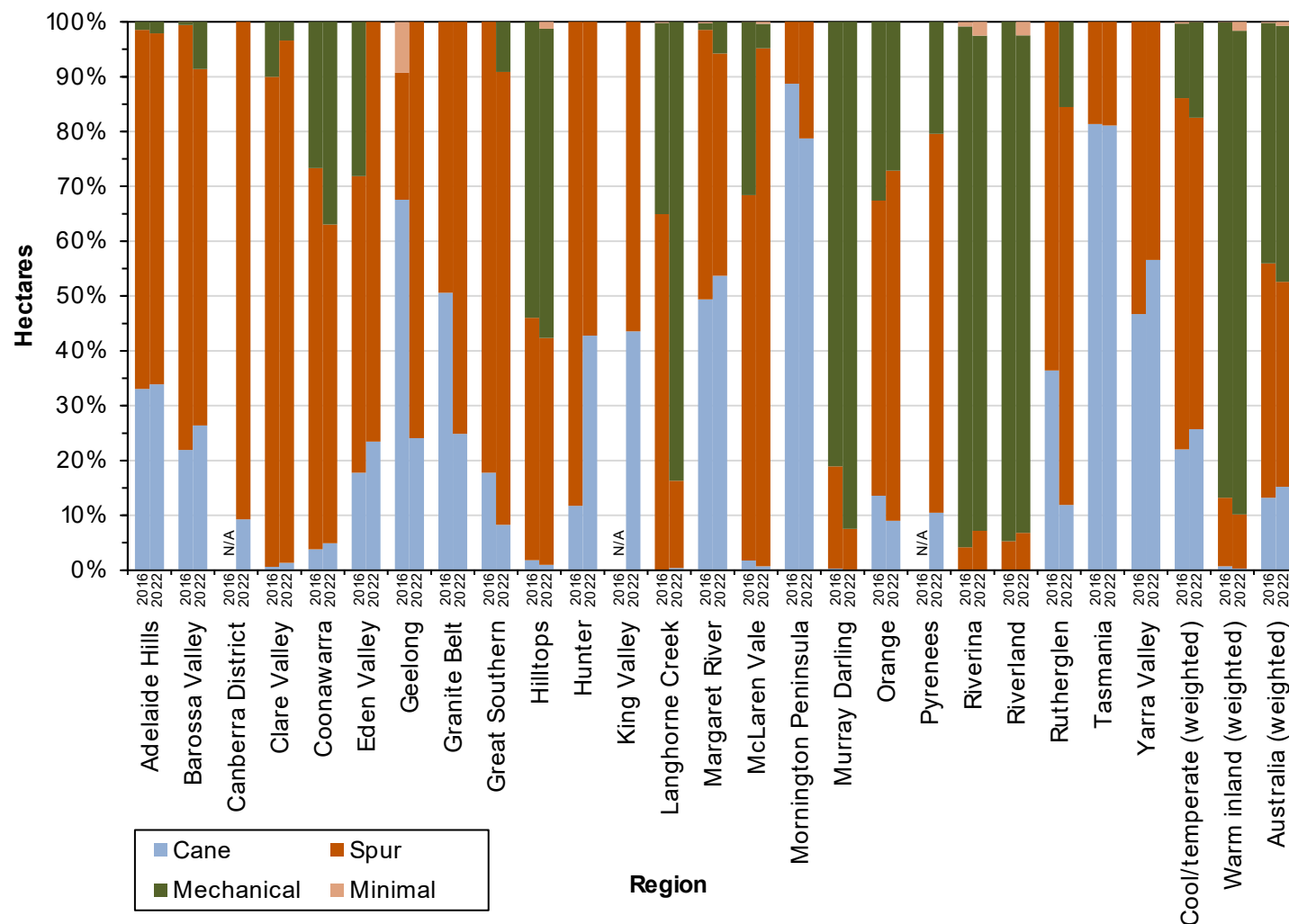
Weighted values for Australia

	2016	2022
Rootstocks	37%	37%
Own roots	63%	63%

- For reference, Vinehealth Australia, who have definitive records just for South Australia, reported that 24% of South Australian vineyard area was on rootstocks in 2022.
- Variability between the 2016 and 2022 surveys in some regions may be due to some large producers completing one survey but not the other.

¹Respondents were asked what area was on non-*vinifera* rootstocks and what area was on own/*vinifera* roots. Reference data was from the Vinehealth Australia (2022) 2021-2022 Annual report.

Pruning method



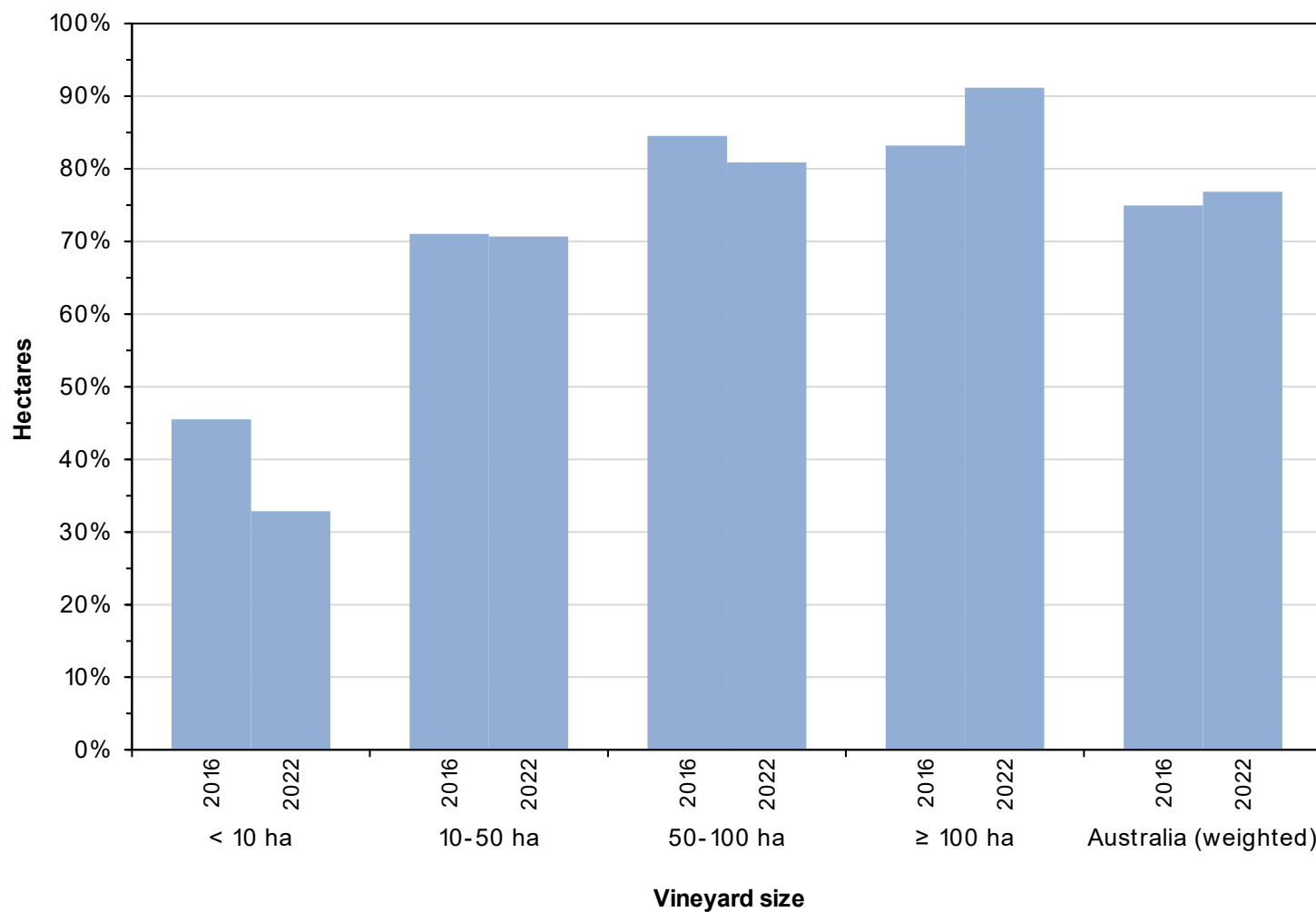
Weighted values for Australia

	2016	2022
Cane	13%	15%
Spur	43%	37%
Mechanical	44%	47%
Minimal	0%	1%

- Aggregate data was similar in the 2022 and 2016 surveys.
- 91% of respondents said that the proportions of their vineyards pruned in different manners was fairly typical of the last 6 years.
- Variability between surveys in some regions may be due to some large producers completing one survey but not the other.

*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.

Mechanical pre-pruning for spur-pruned vines



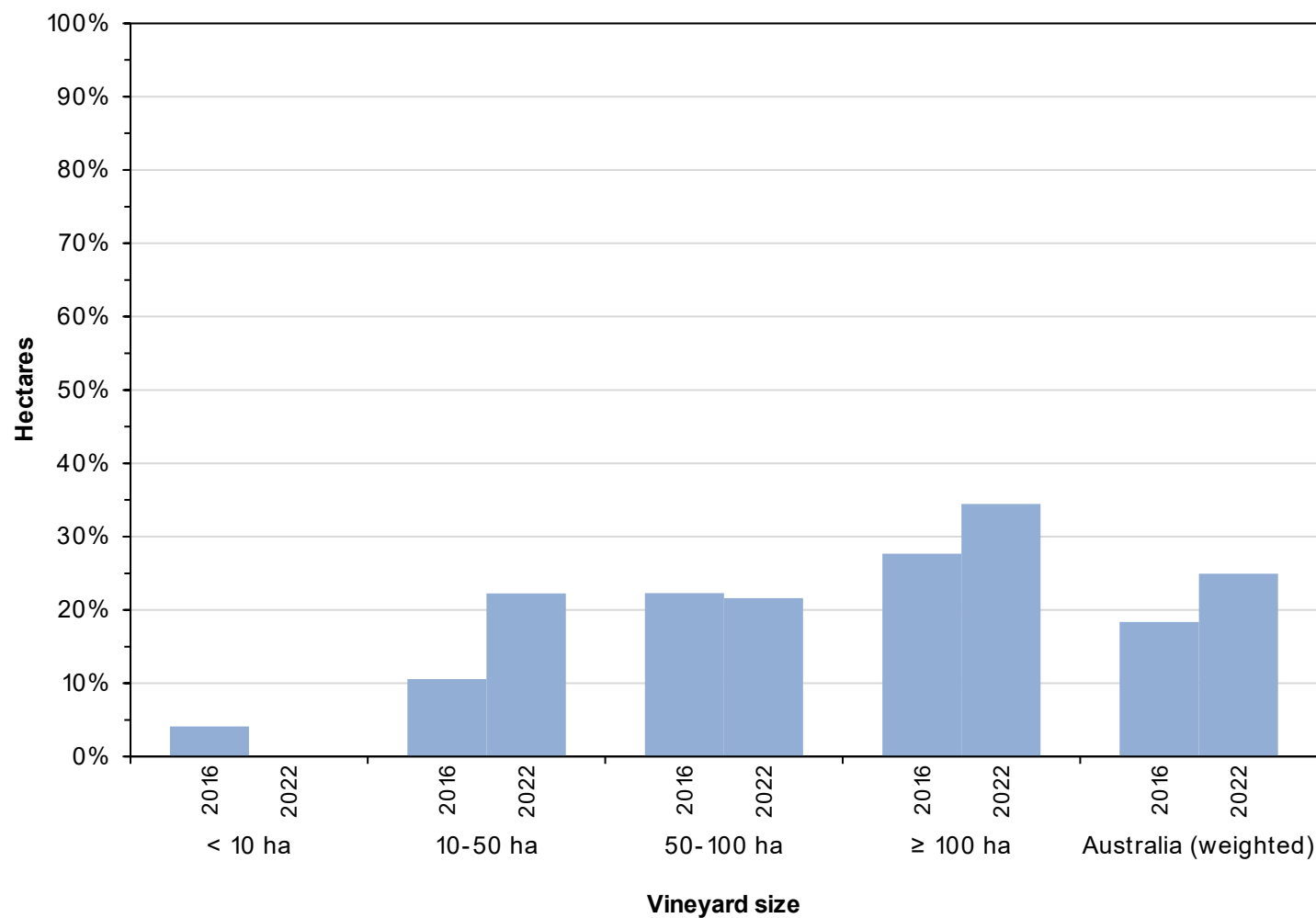
Weighted values for Australia

	2016	2022
Mech. pre-pruning	75%	77%

- Mechanical pre-pruning was very common for spur-pruned vines, even in small vineyards.
- Aggregate data was similar in the 2022 and 2016 surveys.

*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



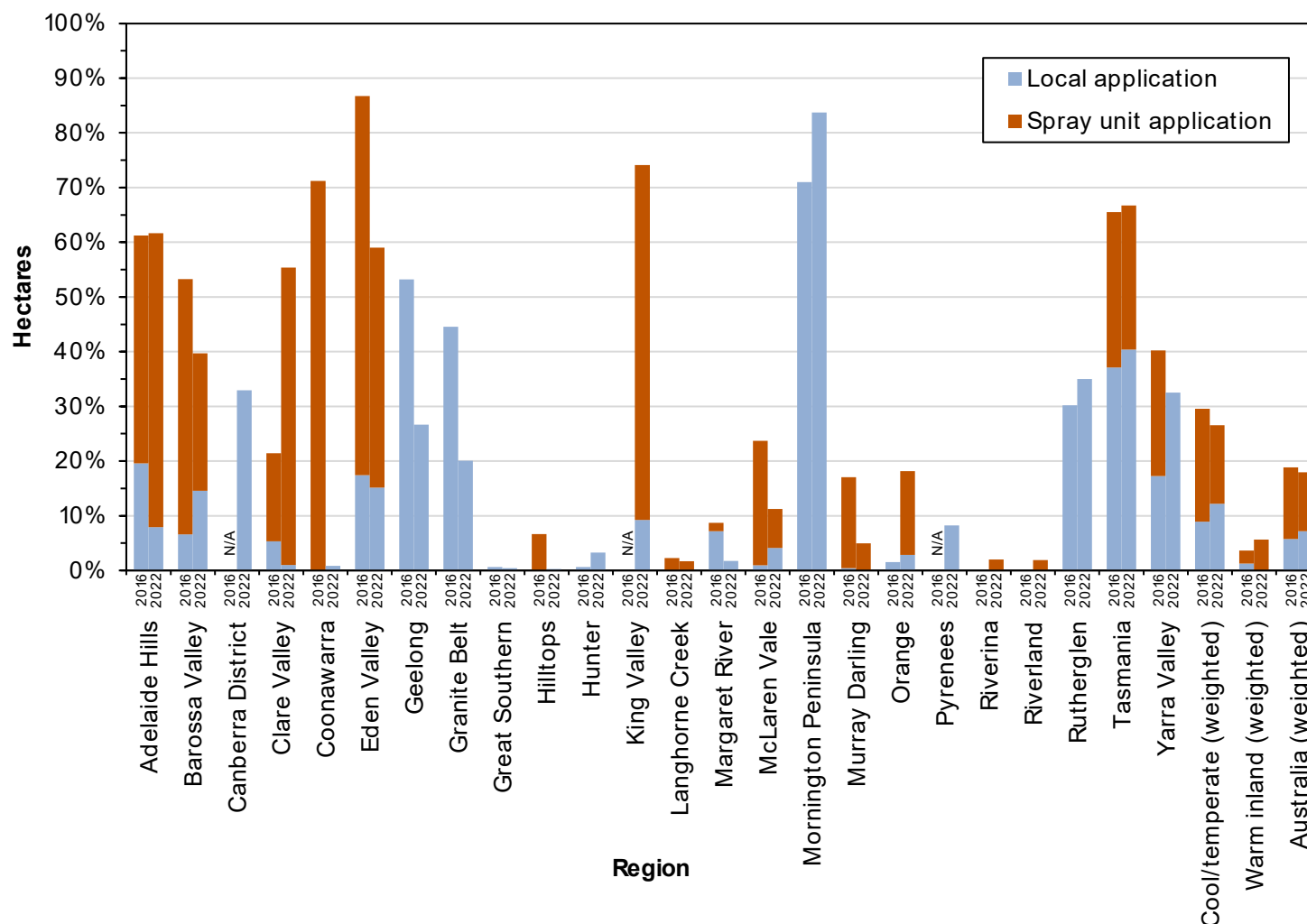
Weighted values for Australia

	2016	2022
Mech. cane rem.	18%	25%

- Aggregate data was slightly higher in the 2022 survey, but mechanisation for cane pruning remains far less common than it is for spur pruning.

*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



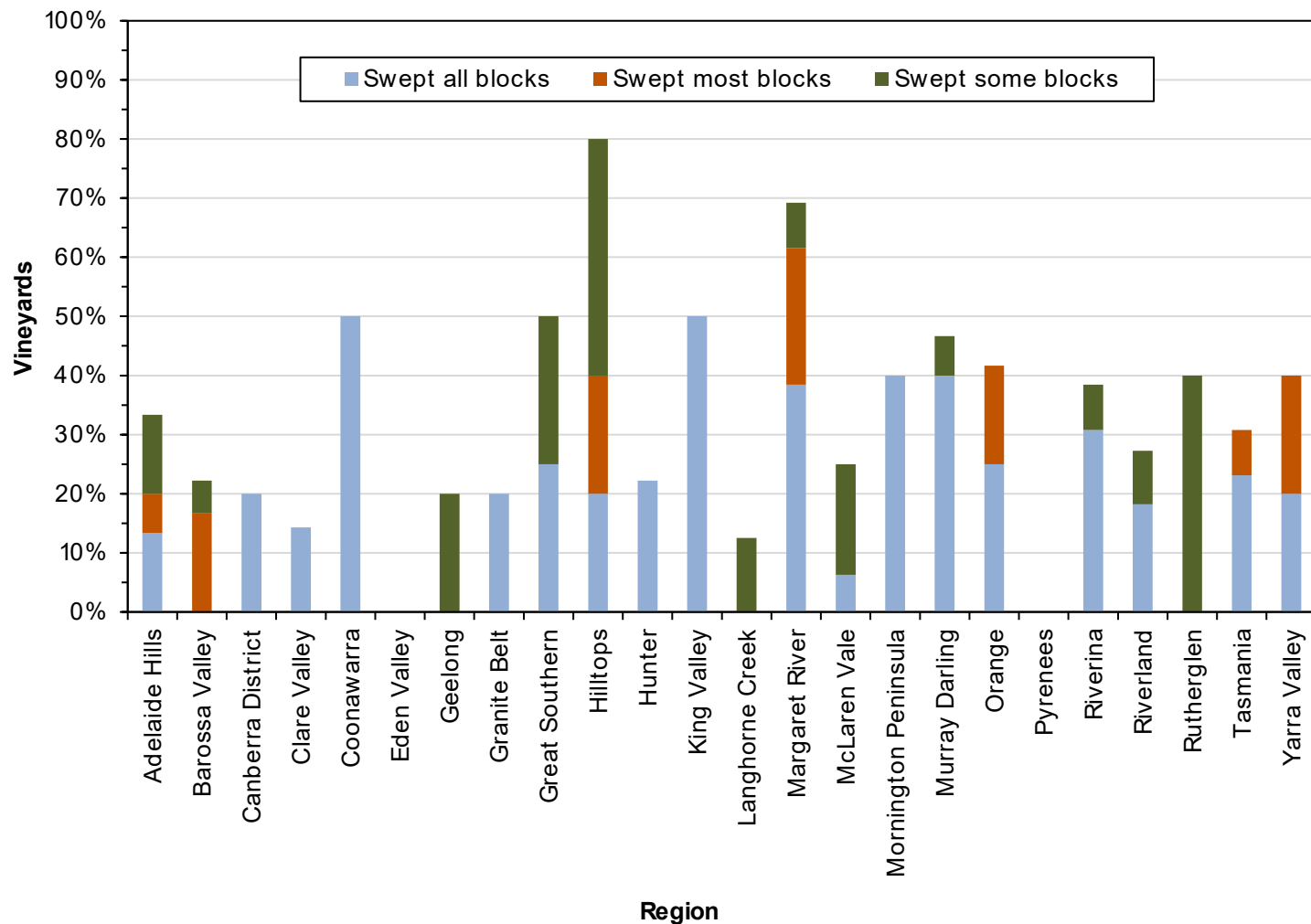
Weighted values for Australia

	2016	2022
Local application	6%	7%
Spray unit app.	13%	11%

- Aggregate data was similar in the 2022 and 2016 surveys.

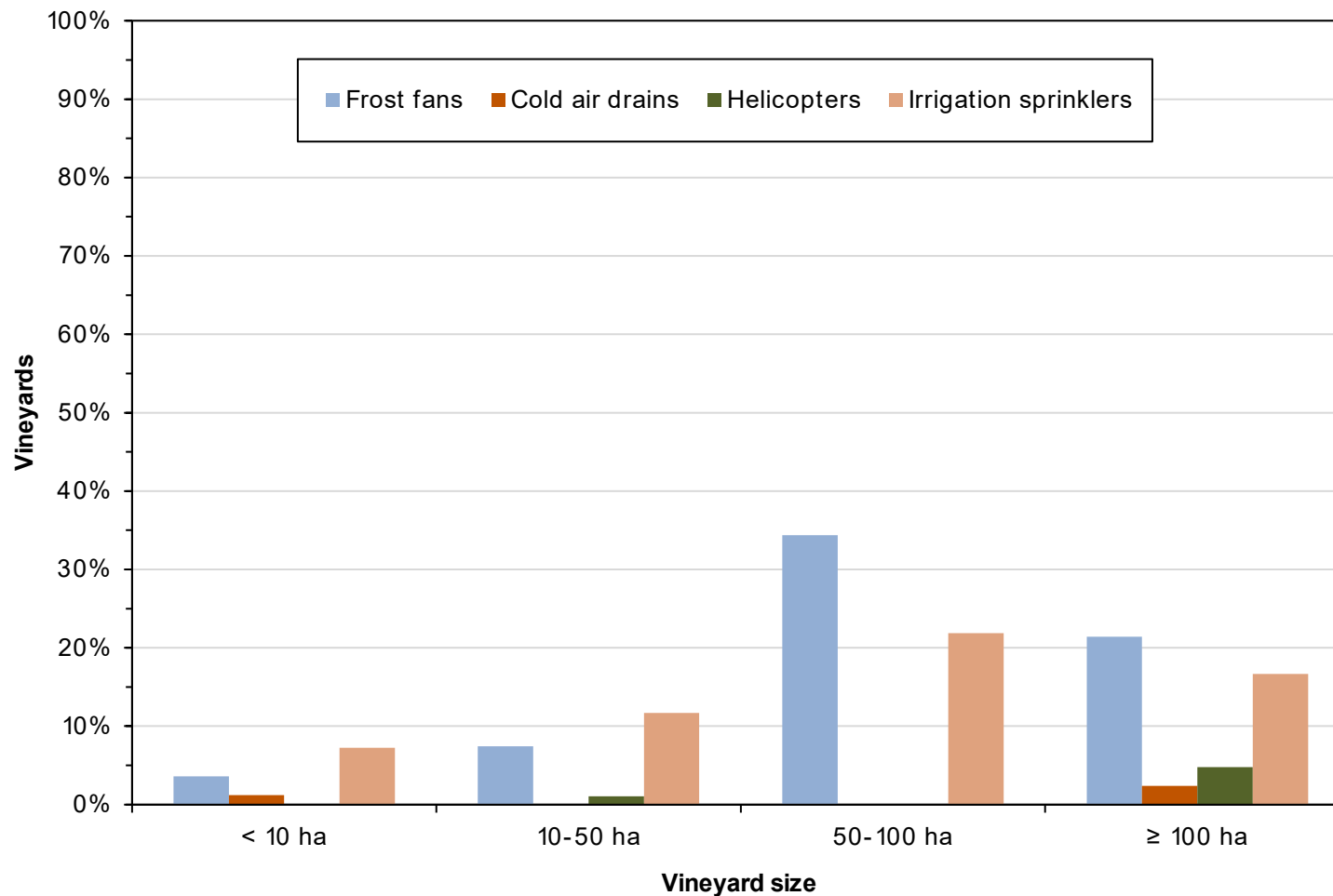
*The question asked first whether any chemical treatments were applied to pruning wounds after pruning (painted or sprayed by hand, or by tractor spray unit). If respondents answered yes, they were then asked to enter the areas to which no treatment was applied, treatment was applied by hand, and treatment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

Vineyard sweeping



*The question asked first whether any sweeping was performed under-vine. A drop-down menu had options of all blocks, most blocks, some blocks, or no blocks. This question was not asked in 2016. The plot shows data for 2022.

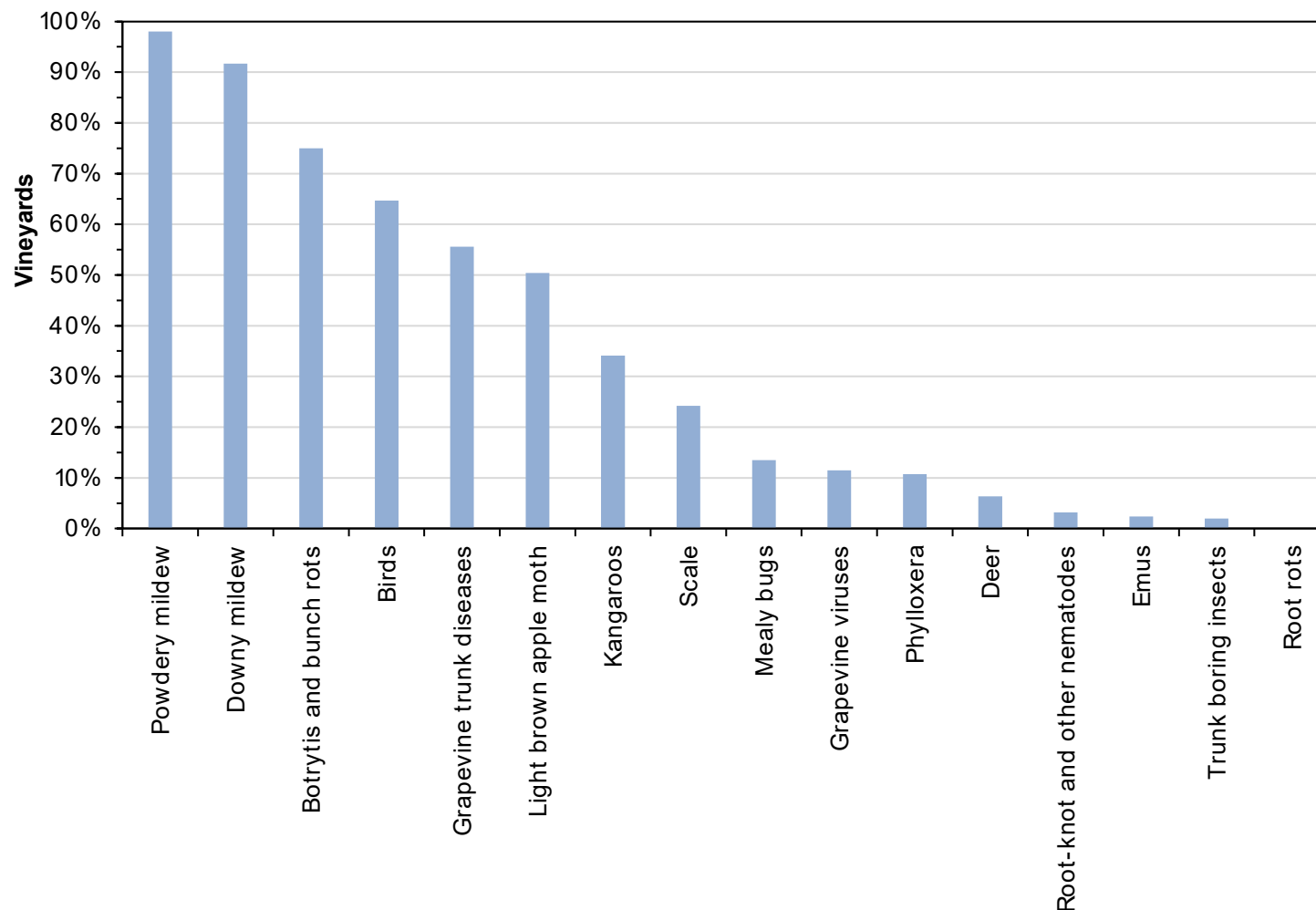
Active frost management techniques are installed or used in the vineyards when needed



- Frost fans and sprinklers were the predominant active frost management techniques, with adoption higher in larger vineyards.
- In addition, multiple respondents mentioned management strategies like mowing.

*The question asked the user which active frost management techniques are installed and used in the vineyards when needed. This question was not asked in 2016. The plot shows data for 2022.

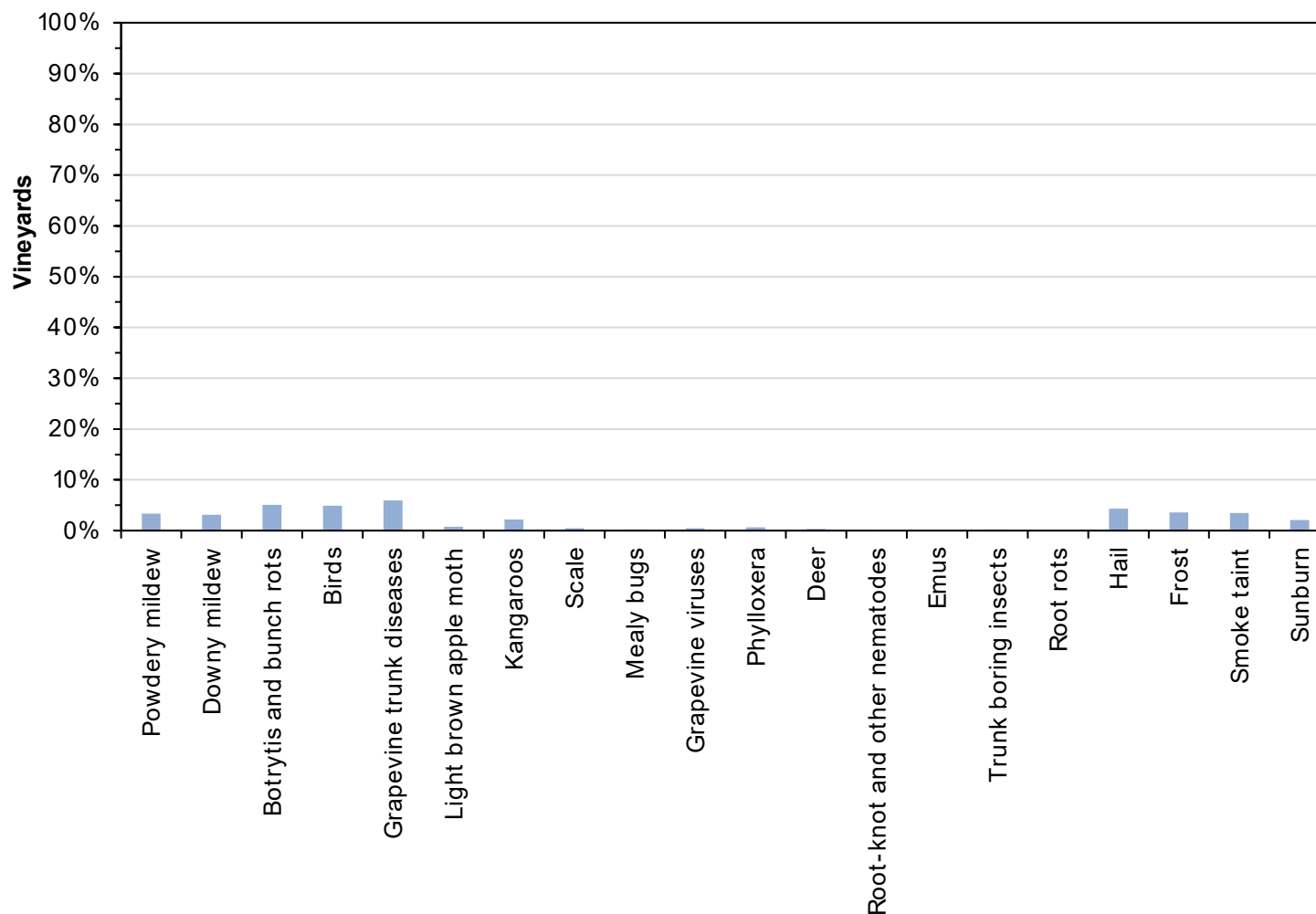
Pests and diseases that are being actively managed



- This was a new variation on questions regarding pests and disease management/impacts for the 2022 survey.
- In the 2016 survey, the largest impacts from pest/disease in the prior 5 years were in descending order: Powdery mildew, botrytis and bunch rots, Downy mildew, Birds, Light brown apple moth, and trunk diseases. This is consistent with the pests and diseases that respondents were most commonly actively managing in this 2022 survey.

*The question asked the user to select from a list, which pests and diseases are you actively managing, with further guidance that active management might include applying sprays, installing fences, removing affected vines, or taking other actions. This question was not asked in the same way in 2016.

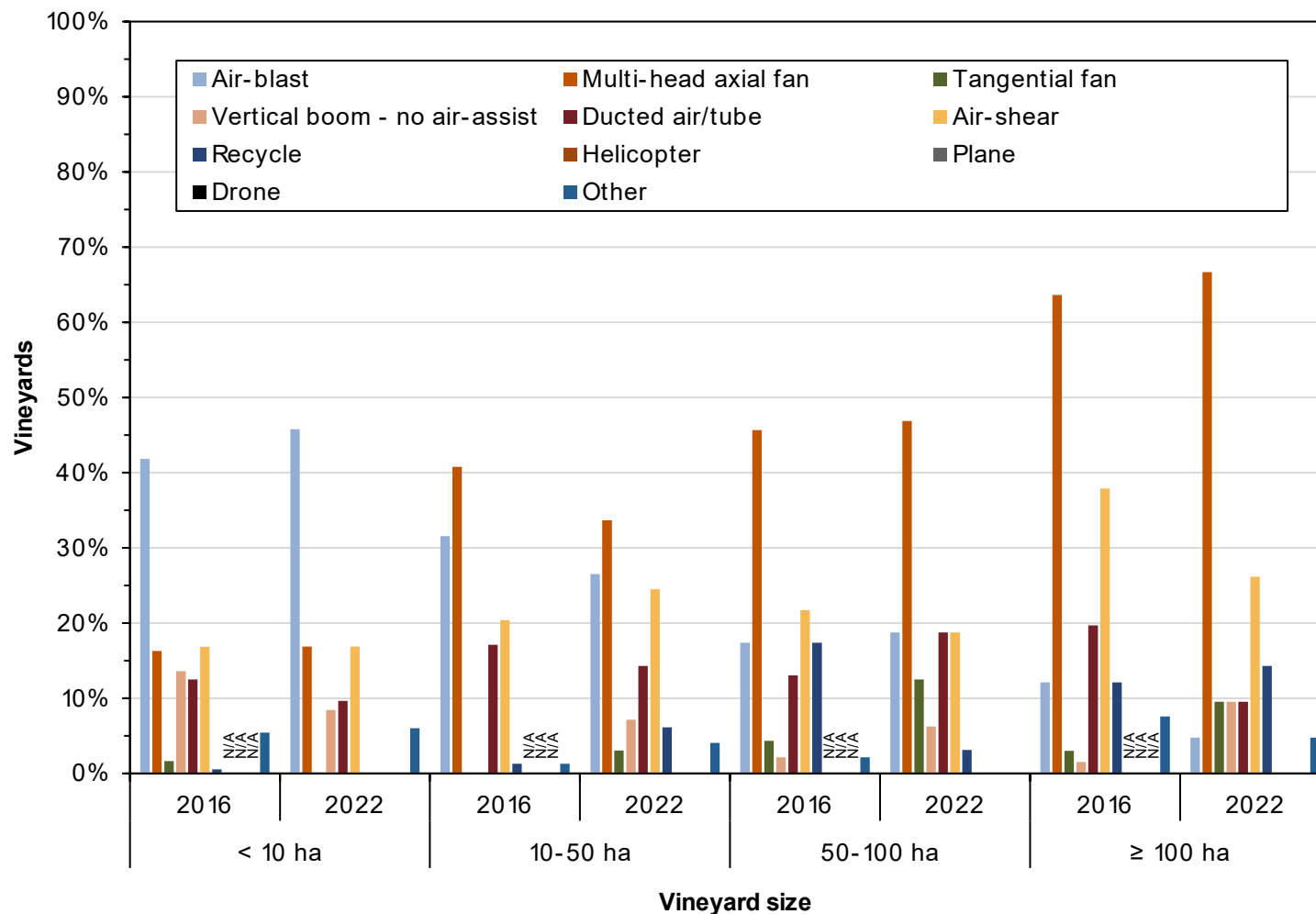
Average crop/yield losses from pests, disease and weather in last 6 years



- This was a new variation on questions regarding pests and disease impacts for the 2022 survey, with other extreme weather events now also being incorporated.

*The question asked the user over the last 6 years, what average annual crop/yield losses have each of the following pests, diseases and weather events caused. For each cause they had a slider that they could drag from 0% to 100%. The percentages displayed are averages for each category. A small number of responses over 50% were excluded from calculations as they were deemed likely to be a misreading of the question and experiences in just the current year. This question was not asked in the same way in 2016.

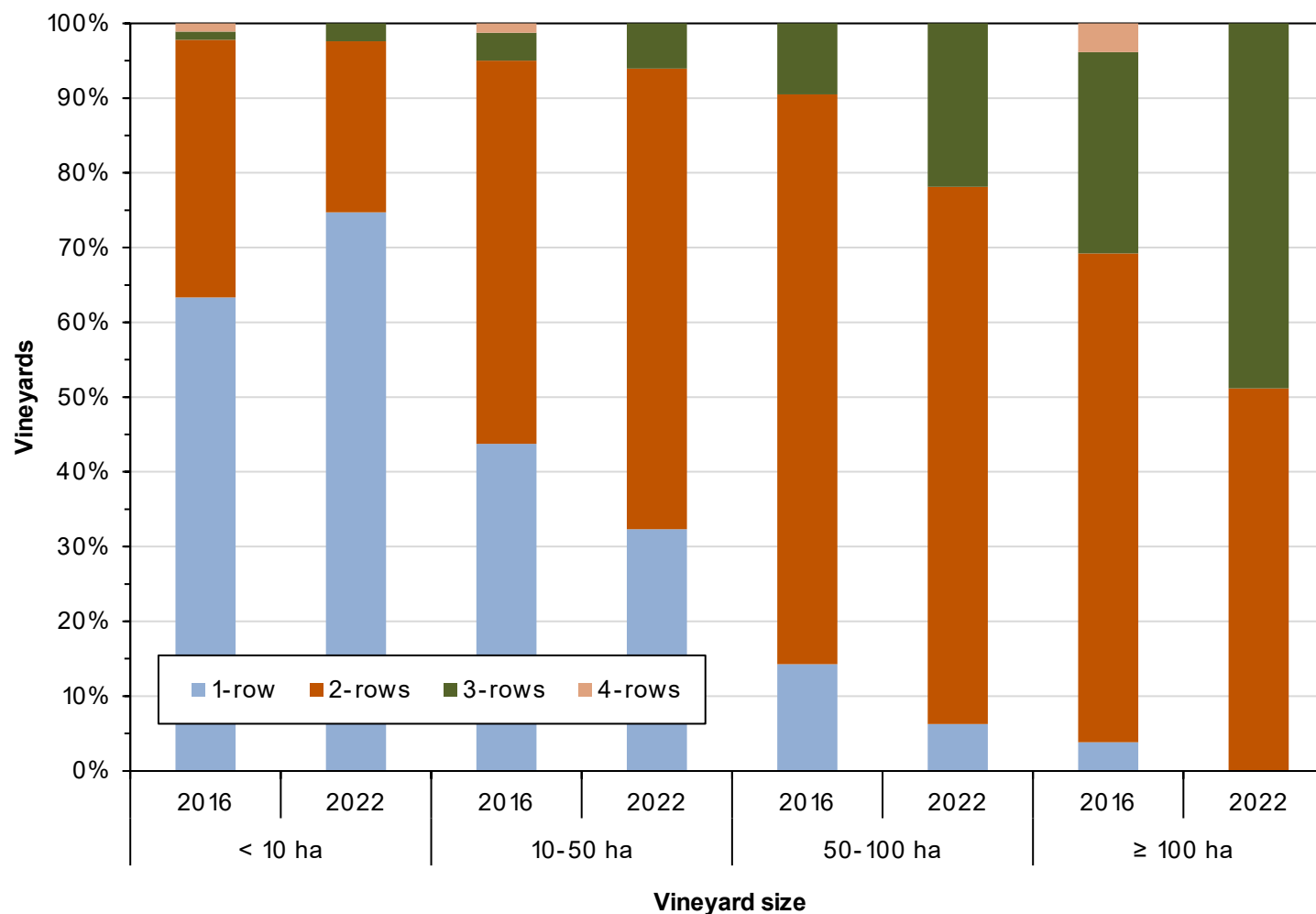
Canopy sprayer types (used at all)



- Results were similar in 2022 to 2016 with air-blast sprayers most common in small vineyards and multi-head axial fan sprayers most common in large vineyards.
- Recycle sprayer use was higher in larger vineyards but still low overall.
- In a follow-up question just for the sprayer that covered the most area, 13 of 80 multi-head axial fan sprayers had electric motors.
- Options were introduced in the 2022 survey regarding aerial sprayers with a goal of capturing possible drone sprayer use, but no respondents used these in the 2021/2022 season.

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

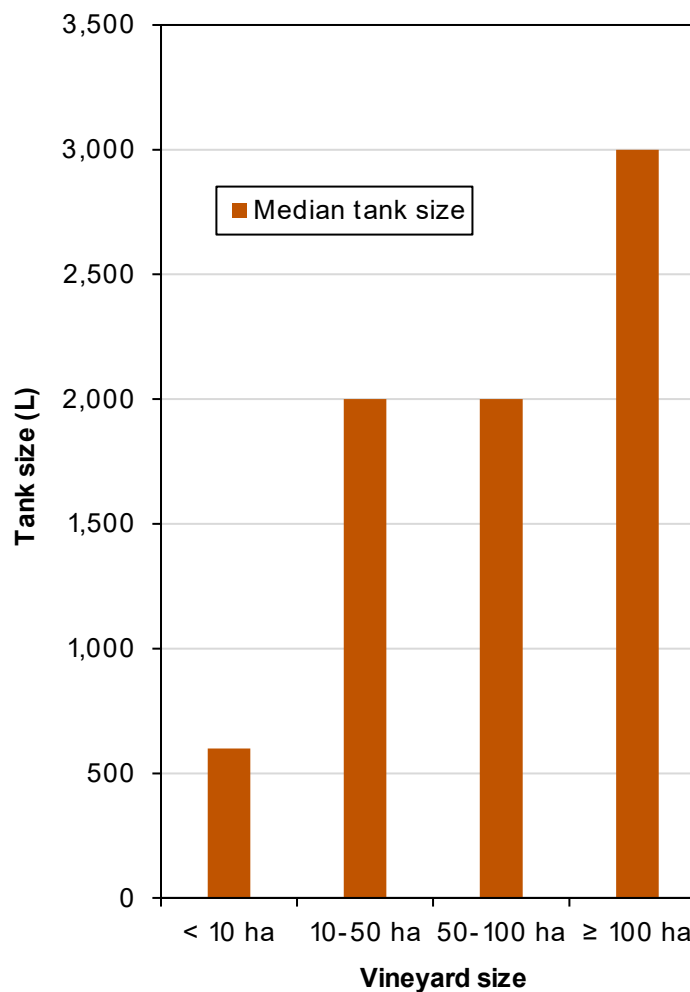
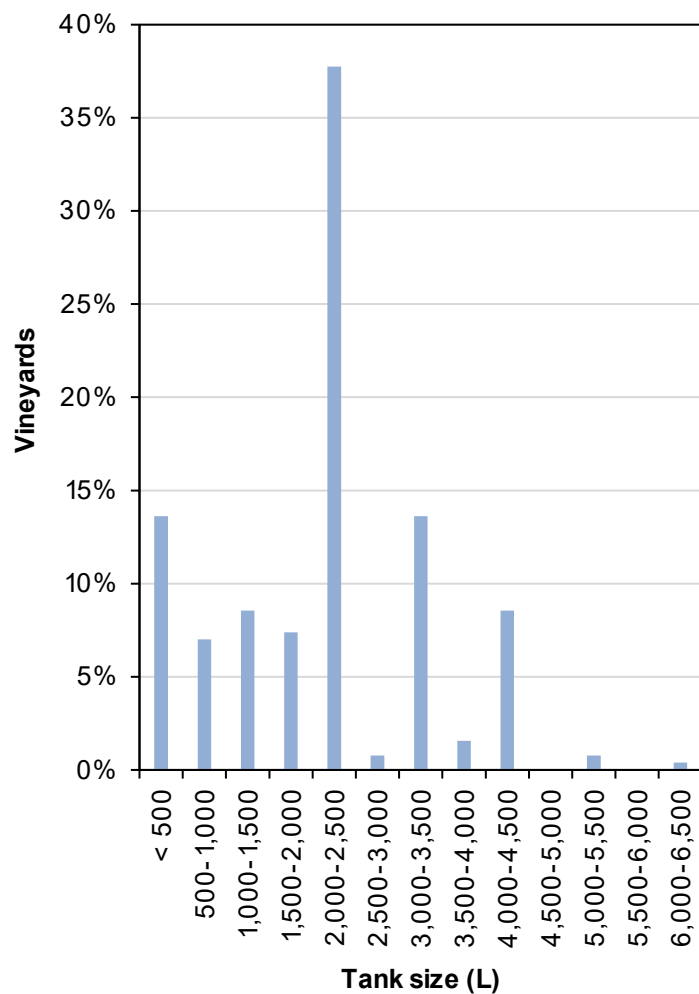
Rows sprayed each pass by the canopy sprayer that covered the most area



- Sprayer size increased with vineyard size, with 3-row sprayers being the largest sprayer size.
- Larger vineyards increased their use of multi-row sprayers between 2016 and 2022, most notably their use of 3-row sprayers.

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

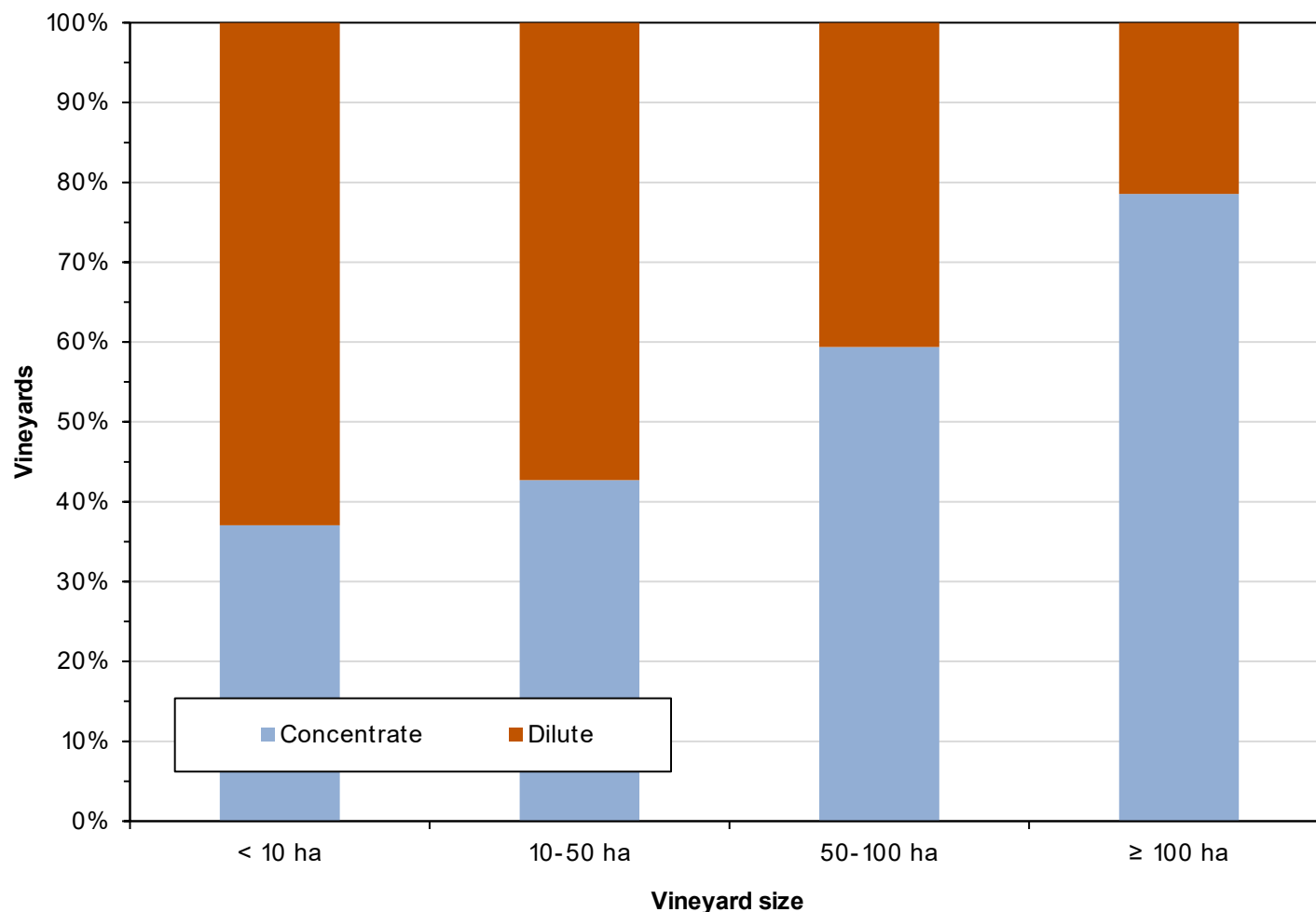
Tank volume of canopy sprayer that covered the most area



- Tanks were most commonly in the 2,000-2,500 L range.
- 3,000 and 4,000 L tanks were also relatively common.
- Median tank size increased with vineyard size.

*The question asked the respondent to enter how many litres the tank can hold for the sprayer that covered the most hectares. This question was not asked in 2016. The plot shows data for 2022.

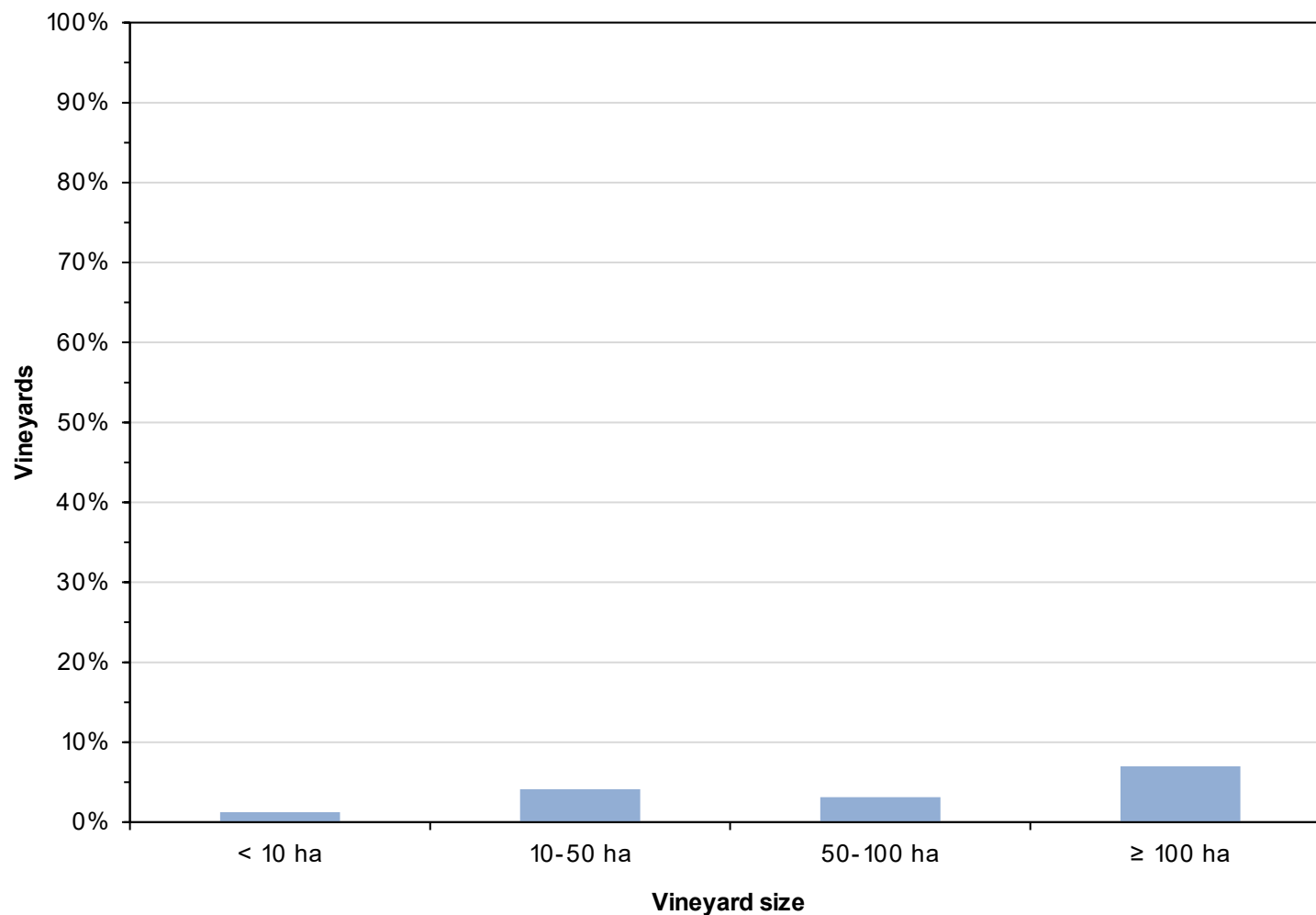
Concentrate or dilute sprays more commonly used



- Larger vineyards were more likely to use concentrate sprays.

*The question asked the respondent whether dilute (high volume) or concentrate (low volume) sprays were more commonly prepared and used. An explanatory note detailed that dilute spraying uses high volumes of water to the point of runoff, while concentrate spraying uses lower volumes of water but with the same quantity of active per ha. The g or mL/100 L rate shown on the label is for dilute spraying, and instructions for concentrate spraying are shown in another section of the label. This question was not asked in 2016. The plot shows data for 2022.

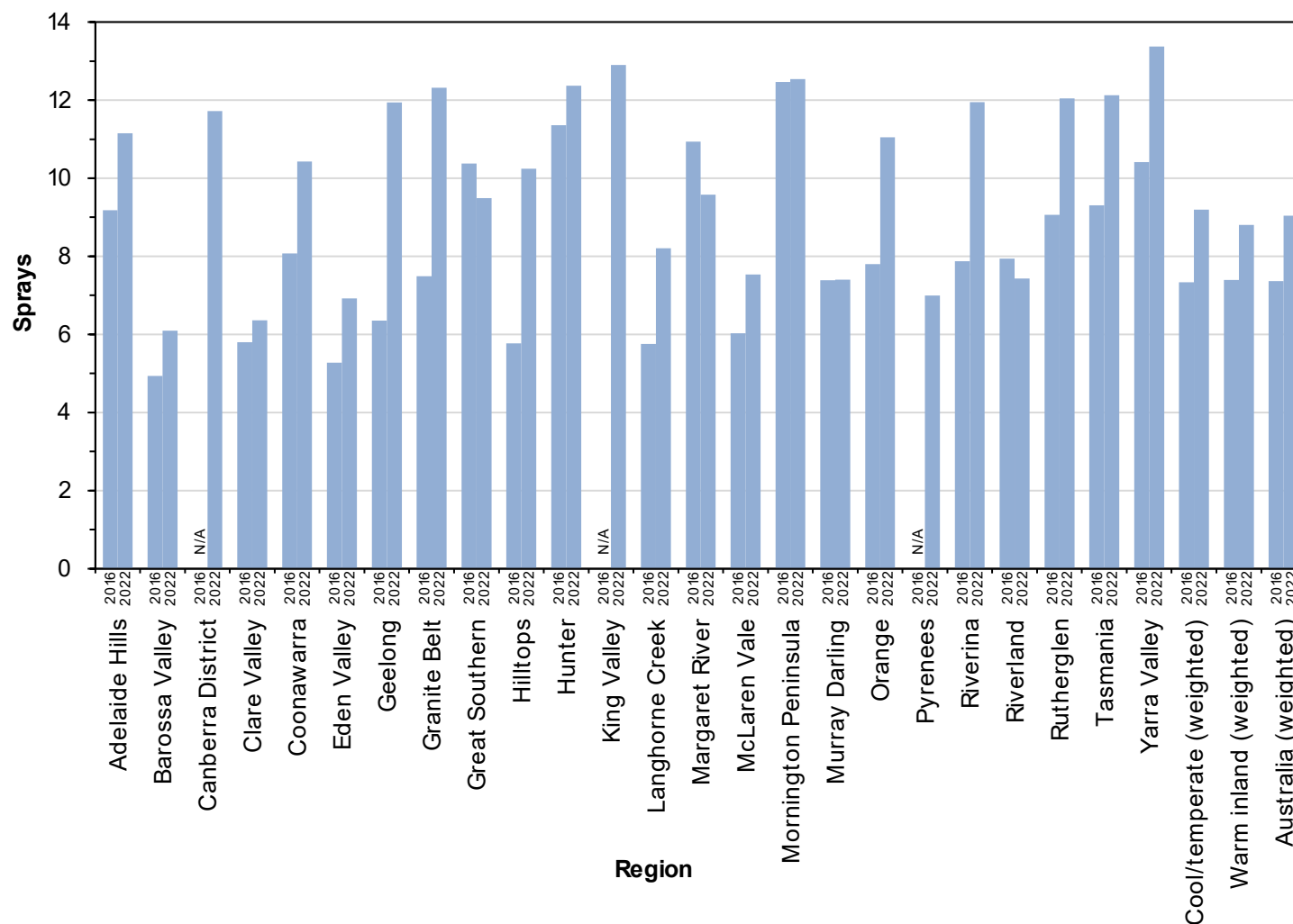
GPS/GNSS-RTK section control on tractor/canopy sprayer



- Few vineyards had systems on their tractors and sprayers that automatically switch spray valves on and off when the tractor enters and exits each row.

*The question asked the respondent whether a system is fitted to the sprayer and/or associated tractor that uses GPS/GNSS-RTK positioning to automatically stop the spray at the end of each row and start it again on entering the next row, for the canopy sprayer that covered the most area. This question was not asked in 2016. The plot shows data for 2022.

Average number of canopy sprays



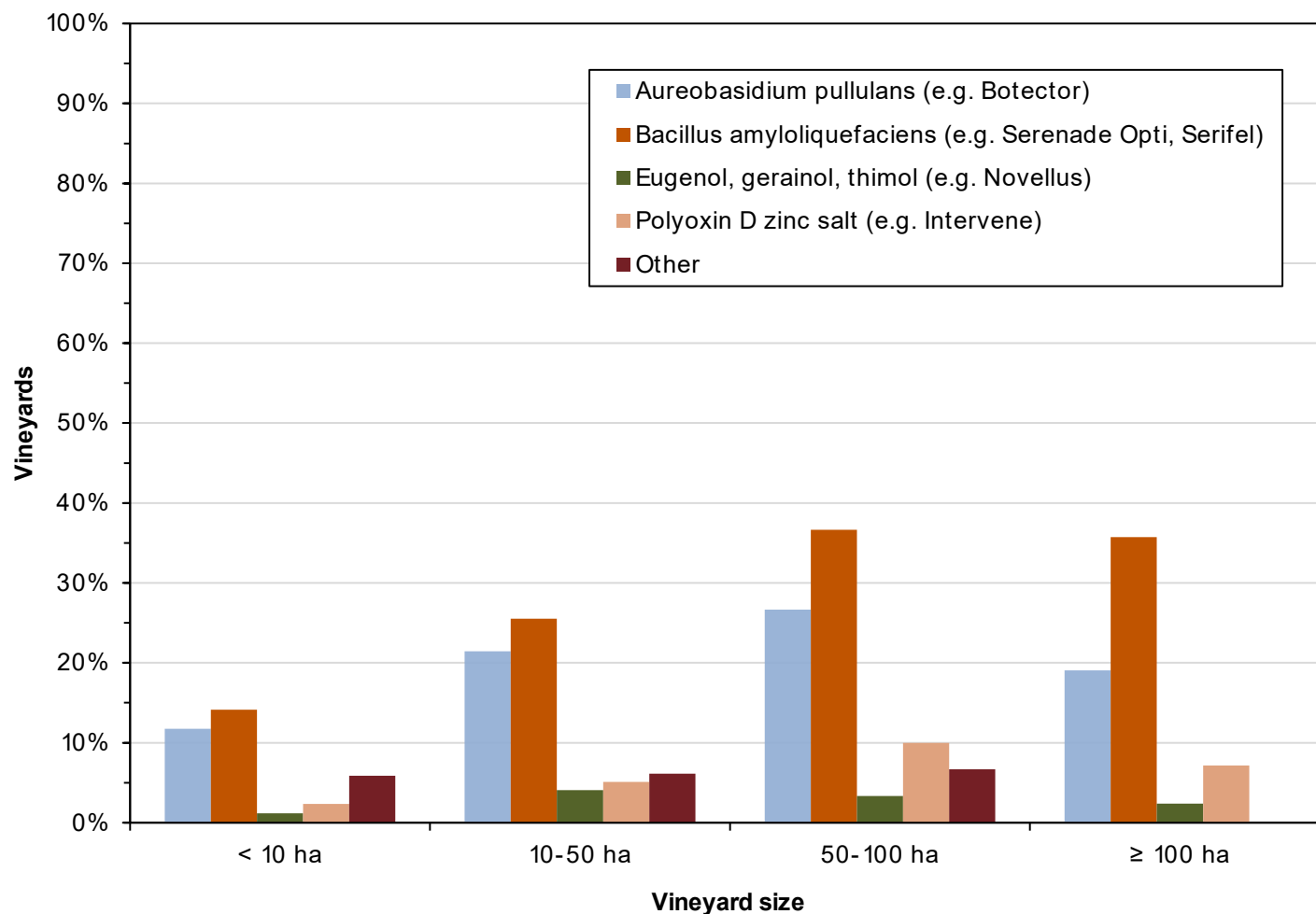
Weighted values for Australia

	2016	2022
Average sprays	7.4	9.0

- In 2016, 75% of respondents described their number of sprays as being fairly typical of the last five years.
- In 2022, 49% of respondents described their number of sprays as being either slightly more (32%) or a lot more (17%) than during the last six years.
- Differences between 2016 and 2022 are likely more related to the 2022 seasonal conditions than to any practice change.

*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/six years (a lot less, slightly less, fairly typical, slightly more, a lot more).

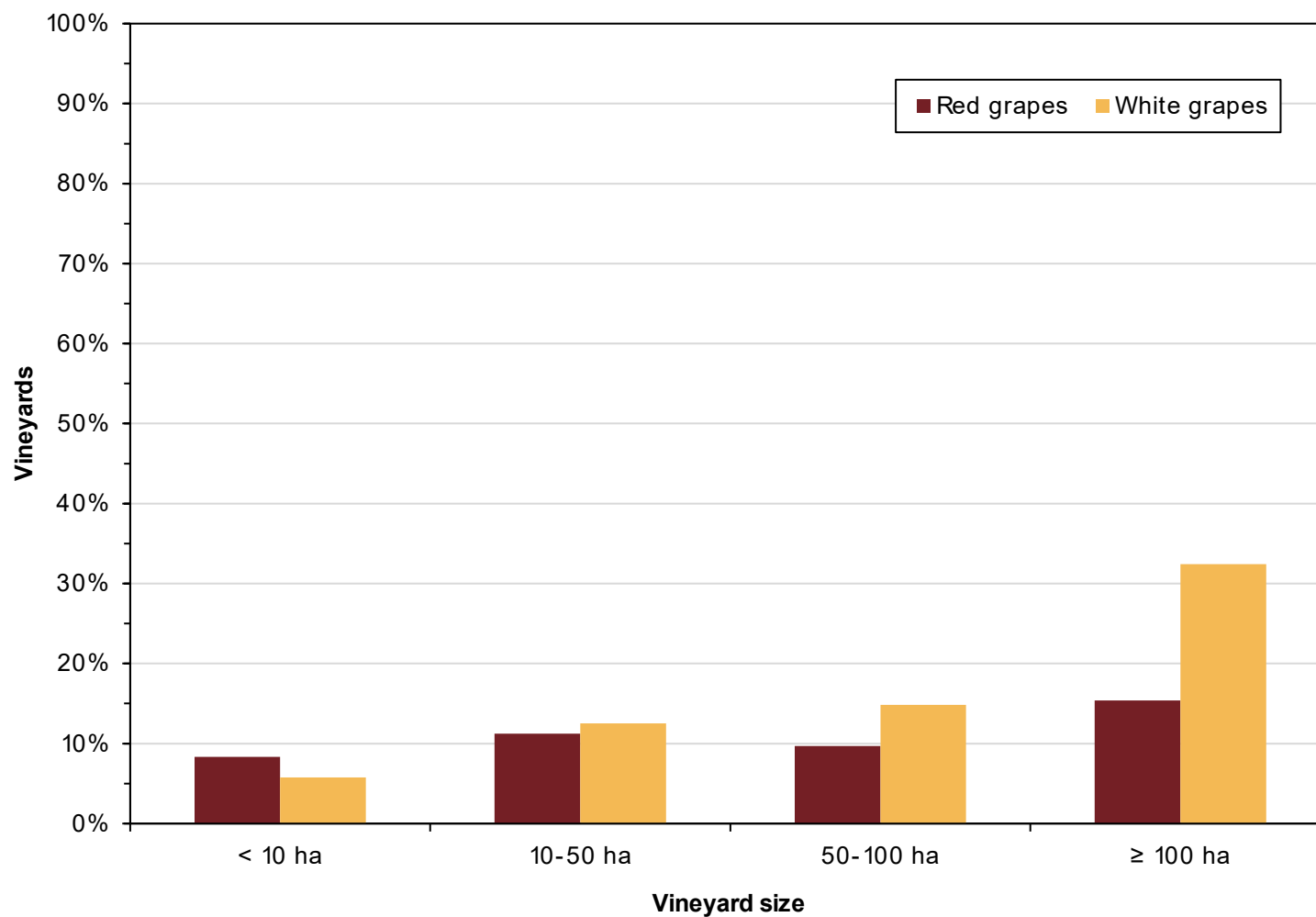
Biological fungicides for botrytis (used at all)



- Biological fungicides for botrytis were the most cited new product to have a positive impact in the 2022 survey (see page 77)
- For respondents selecting 'Other', the most common products mentioned were potassium salts of fatty acids (Ecoprotector) and *Trichoderma harzianum*.

*The question asked whether any of these biological fungicides were used in the vineyards to try and prevent botrytis. This question was not asked in 2016. The plot shows data for 2022.

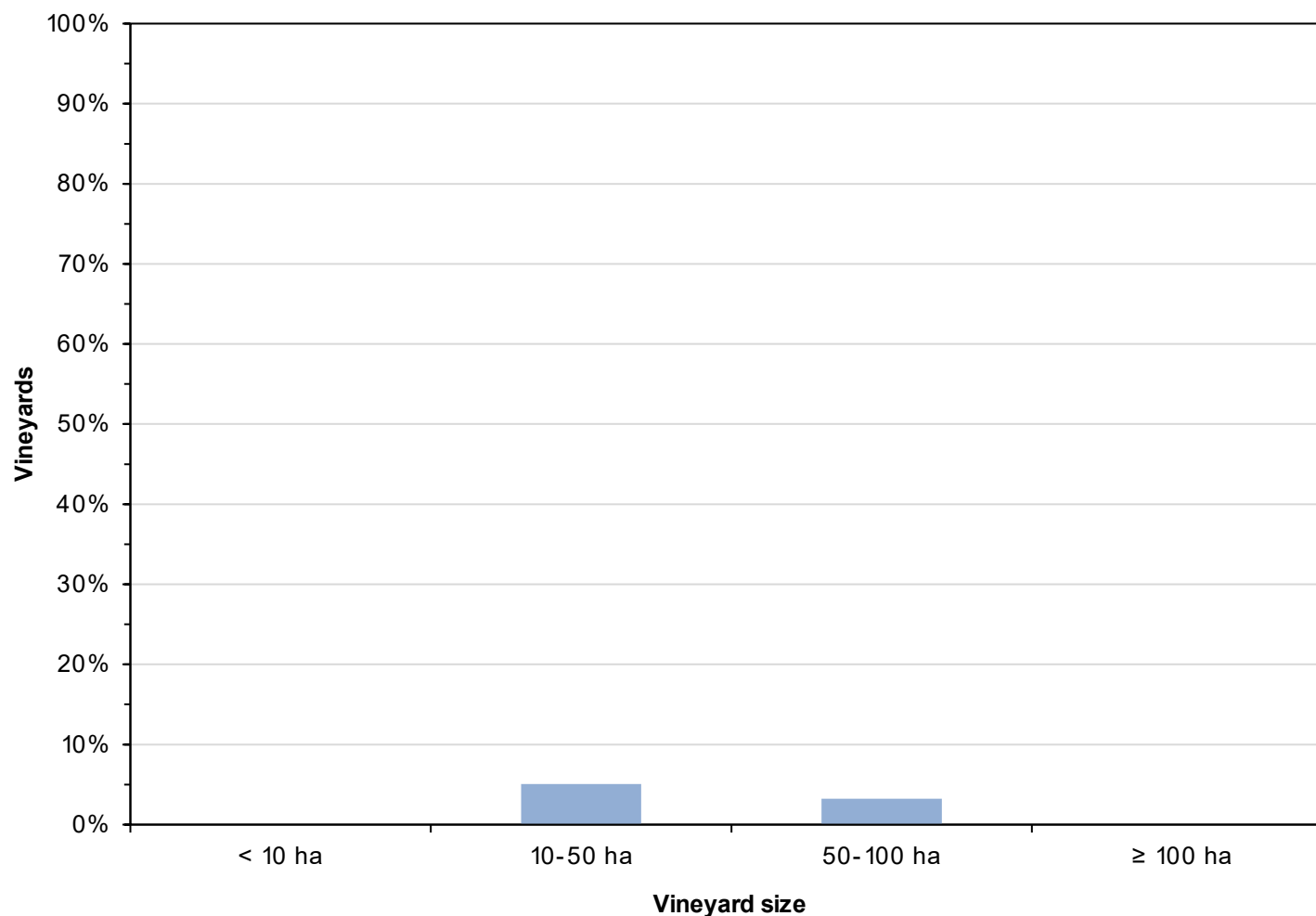
Foliar sprays of sulfur and nitrogen around veraison to enhance thiol aromas (used at all)



- The question explicitly mentioned application around veraison, but it is possible that sprays for this purpose may also have been applied at other times.

*The question asked for each red and white grapes whether some received extra foliar nitrogen and sulfur sprays around veraison to try and enhance tropical thiol aromas. This question was not asked in 2016. The plot shows data for 2022.

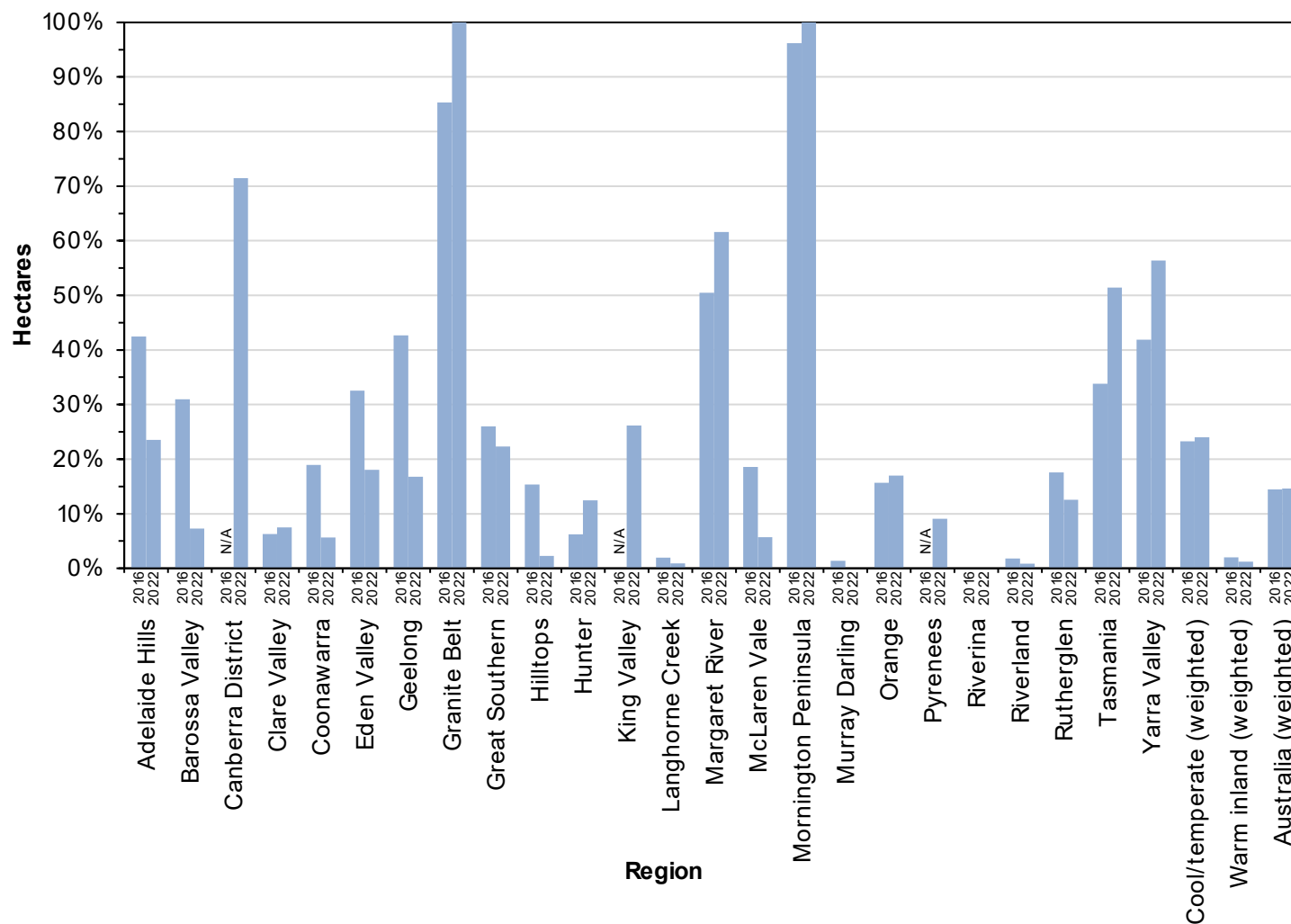
Beneficial insects/mites purchased and released to control pest insects (used at all)



- 6 respondents reported releasing beneficial insects/mites, most commonly for controlling mealybug and scale.
- Beneficial insects/mites listed:
 - *Cryptolaemus*
 - Lacewings
 - *Typhlodromus doreenae* (Doreen)
 - *Trichogramma*
 - Mites

*The question asked whether any beneficial insects were purchased and then released in vineyards to control pest insects, and if yes, what beneficial insects were released and what pest insects were they managing. This question was not asked in 2016. The plot shows data for 2022.

Shoot thinning



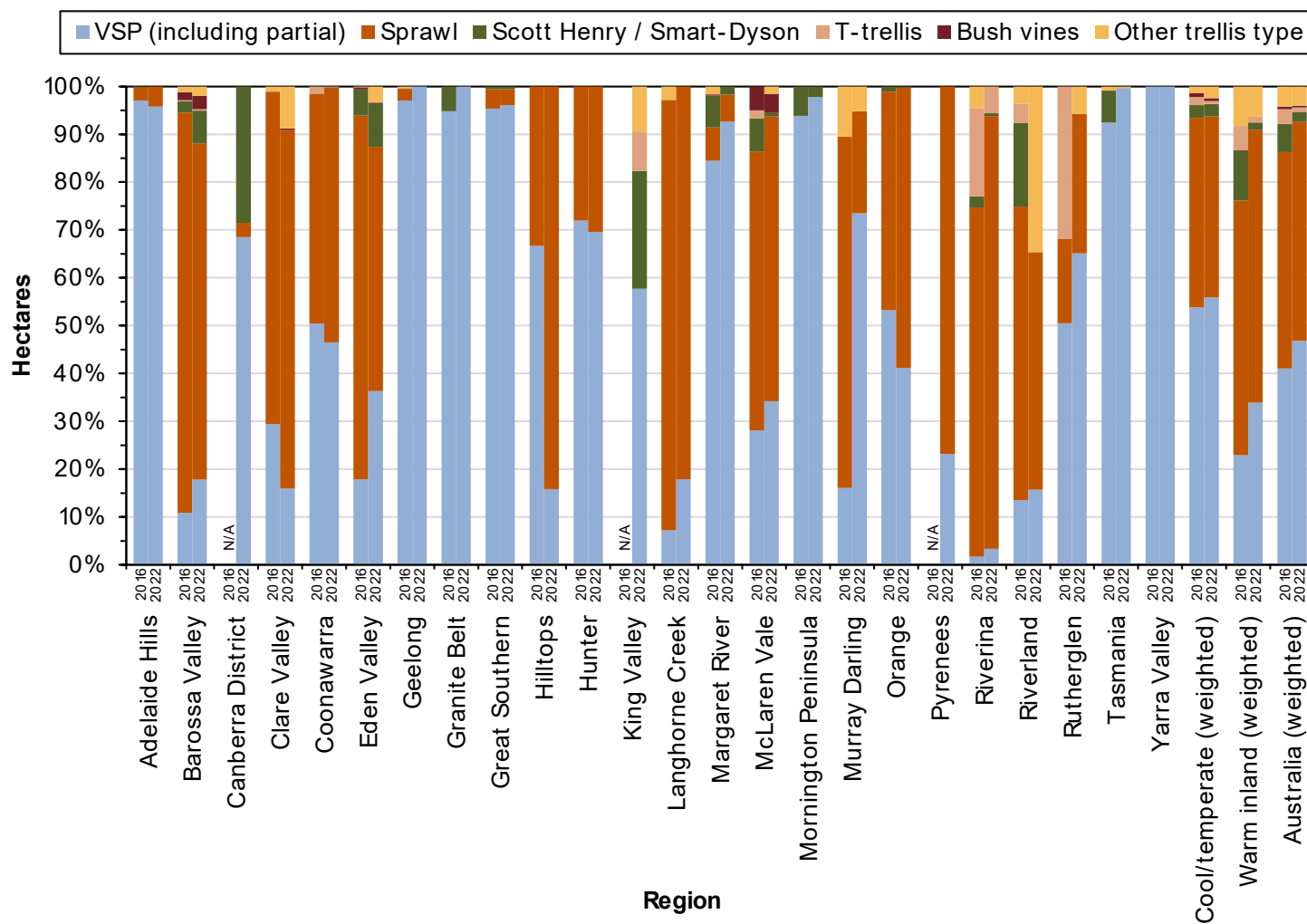
Weighted values for Australia

	2016	2022
Shoot thinning	14%	15%
Mechanisation	1.2%	0.2%

- Aggregate data was similar in the 2022 and 2016 surveys.
- Negligible shoot thinning was performed mechanically in both surveys.
- Of those respondents that performed some shoot thinning in 2022, 67% said that the amount was fairly typical, 13% slightly more, and 13% a lot more. In the 2016 survey, 85% of respondents said that the amount performed was fairly typical.

*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/six years (a lot less, slightly less, fairly typical, slightly more, a lot more). The level of mechanisation was calculated from the area mechanically shoot thinned divided by the total area shoot thinned.

Generalised training/trellis system



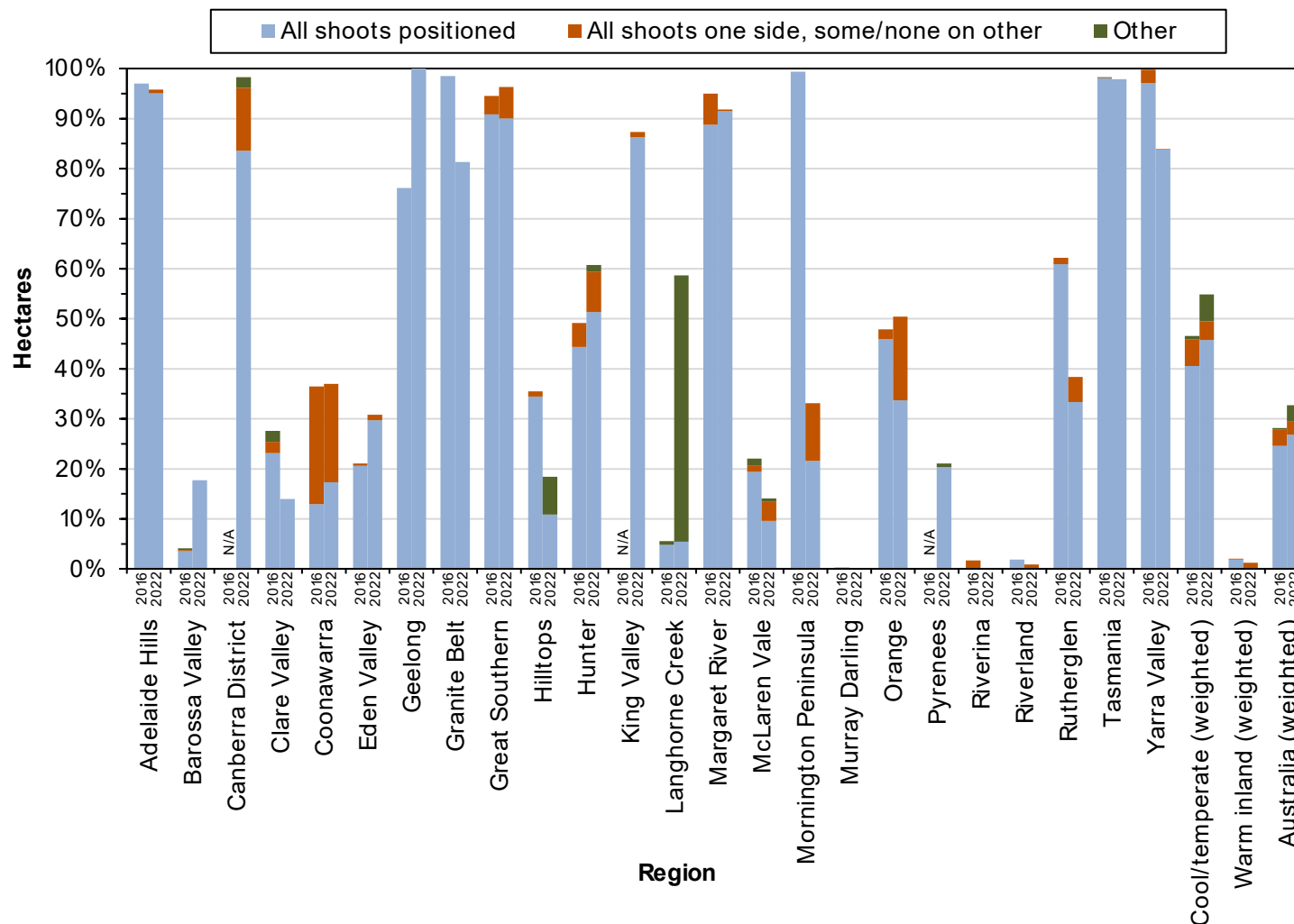
Weighted values for Australia

	2016	2022
VSP (incl. partial)	41%	47%
Sprawl	45%	46%

- Aggregate data was similar in the 2022 and 2016 surveys. There were slight reductions in use of rarer systems like Scott Henry, Smart-Dyson and T-Trellis, but this change could just relate to different vineyards responding to the surveys.

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

Shoot positioning/wire lifting



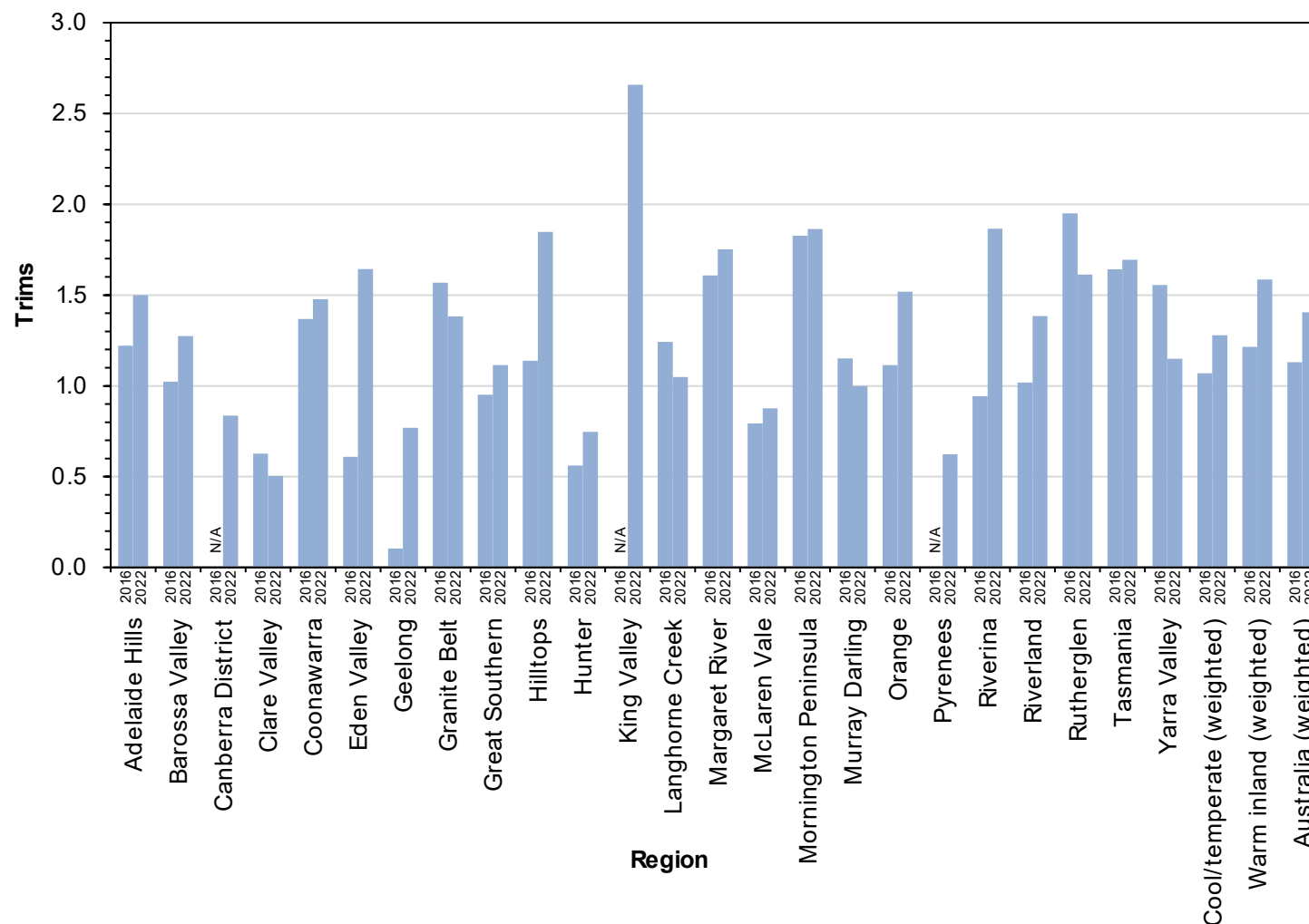
Weighted values for Australia

	2016	2022
Shoot positioning	27%	33%
Mechanisation	6%	5%

- Aggregate data was similar in the 2022 and 2016 surveys.
- Notably, still only a very small proportion of shoot positioning is being performed mechanically (only 5% of the 33% of area that is shoot 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. Users that had answered that some shoot positioning was performed were asked to select from a menu to the nearest 10% what % of shoot positioning/wire lifting was performed by machine vs by hand. The hectares of shoot positioning relative to the total were then calculated.

Average number of trims



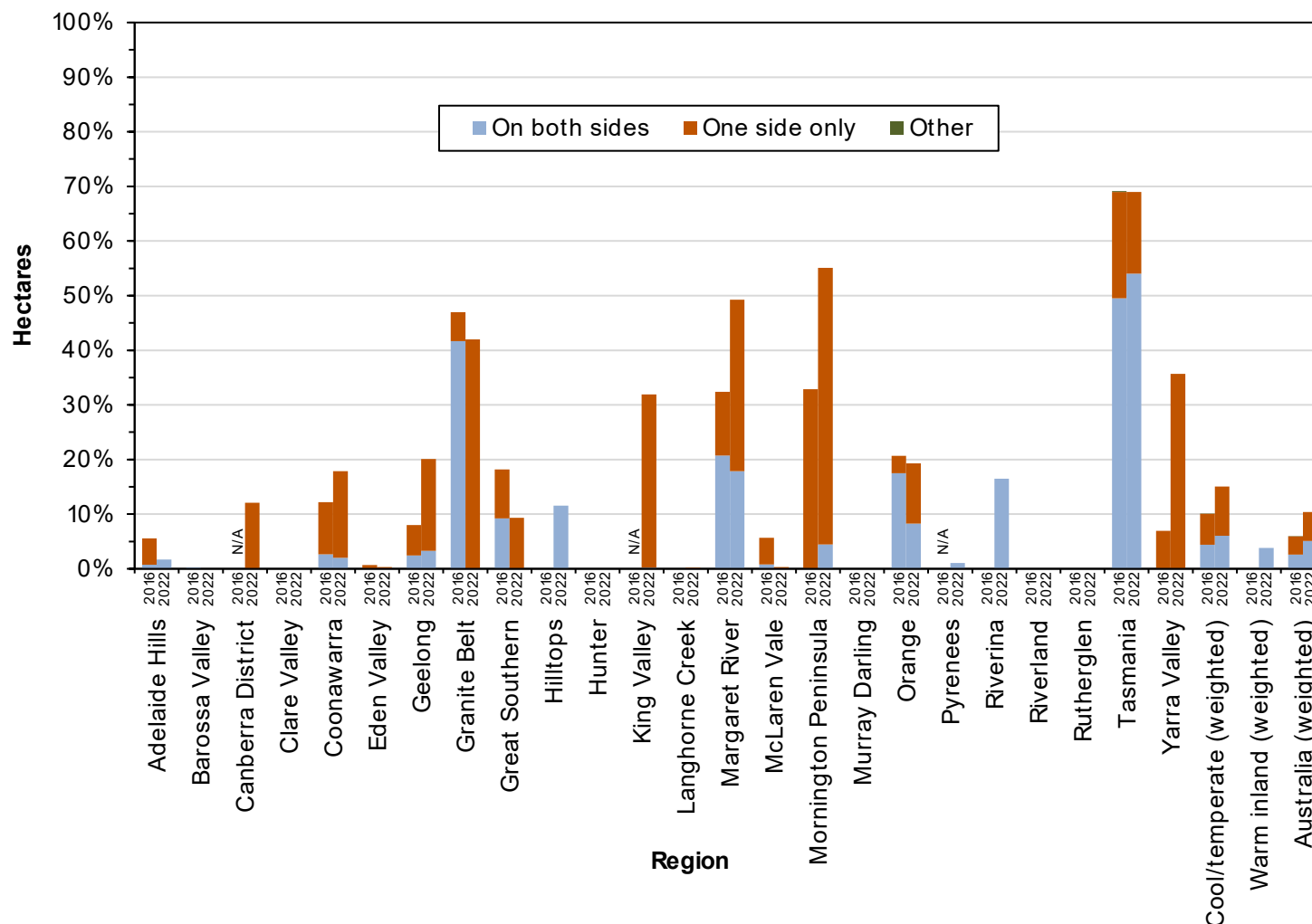
Weighted values for Australia

	2016	2022
Average trims	1.1	1.4

- Aggregate number of trims was slightly higher in 2022 than 2016.
- 70% of respondents said that the number of trims was fairly typical of the last six years, while 23% said it was slightly more or a lot more. In 2016, 80% had said the number of trims was fairly typical of the prior five years. Differences in number between 2016 and 2022 are likely season-related rather than a practice change.

*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/six years (a lot less, slightly less, fairly typical, slightly more, a lot more).

Leaf plucking



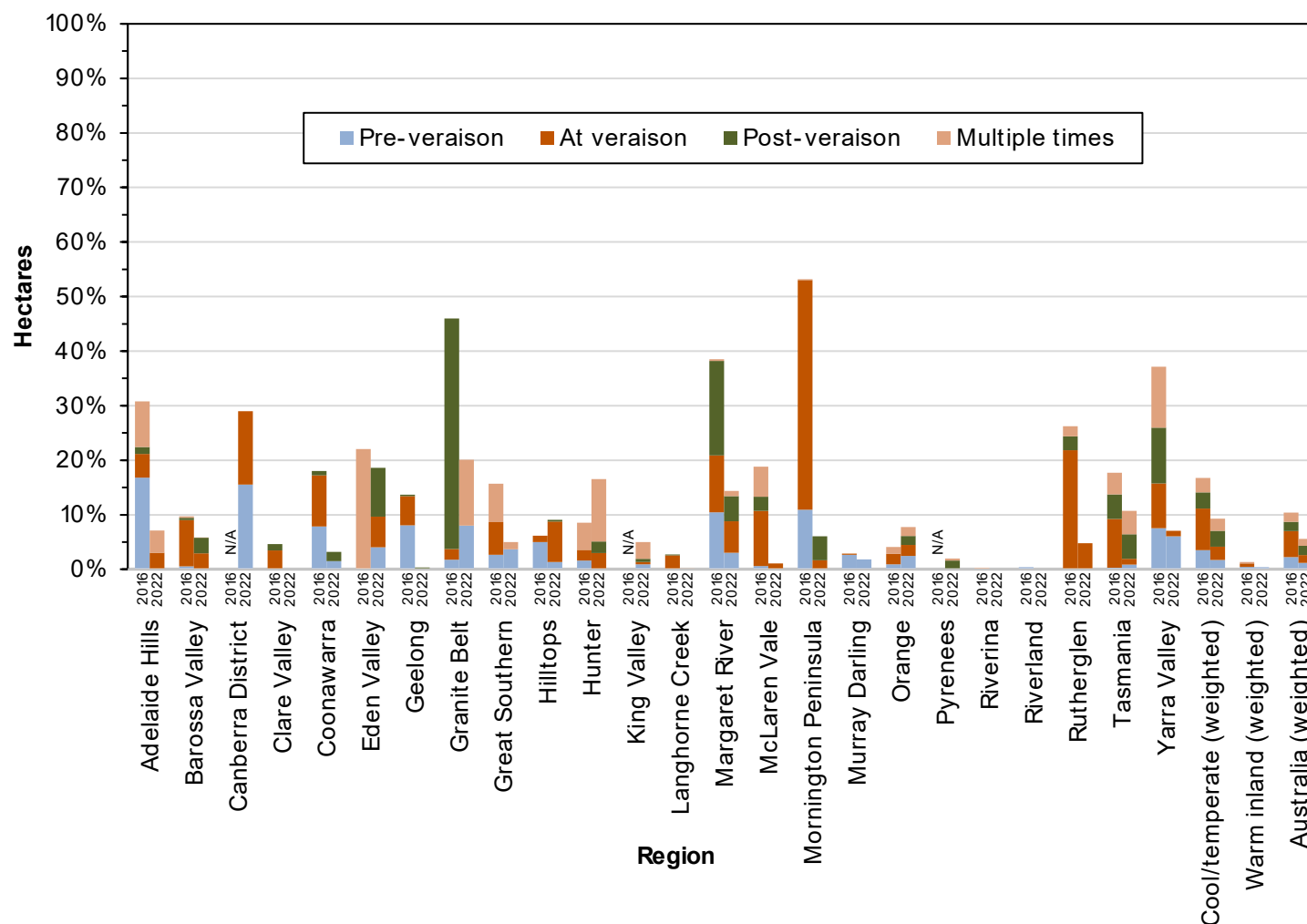
Weighted values for Australia

	2016	2022
Leaf plucking	6%	10%
Mechanisation	54%	71%

- Slightly more leaf plucking was performed in the 2022 survey than in the 2016 survey, but it was still a relatively uncommon practice.
- The proportion of mechanisation was higher in this 2022 survey, with 71% of leaf plucking being performed mechanically in the 2021/2022 season.

*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. Users that had answered that some leaf plucking was performed were asked to select from a drop-down 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 were then calculated.

Crop thinning



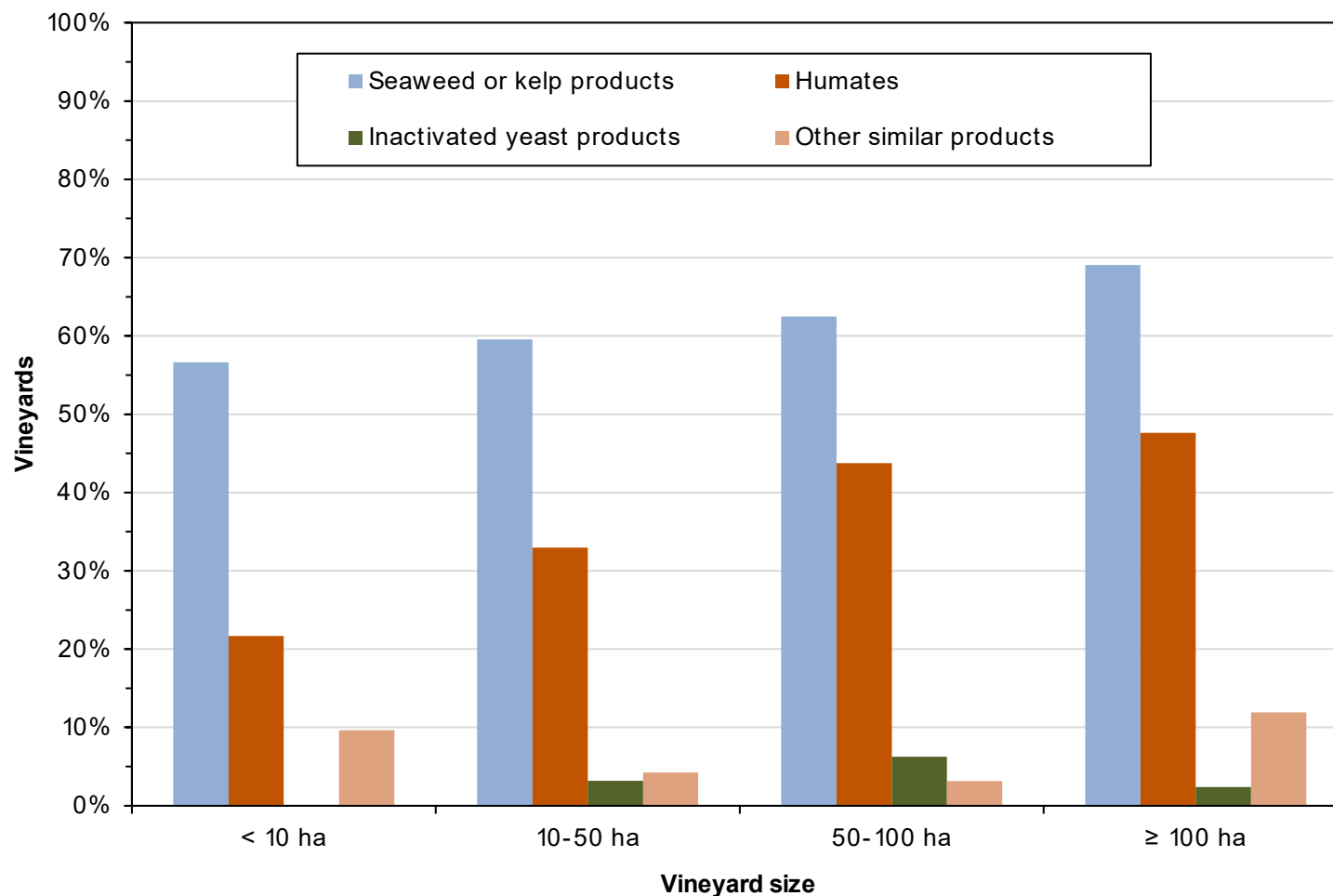
Weighted values for Australia

	2016	2022
Crop thinned	10%	6%
Mechanisation	6%	6%

- Slightly less crop thinning was performed in the 2022 survey than in the 2016 survey.
- The proportion of mechanisation was low and similar in both surveys.

*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. Users that had answered that some crop thinning was performed were asked to select from a drop-down 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 were then calculated.

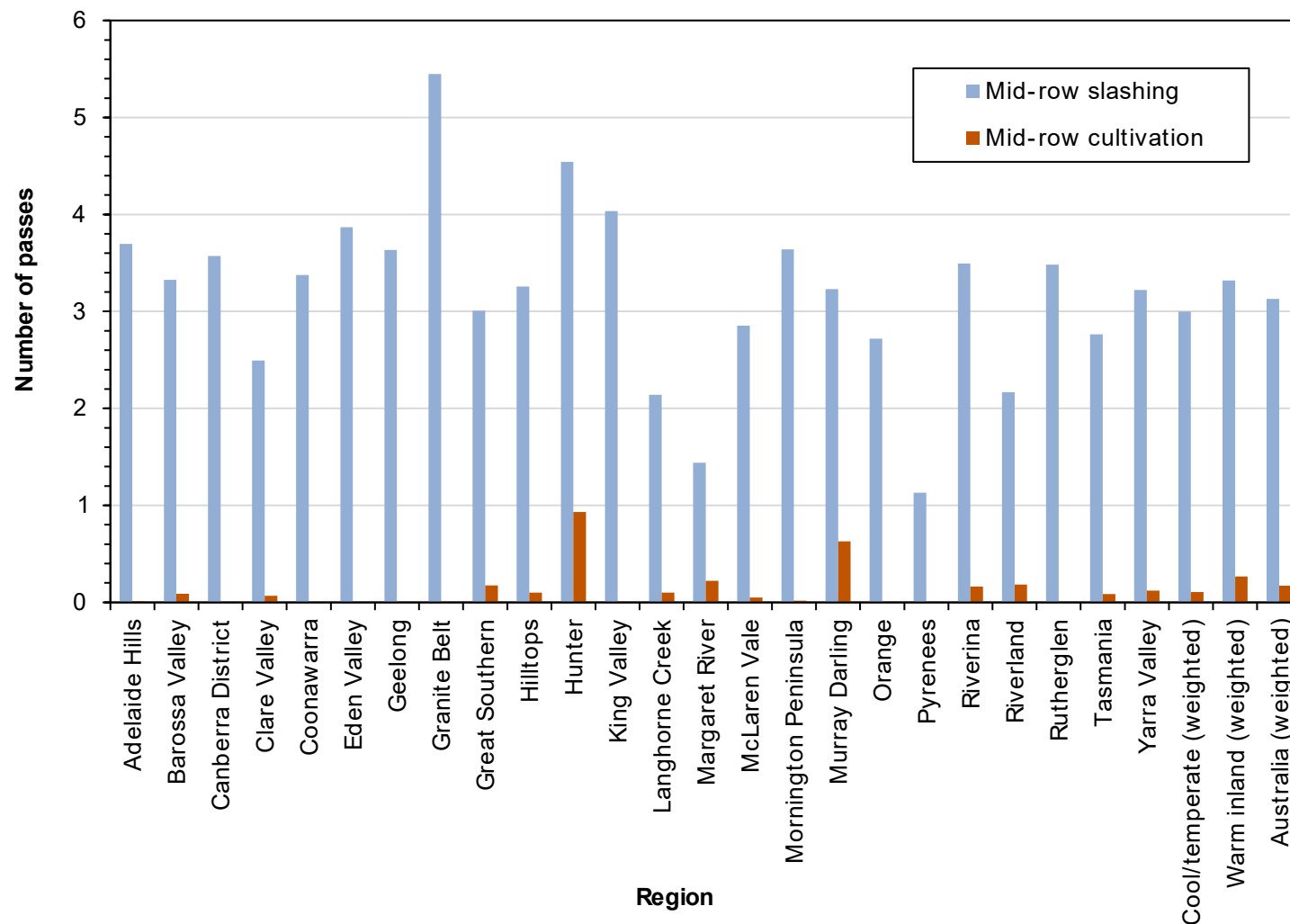
Nutrition and plant stimulant products (used at all)



- Seaweed/kelp products and humates were quite commonly used.
- Inactivated yeast products were only used to a small extent.

*The question asked whether any of these products were applied. This question was not asked in 2016. The plot shows data for 2022.

Average number of mid-row slashing and cultivation passes



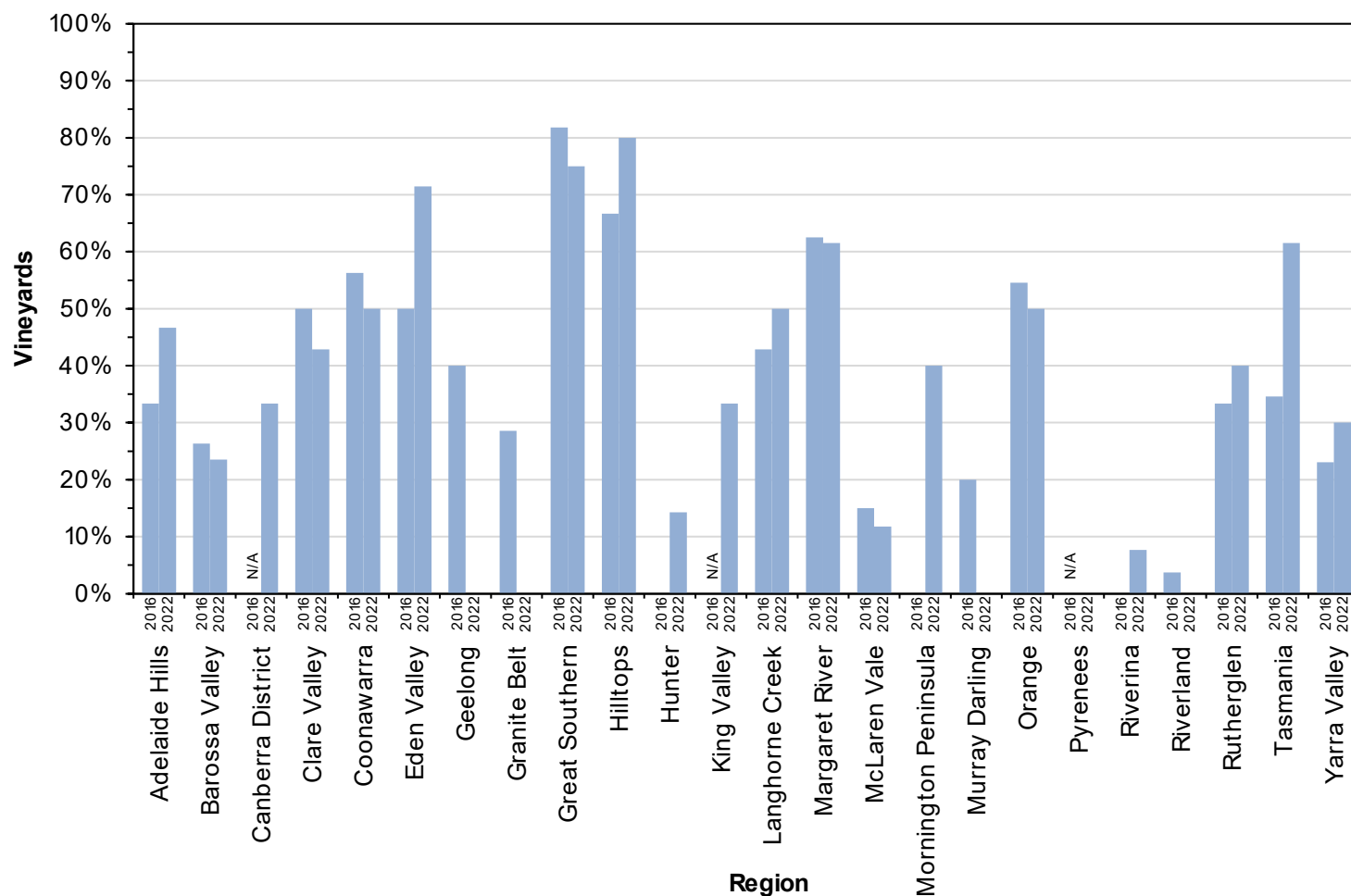
Weighted values for Australia

	2016	2022
Slashing passes	N/A	3.1
Cultivation passes	N/A	0.2

- Mid-rows were more commonly managed by slashing than cultivation.
- Around 60% described the number of passes as fairly typical of the last 6 years, with 20% saying the number of passes was slightly more and 10% a lot more.
- This was a new question in the 2022 survey. A related question in the 2016 survey did however show that slashing/mowing was the dominant means of managing mid-rows.

*The first question asked whether any mid-row slashing was performed in the season and if respondents answered yes, they were asked to specify the area that was slashed 0, 1, 2, 3, 4, 5 or more than 5 times. An average number for each region was calculated by weighting the slashings according to the relative areas. Users were also asked to select how typical the number of slashings was of the last six years (a lot less, slightly less, fairly typical, slightly more, a lot more). A similar question and calculation method was asked for the number of cultivations, with the user asked to specify the area that was cultivated 0, 1, 2, 3, or more than 3 times. These questions were not asked in 2016.

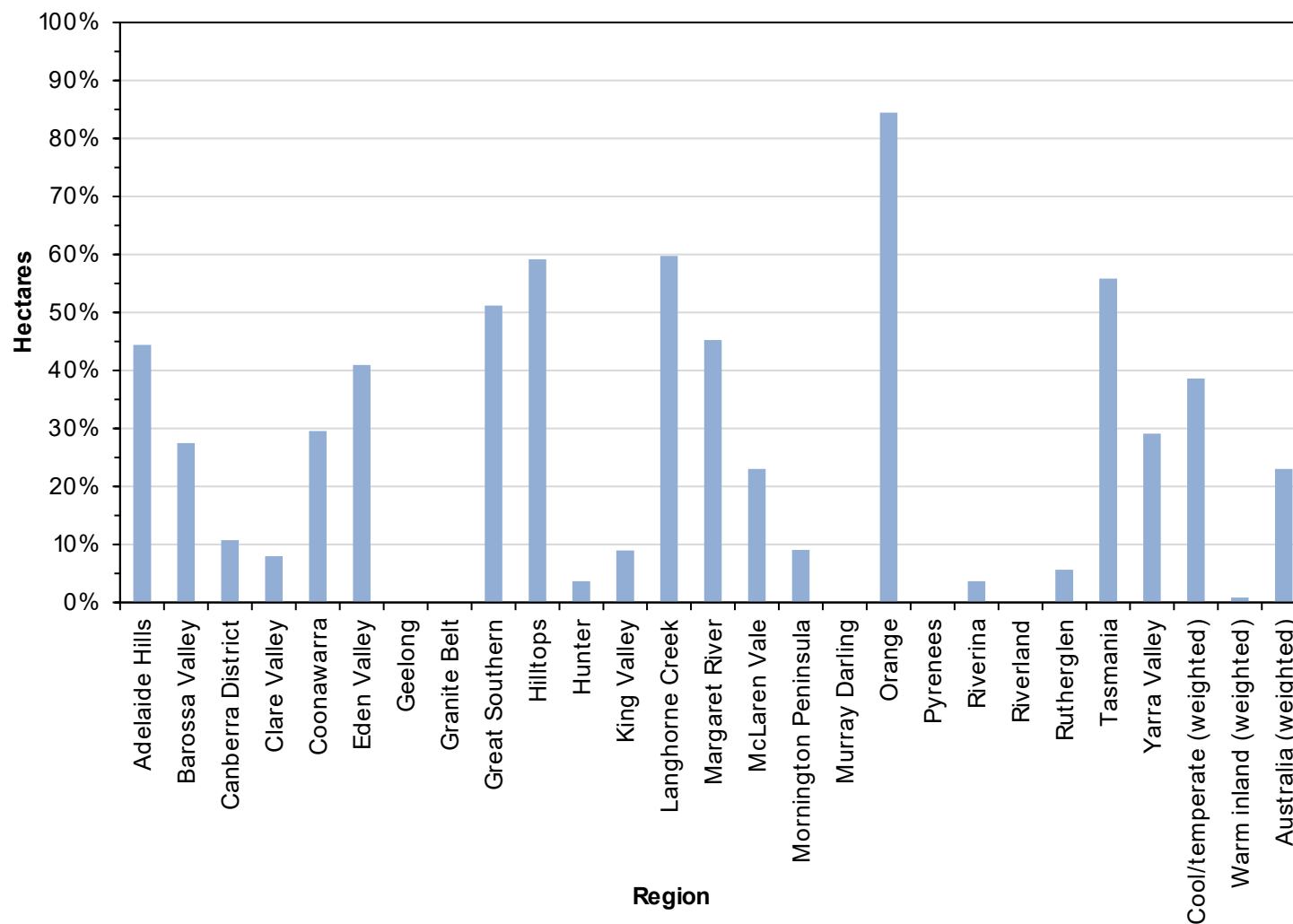
Livestock grazing (used at all)



- Livestock grazing was used by a similar proportion of respondents in 2022 and 2016.
- A new question was added in 2022 and is reported on the next page to understand the area grazed not just whether vineyards used livestock grazing at all.

*The question asked whether any livestock were grazed in the vineyards (yes/no).

Livestock grazing vineyard area



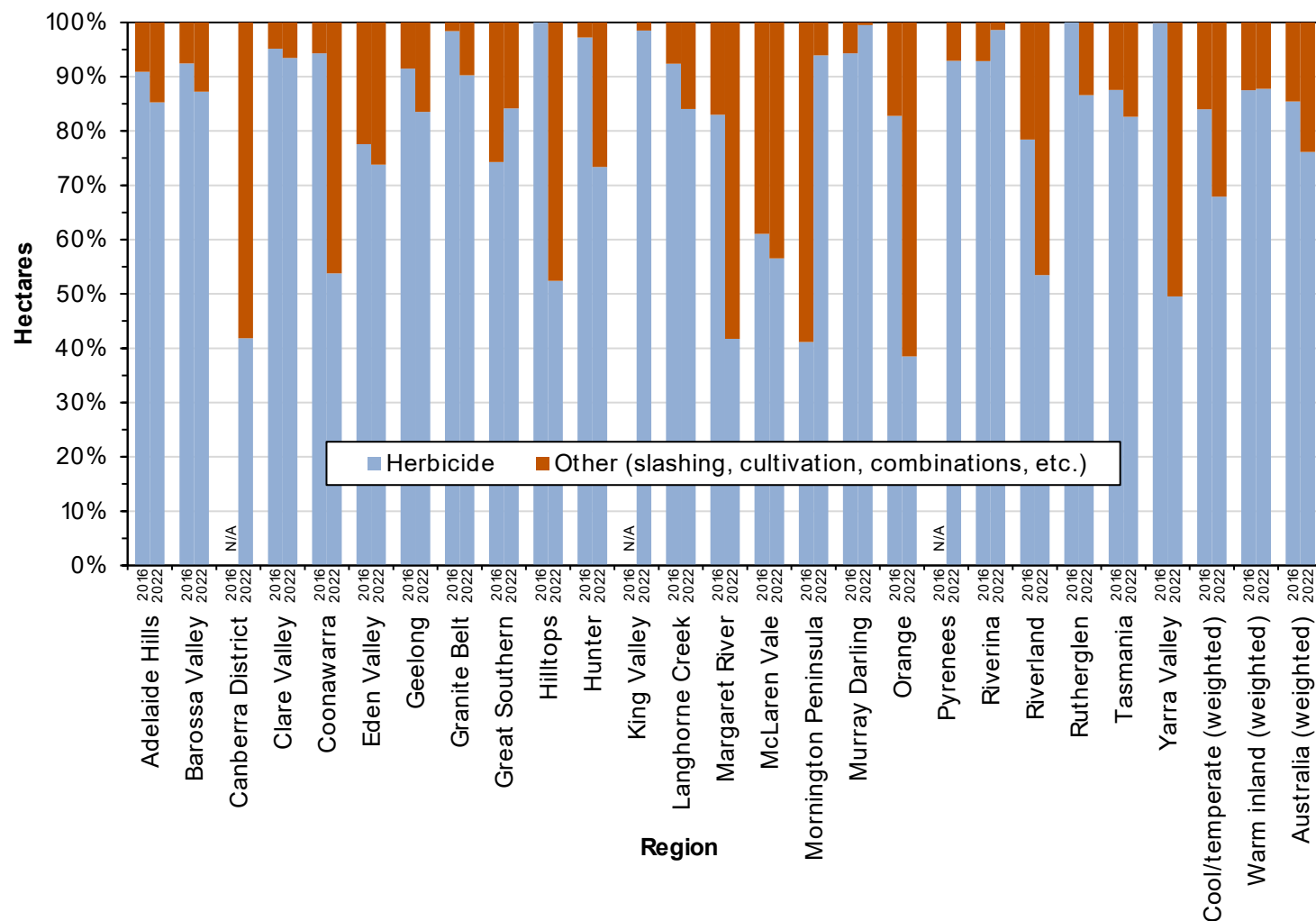
Weighted values for Australia

	2016	2022
Livestock grazing	N/A	23%

- Livestock grazing varied between regions with 23% of Australia's vineyard area having some grazing.
- This was a new question in the 2022 survey to establish the actual area of vineyards where livestock grazed.

*If respondents selected that yes some livestock grazing was performed, they were asked to enter the areas that were grazed and not grazed. This question was not asked in 2016.

Under-vine strip management



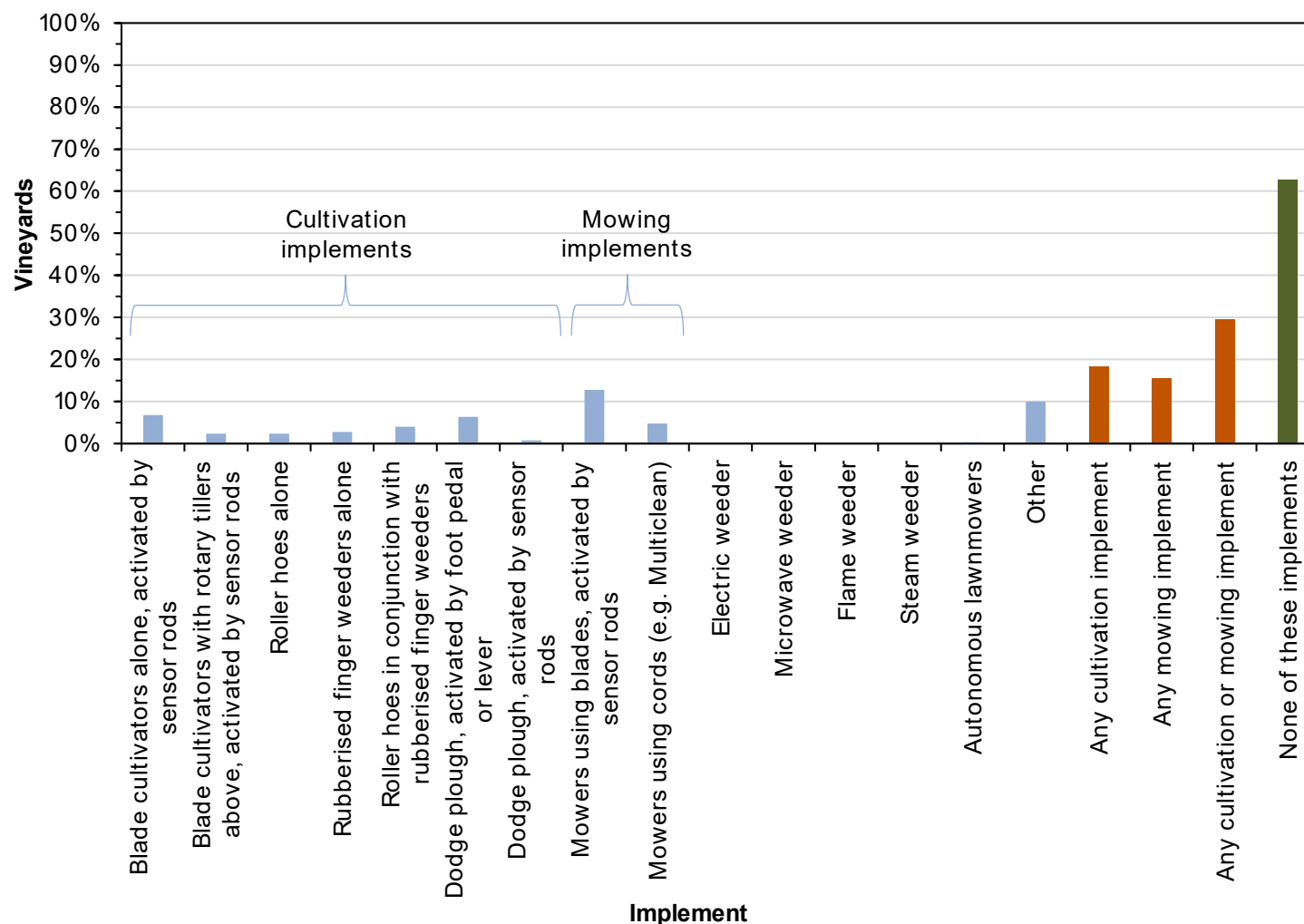
Weighted values for Australia

	2016	2022
Herbicide	85%	76%

- Herbicide remains the dominant technique for under-vine weed management, but its use appears to have decreased to a small extent between the 2016 and 2022 surveys.

*Respondents were asked to select what under-vine management methods were used for the 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 just herbicide or other techniques.

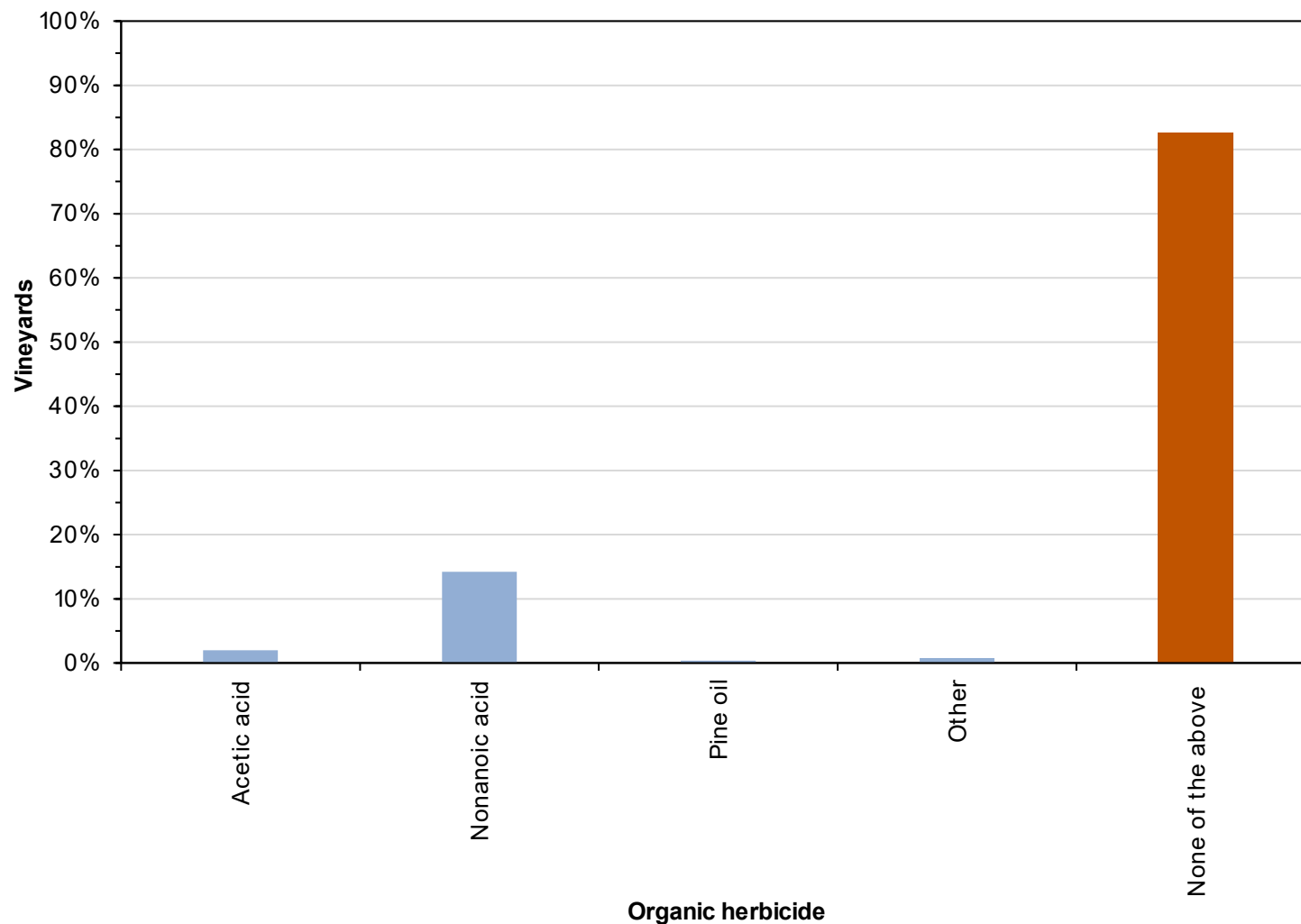
Under-vine weeding implements (used at all)



- 18% of respondents used at least one under-vine cultivation implement, and 16% used at least one mowing implement.
- Blades were the most common cultivation tool, followed closely by traditional manually activated dodge ploughs.
- 10% of respondents selected 'Other', with the most common description being a hand-held whipper-snipper/brush cutter, with a few also listing vigorous/wire sweeping.
- No respondents used electric, microwave, flame or steam weeders.
- 63% of respondents used none of the implements listed.

*Respondents were asked to select which under-vine management tools were used in the season. This question was not asked in 2016. The plot shows data for 2022.

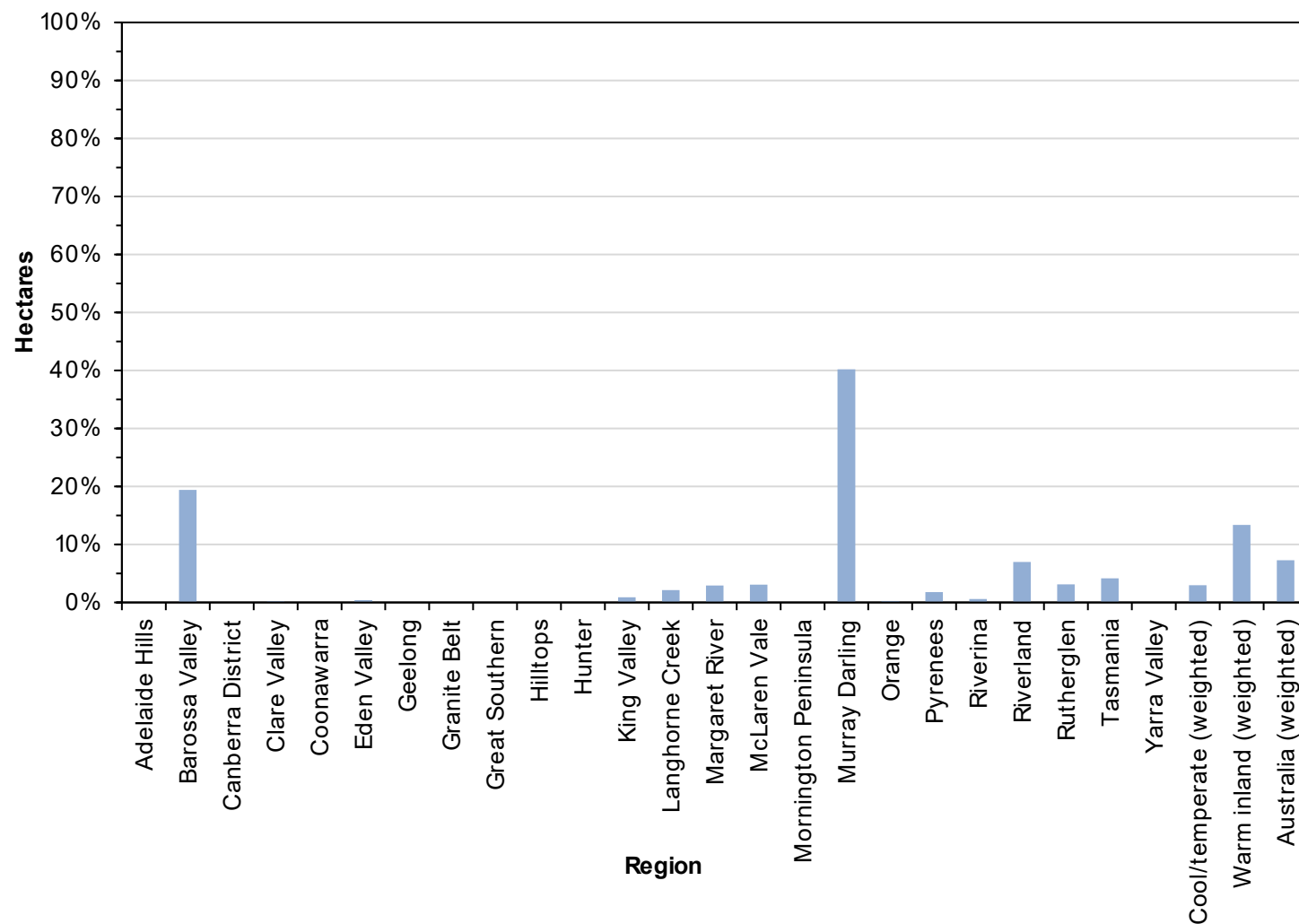
Under-vine organic herbicides (used at all)



- 83% of respondents did not use any organic herbicides.
- The most popular organic herbicide was nonanoic acid, with 14% of respondents using products containing this active ingredient.
- A few respondents noted the poor performance of nonanoic acid as a herbicide.

*Respondents were asked to select which organic herbicides were used in the season. This question was not asked in 2016. The plot shows data for 2022.

Under-vine sowing of cover crops



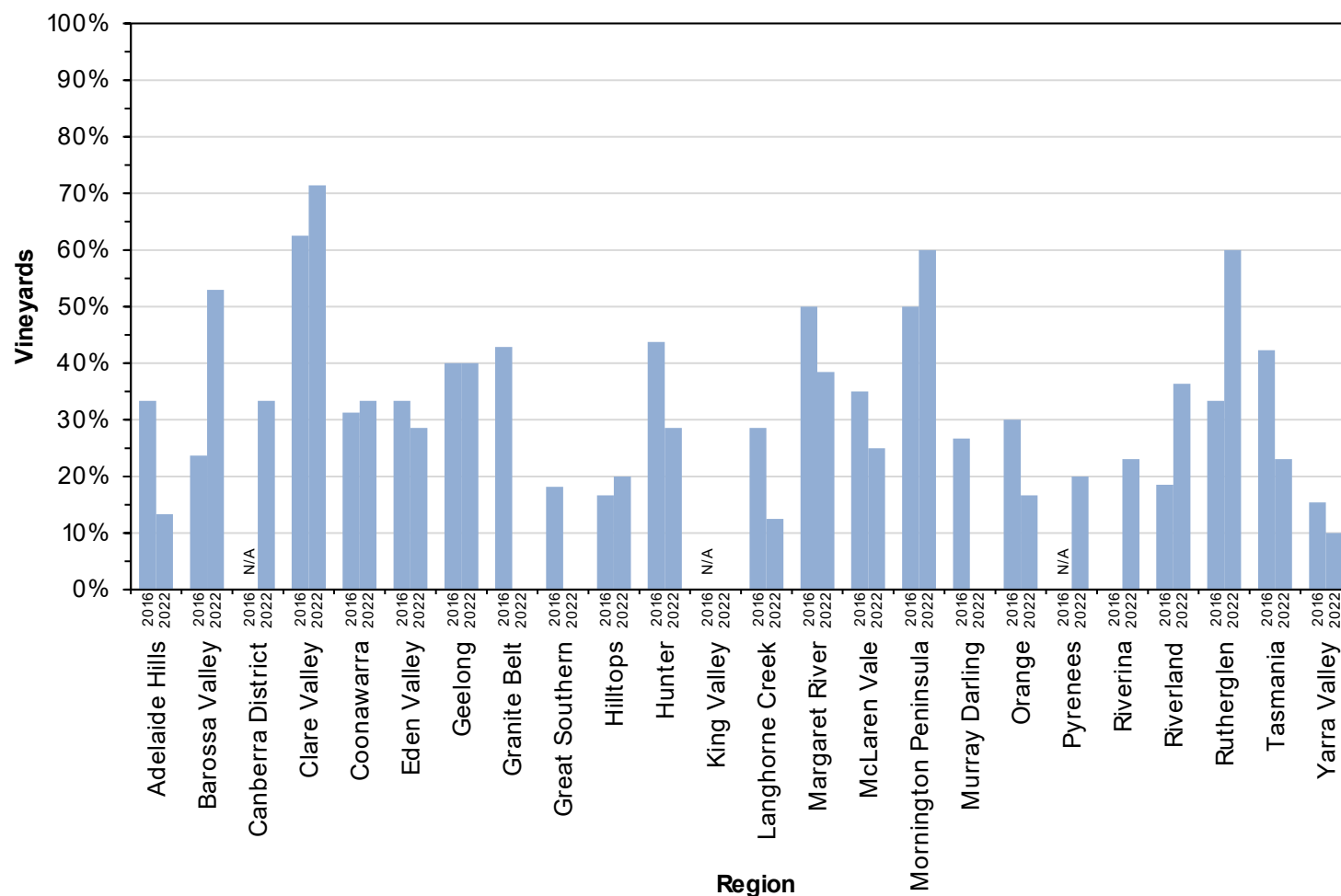
Weighted values for Australia

	2016	2022
Sowing under-vine	N/A	7%

- What counts as under-vine sowing was not explicitly defined in the question, so there is a possibility that results are overstated and capture some mid-row sowing.

*Respondents were first asked whether any cover crops were sown under-vine in the season, and if they answered yes, they were asked to enter the areas sown under-vine and not. This question was not asked in 2016. The plot shows data for 2022.

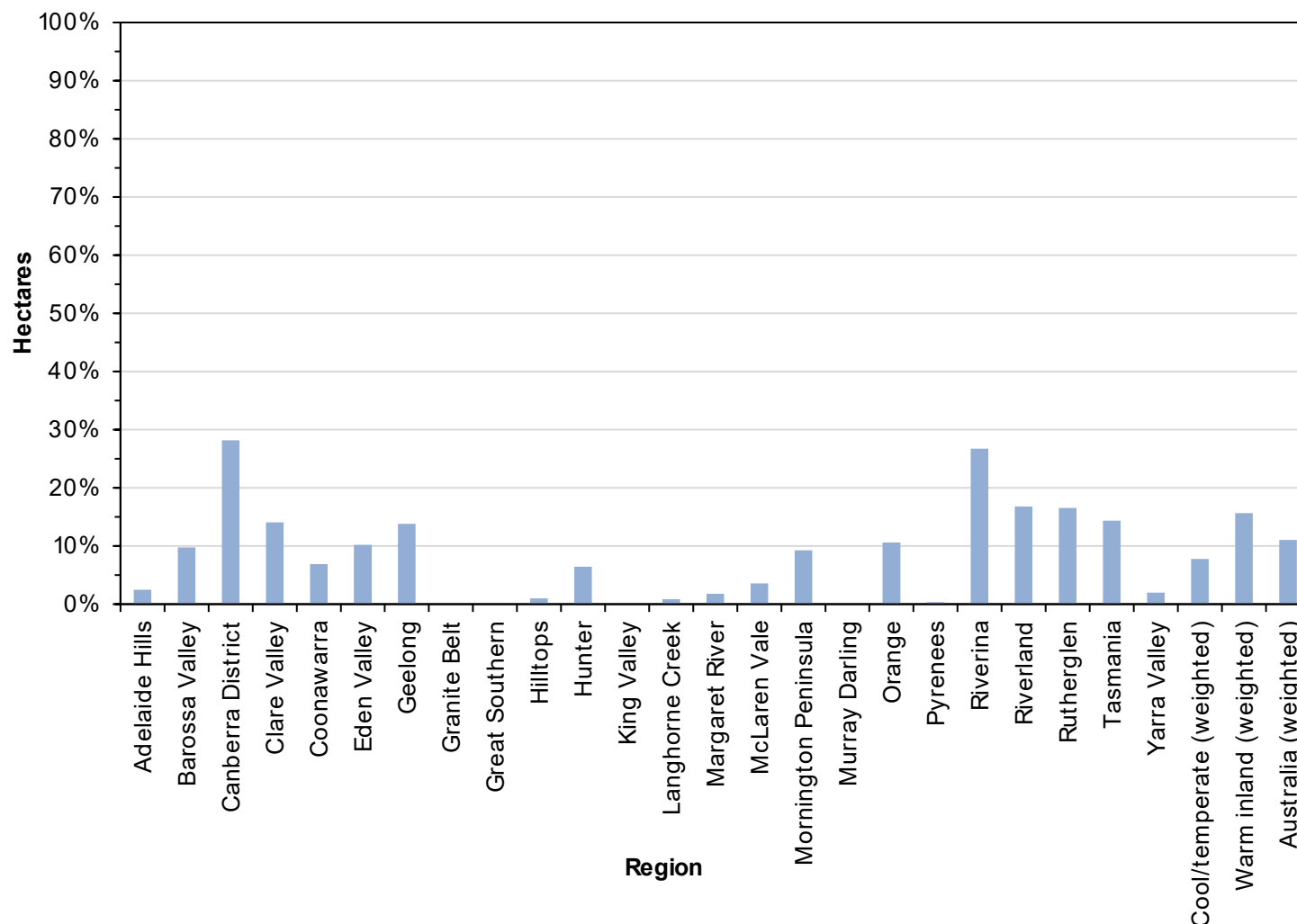
Under-vine strip mulching (used at all)



- Many producers added mulch under-vine to part of their vineyard in both the 2016 and 2022 surveys.
- 57% of those adding mulch used compost, 27% used straw mulch and 27% used another type of mulch, the most common being woodchips.
- A new question was added in 2022 and is reported on the next page to understand the area mulched, not just whether vineyards added any mulch.

*Respondents were asked whether any mulch was applied to under-vine strips during the season. If they answered yes, they were also asked to check boxes on the type of mulch used: Compost, straw and 'Other'.

Under-vine strip mulching vineyard area



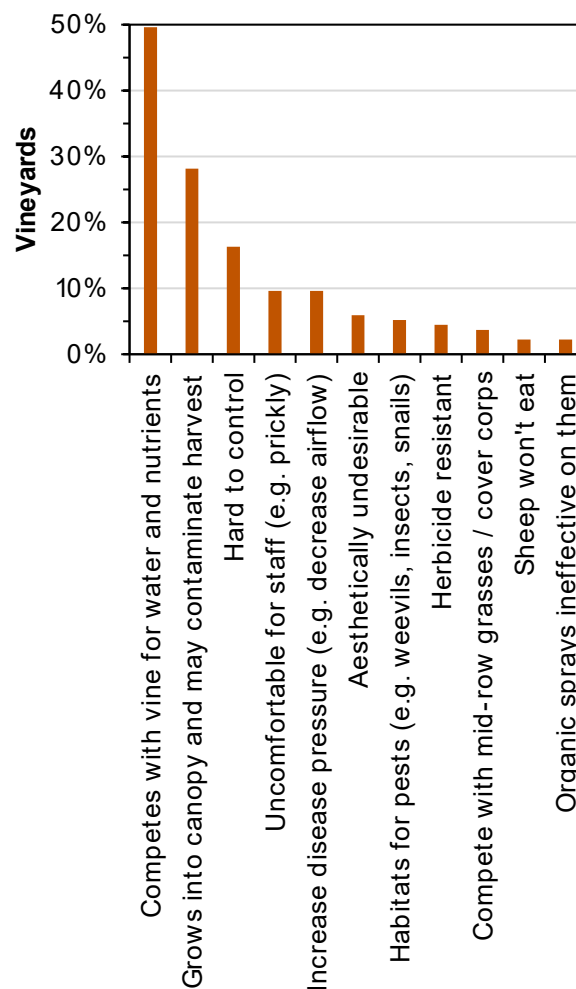
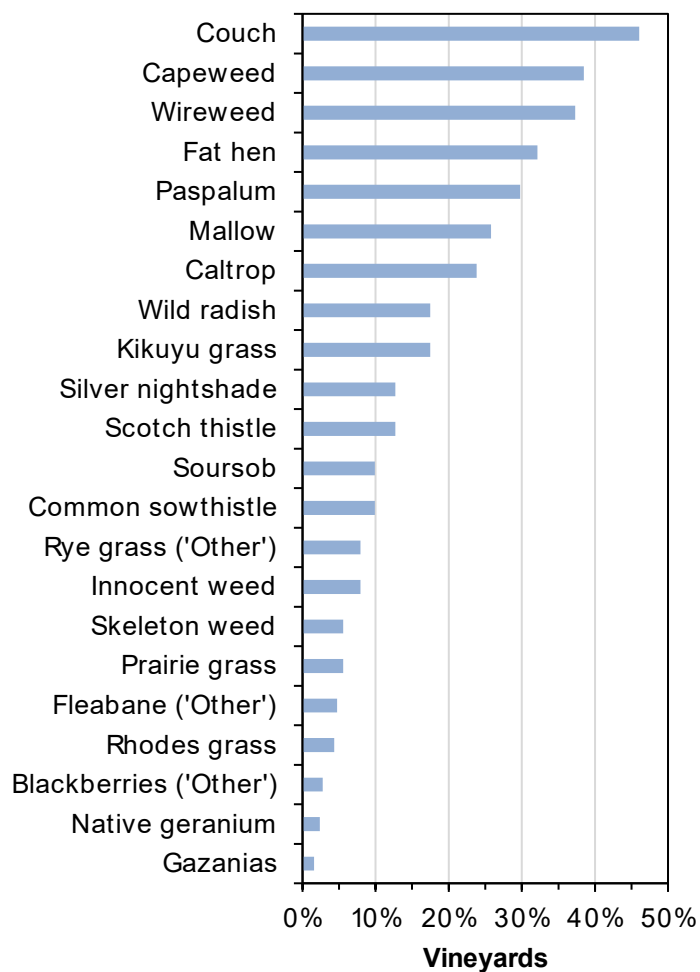
Weighted values for Australia

	2016	2022
Under-vine mulch	N/A	11%

- While many vineyards applied some mulch, only around 11% of the vineyard under-vine areas were mulched in total.
- This was a new question in the 2022 survey to establish the actual area of vineyard area with under-vines receiving mulch, not just whether vineyards added mulch at all.

*Respondents who said that they applied some under-vine mulch were asked to enter what area received mulch and what area did not. This question was not asked in 2016. The plot shows data for 2022.

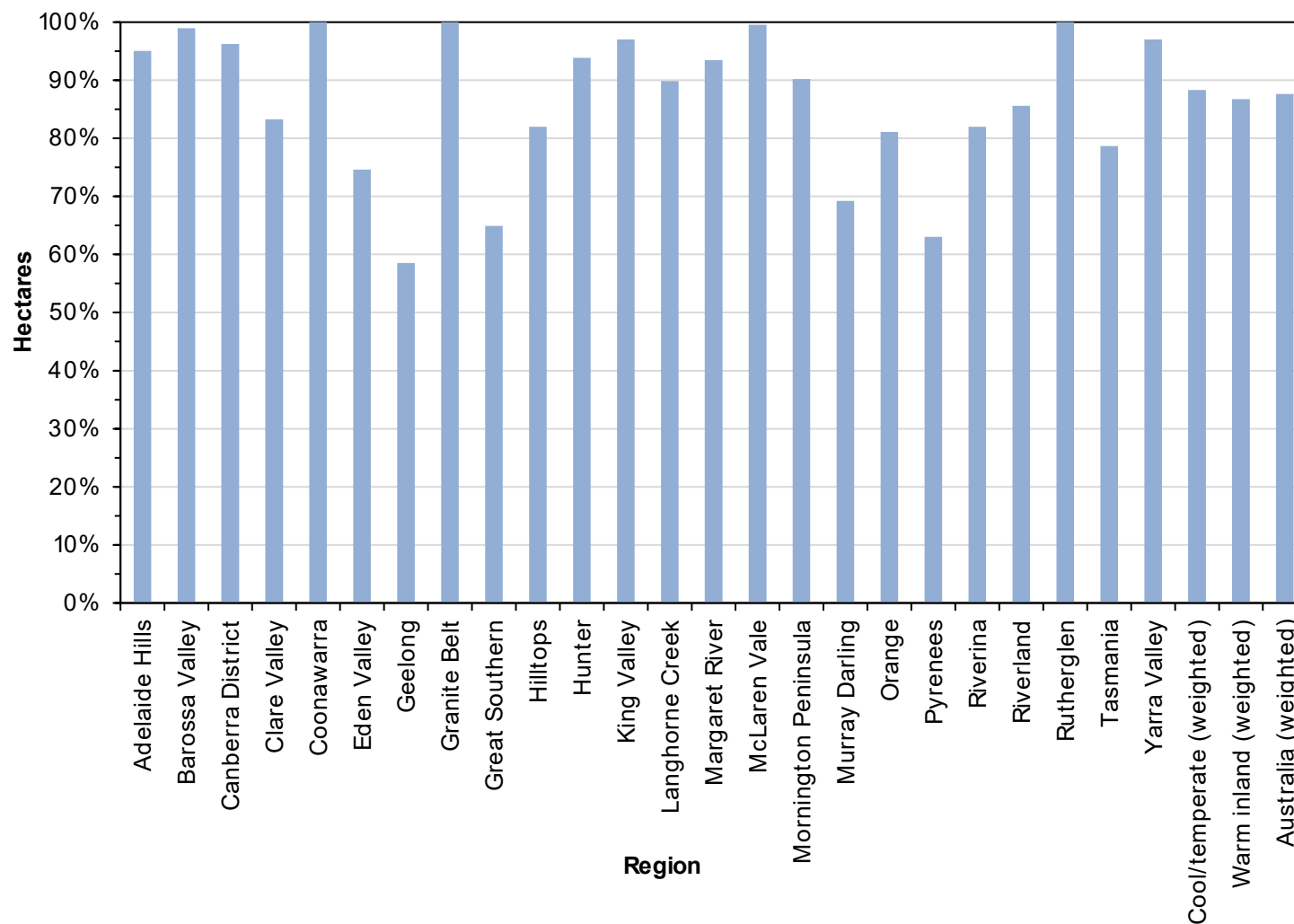
Main weed species causing issues and the issues that they cause



- Many weed species were selected as causing issues, with couch being #1 with 46% of respondents selecting it.
- The two most nominated issues with weeds were competition for water and nutrients and potentially contaminating the harvest.

*Respondents were asked to select from a list, which were the main weed species causing issues in their vineyard. There were also spots to add others, and 3 other options that were raised by more than 2% of respondents have been added to the chart and denoted 'Other'. Respondents also had an open text box where they were asked what issues the selected weed species cause. These responses were grouped into common themes. This question was not asked in 2016. The plot shows data for 2022.

Mobile phone coverage



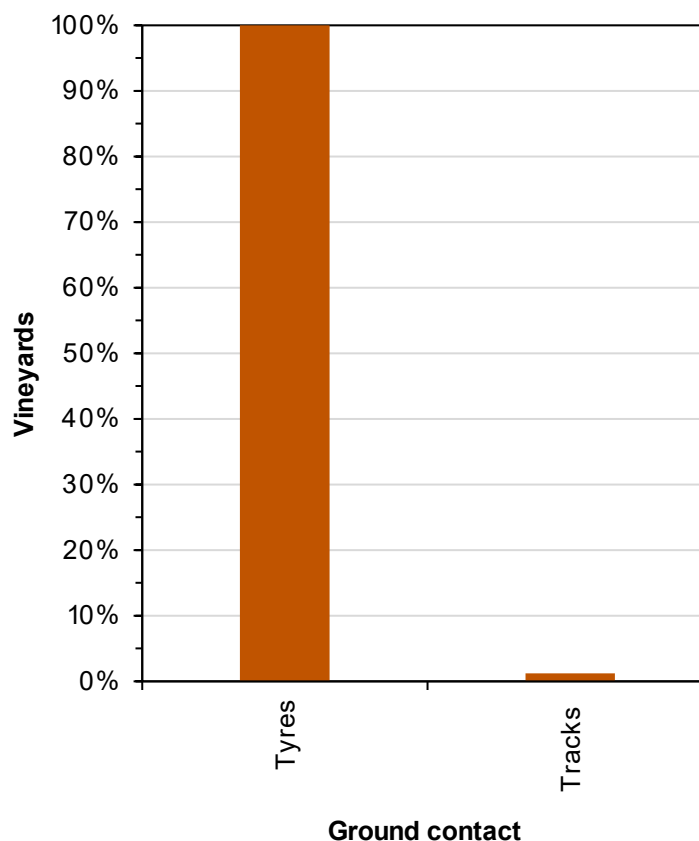
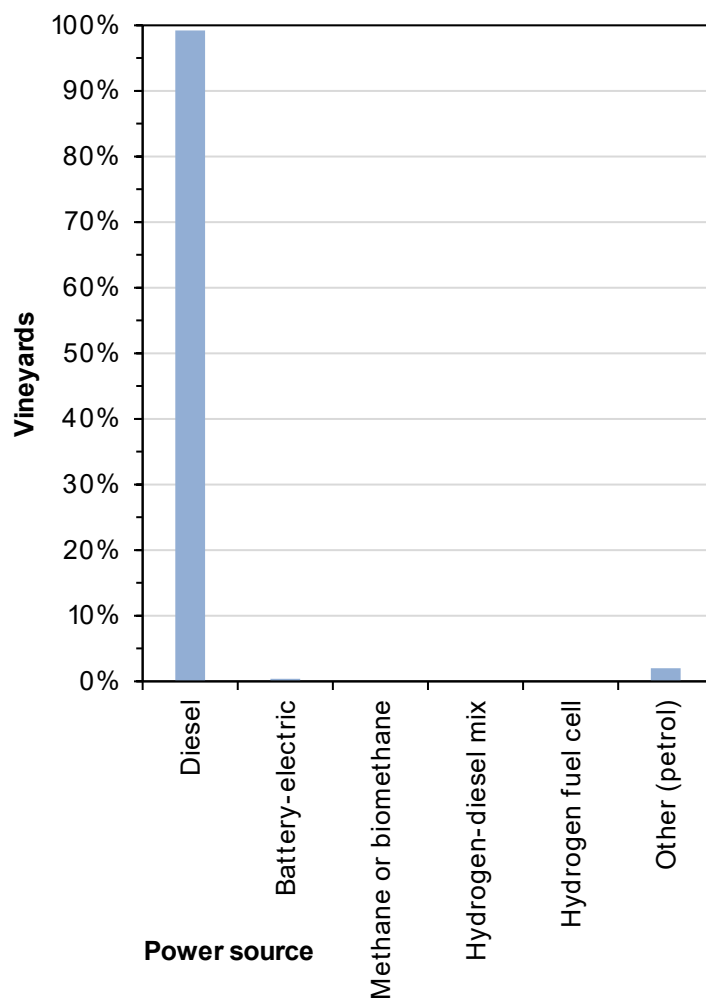
Weighted values for Australia

	2016	2022
Mobile coverage	N/A	88%

- Mobile phone coverage varied between regions.

*Respondents were asked to select from a list the percentage of their vineyard area that has mobile phone coverage. This question was not asked in 2016. The plot shows data for 2022.

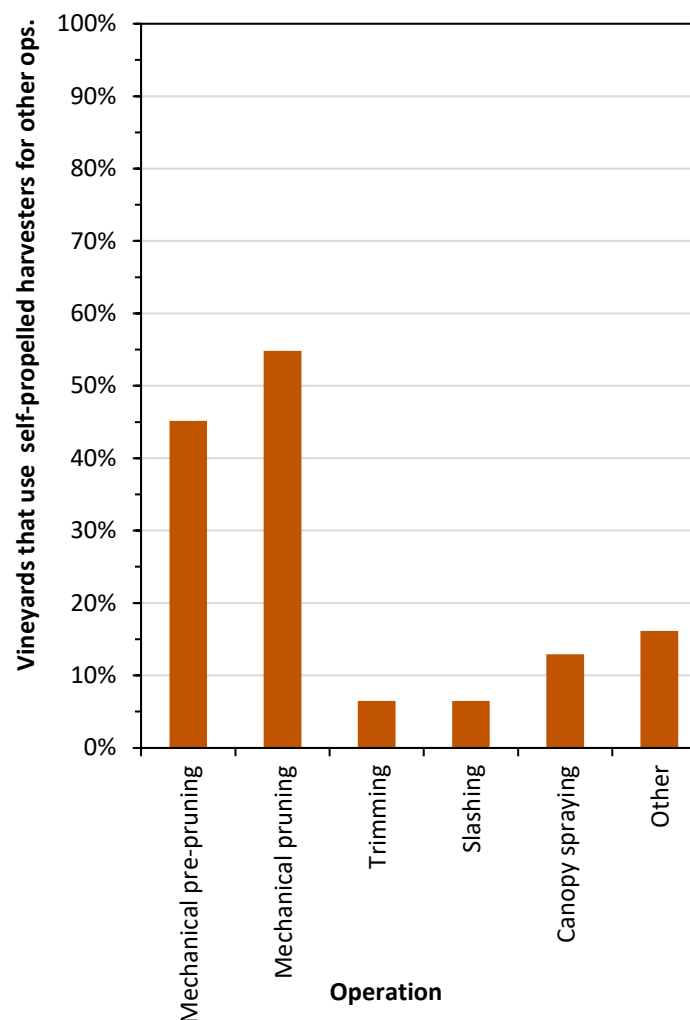
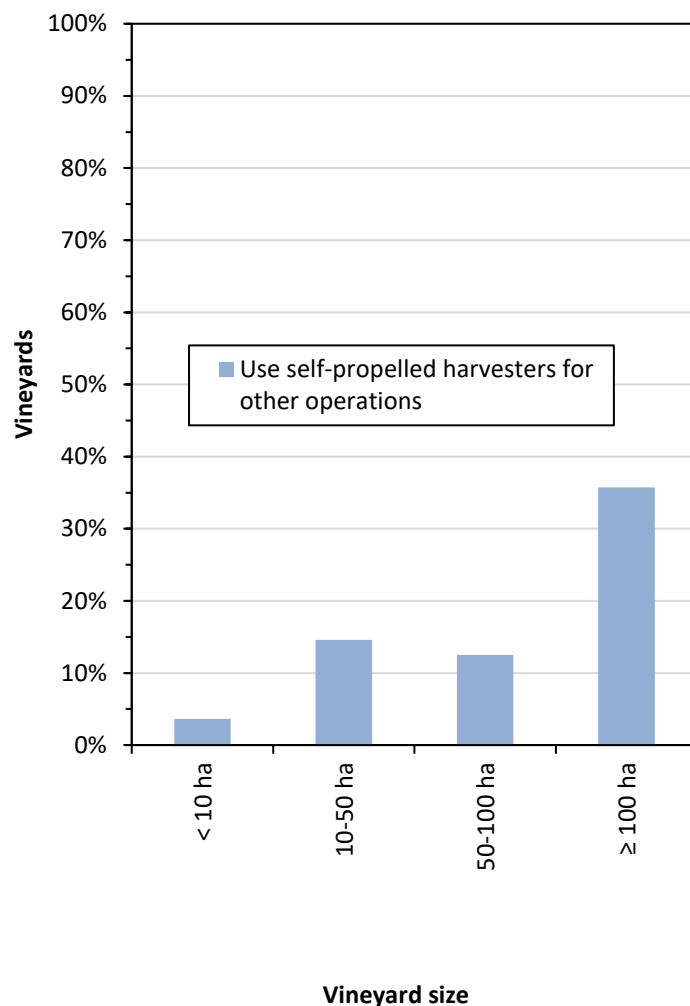
Tractor/robot power sources (excluding UTVs), and use of tyres or tracks (used at all)



- Tractors are almost exclusively powered by diesel (when respondents selected 'Other', it was petrol).
- Manufacturers have been slow in offering alternative-fuel vehicles.
- Battery-electric robots had not been adopted.
- Vehicles predominantly used tyres, with only 3 respondents having a tracked vehicle.
- The power source question specifically excluded RTV/ATV/UTVs. Some vineyards are now using battery-electric models of these.

*Respondents were asked to select all power sources used for tractors and robots, and in the next question whether the tractors and robots used have tyres or tracks. This question was not asked in 2016. The plot shows data for 2022.

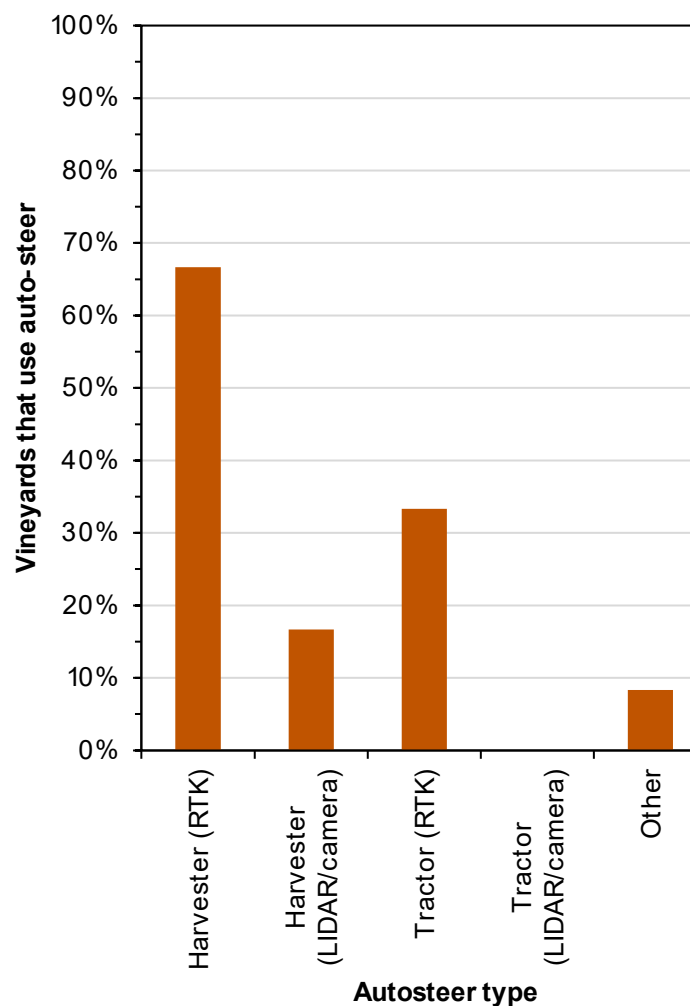
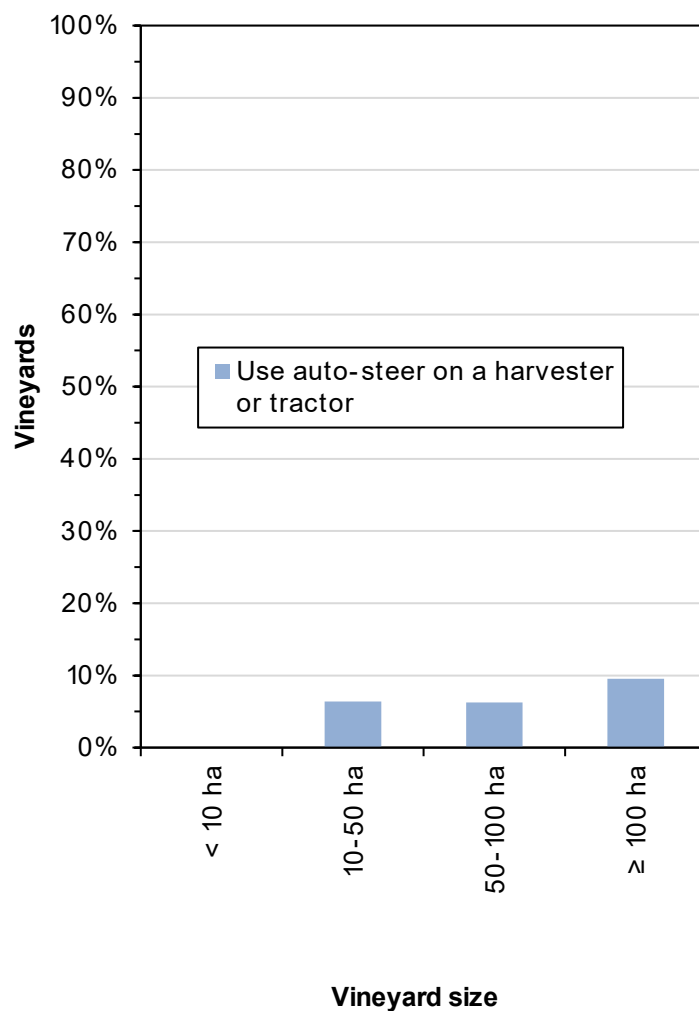
Using self-propelled harvesters as tool carriers and for what operations (used at all)



- Self-propelled harvesters were not commonly used for other vineyard operations. Even in very large vineyards (≥ 100 ha) only 36% used them at all for other operations.
- The most common non-harvesting use was for pre-pruning or pruning.
- 'Other' responses included post knocking, under-vine weeding and leaf plucking.

*Respondents were asked whether self-propelled harvesters were used as tool carriers for other operations in the vineyard. If they selected yes, they were then asked to select which operations they were used for. This question was not asked in 2016. The plot shows data for 2022.

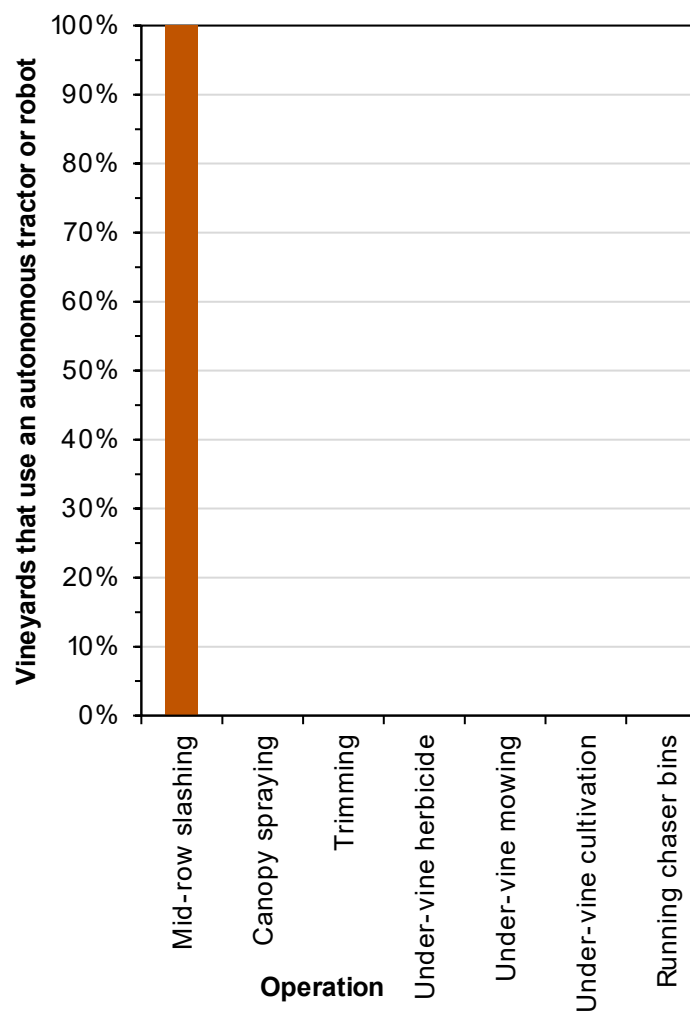
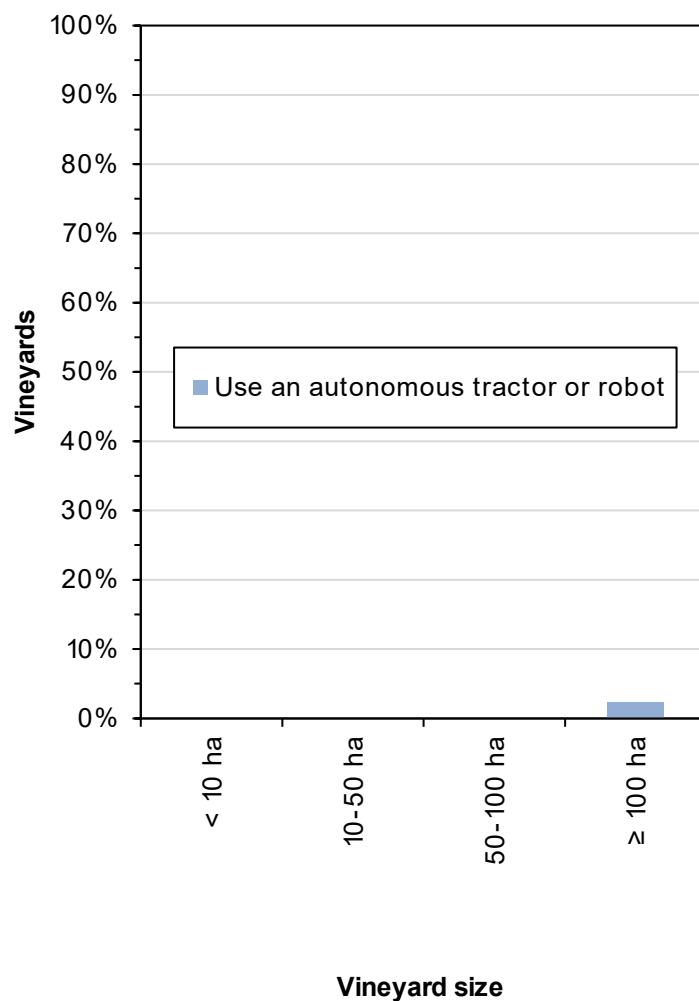
Use auto-steer on any tractors or harvesters (used at all)



- Use of auto-steer was very low in vineyards. Even in ≥ 100 ha vineyards only 10% used auto-steer on a harvester or tractor.
- The small number using auto-steer were more likely to be using it on a harvester than a tractor and to be using satellite positioning with RTK rather than a LIDAR/camera system.

*Respondents were asked whether auto-steer is installed on any tractors or harvesters. If they selected yes, they were then asked to select whether it was on a harvester or tractor and whether it was based on satellite positioning with RTK or LIDAR/camera. This question was not asked in 2016. The plot shows data for 2022.

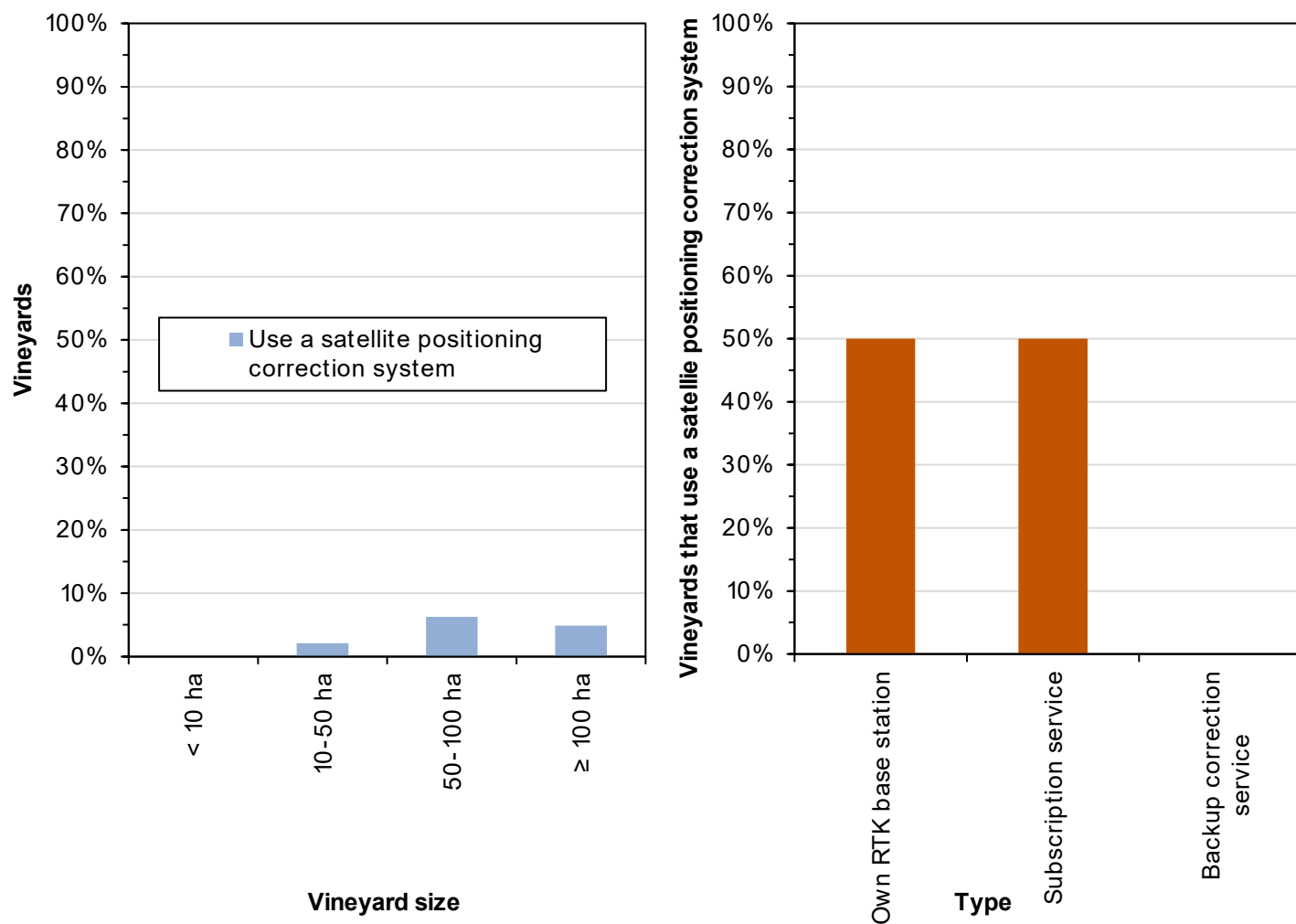
Use an autonomous (driverless) tractor or robot



- Only one responding vineyard used an autonomous robot or tractor and it was just a trial.
- It was employed only for mid-row slashing.
- One tractor autonomy-kit not included in the survey was also being trialled for mid-row slashing, canopy spraying and under-vine mowing and cultivation.

*Respondents were asked whether any autonomous tractors or robots were used (i.e. vehicles that can operate without a driver on-board). If they selected yes, they were then asked to select which operations they were used for. This question was not asked in 2016. The plot shows data for 2022.

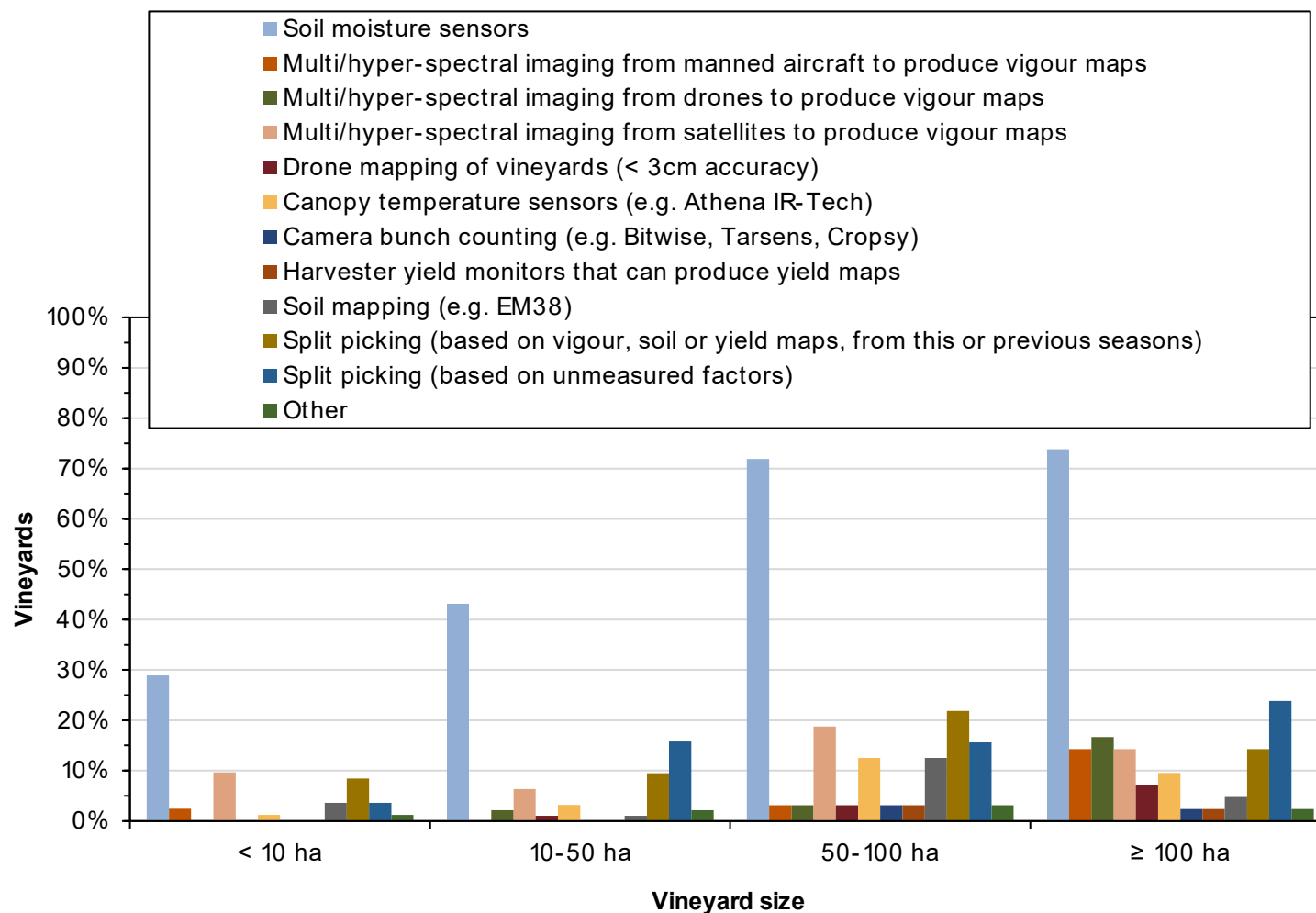
Satellite positioning correction system (RTK base station, subscription, etc.)



- Of the very small number of vineyards using a satellite positioning correction system, half had their own RTK base station and half used a subscription service.

*Respondents were asked whether they had an RTK base station or subscription service. If they selected yes, they were then asked to select which type was used. This question was not asked in 2016. The plot shows data for 2022.

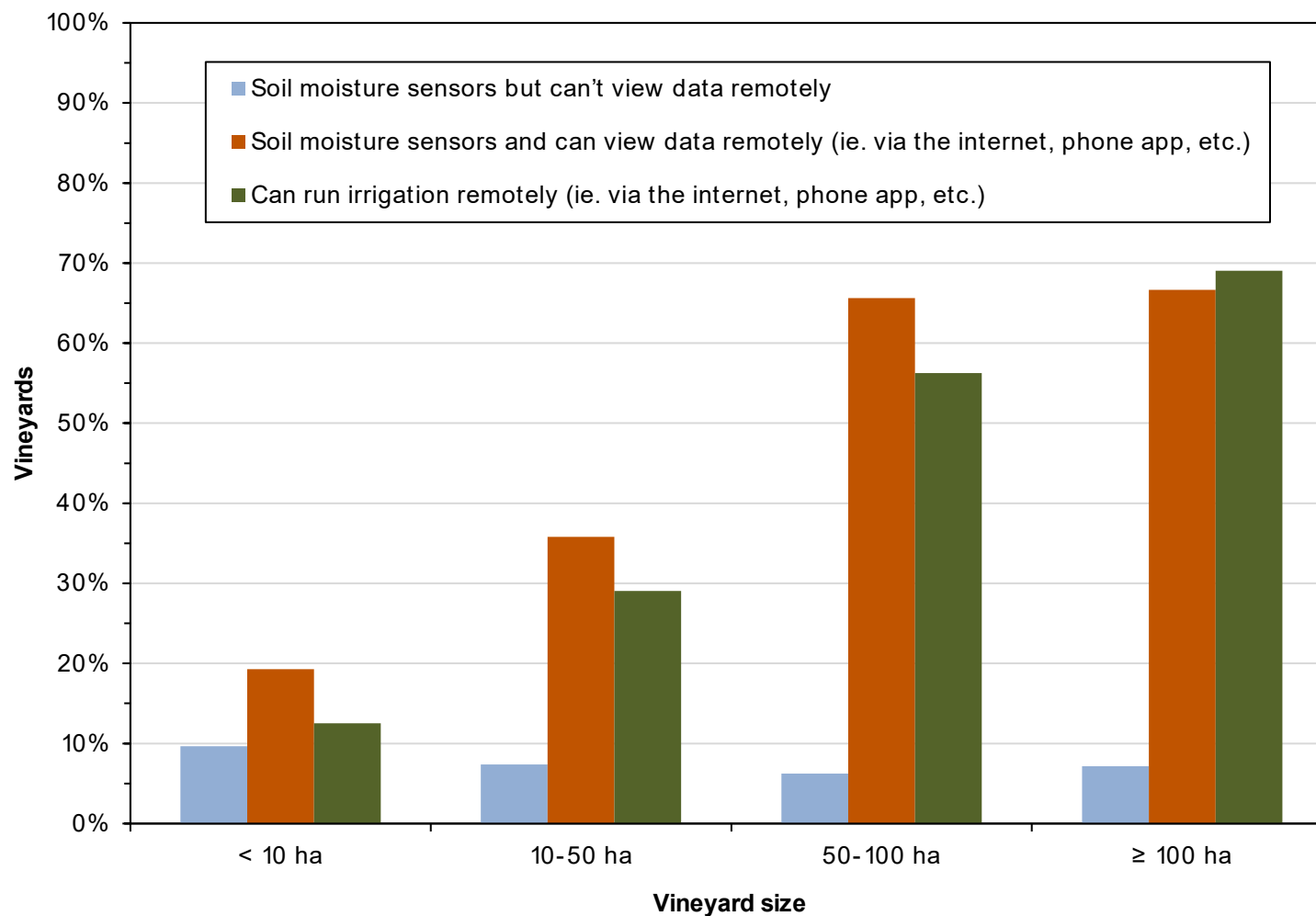
Sensors and precision viticulture techniques (used at all)



- Soil moisture sensors were by far the most common sensor technology or precision viticulture technique to be used in 2022, as they were in the 2016 edition of the survey.
- Split picking was the next most common technique to be used, but this was often based on unmeasured factors, rather than explicit vigour, soil, or yield maps.
- There were some limited trials and adoption of new technologies on the market, including canopy temperature sensors, camera bunch counting, and satellite-derived vigour mapping.
- Generally, adoption of most sensor technologies and precision viticulture techniques remains very low as it was in the 2016 survey.

*The question asked the user to select all of the techniques that were used in the season.

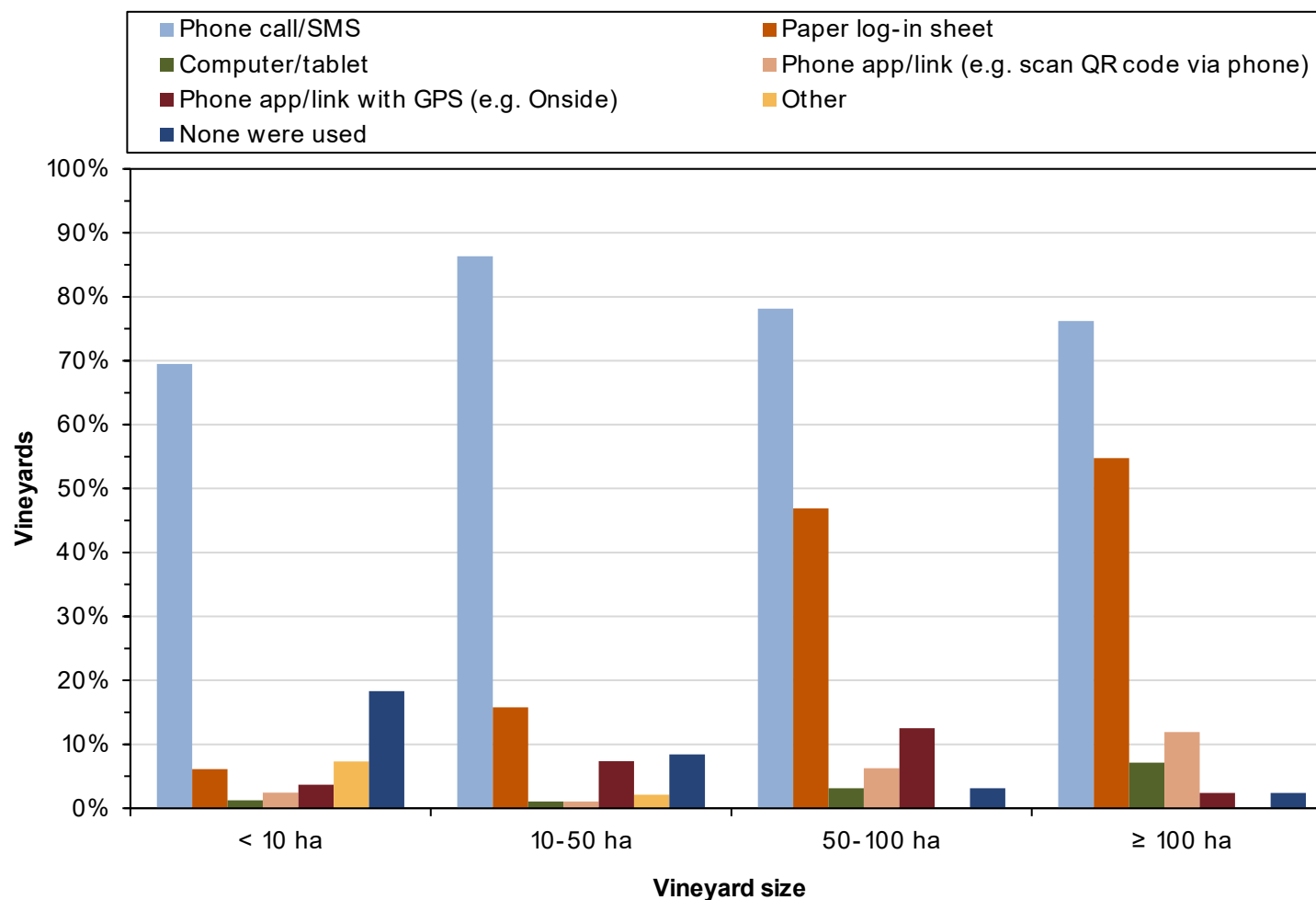
Ability to view soil sensors and operate irrigation remotely? (internet, app, etc.)



- Most vineyards with soil sensors were able to view their data remotely (via the internet, phone app, etc.)
- A similar proportion of growers could also run their irrigation remotely.

*Users who selected that they used a soil moisture sensor were asked whether they can view the data remotely (i.e. via the internet, phone app, etc.). All respondents were asked whether they can run their irrigation remotely (i.e. via the internet, phone app, etc.). This question was not asked in 2016. The plot shows data for 2022.

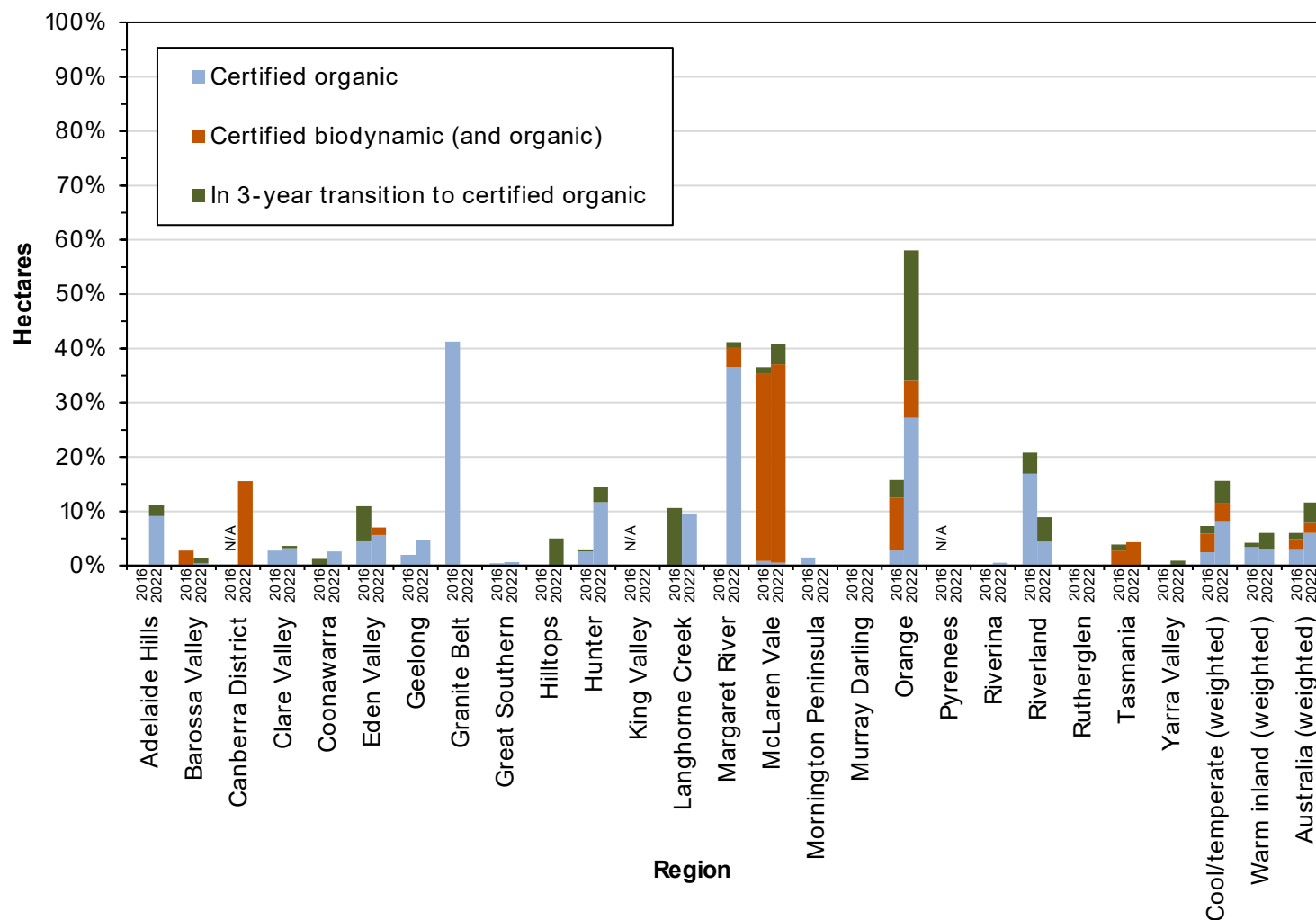
Visitor/contractor check-in techniques



- Phone calls or SMS were the most common method for site check-in.
- Larger sites were more likely to have a paper log-in sheet or web phone app.
- Web phone apps with GPS like Onside had a low market penetration overall.
- Several respondents also noted that visits were by appointment only, or that visitors needed to come by the house or office to access the site.

*Users were asked how visitors and contractors notify you/check-in when entering the vineyard. This question was not asked in 2016. The plot shows data for 2022.

Organic/biodynamic vineyard certification (vineyard)



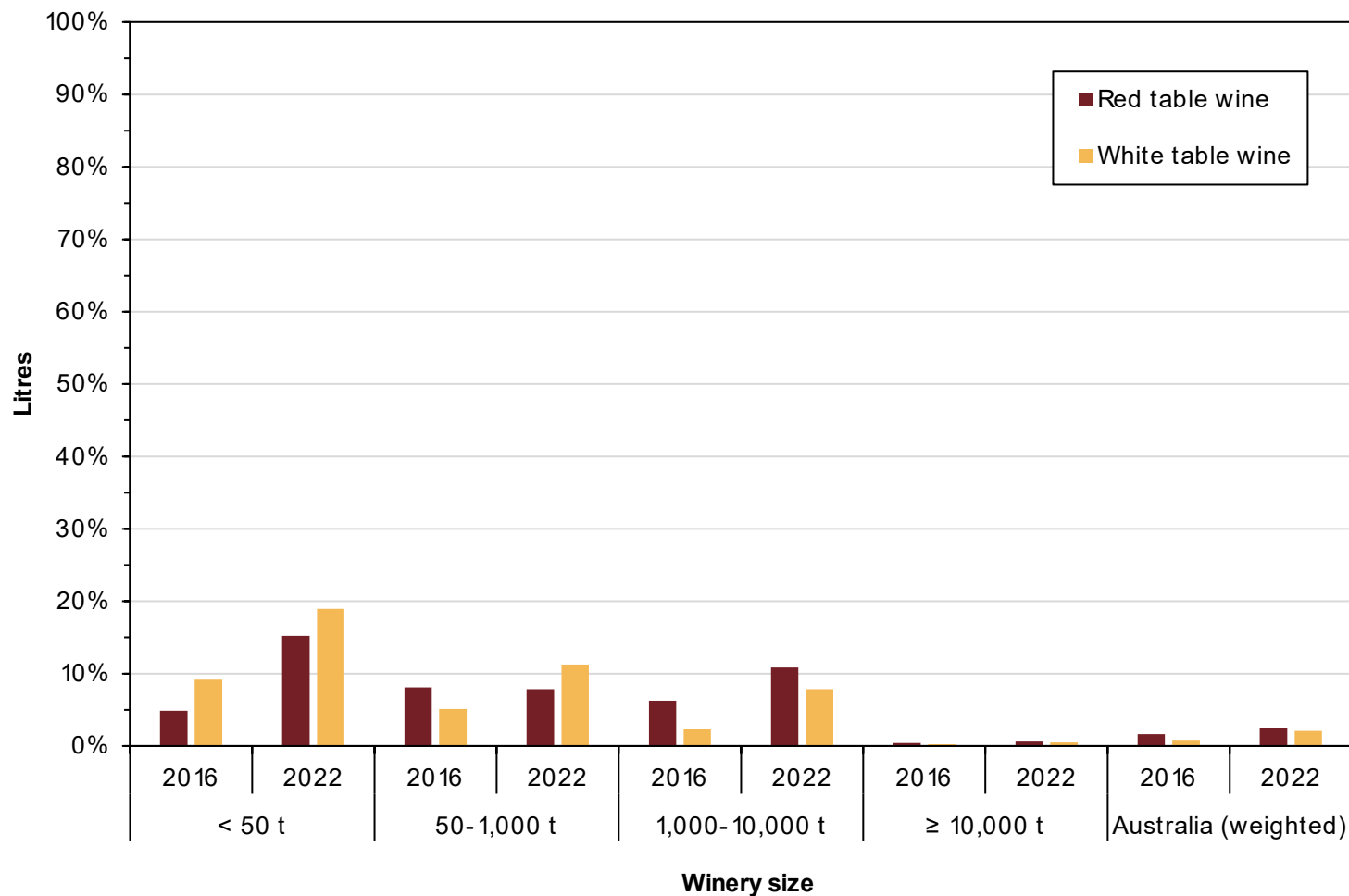
Weighted values for Australia

	2016	2022
Certified organic	3%	6%
Biodynamic	2%	2%
In-transition	1%	4%

- Organic and biodynamic wine grapes make up a small proportion of the total vineyard area but did increase between 2016 and 2022.
- Some caution should be applied in drawing too much from the increased numbers, given the still relatively small percentage of organic vineyards and therefore possibility for a few respondents participating in one survey but not the other to skew the results.

*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 then prompted to specify the areas not certified, certified organic, certified biodynamic (and organic) and in the transition process.

Organic certified wine production (winery data for comparison)



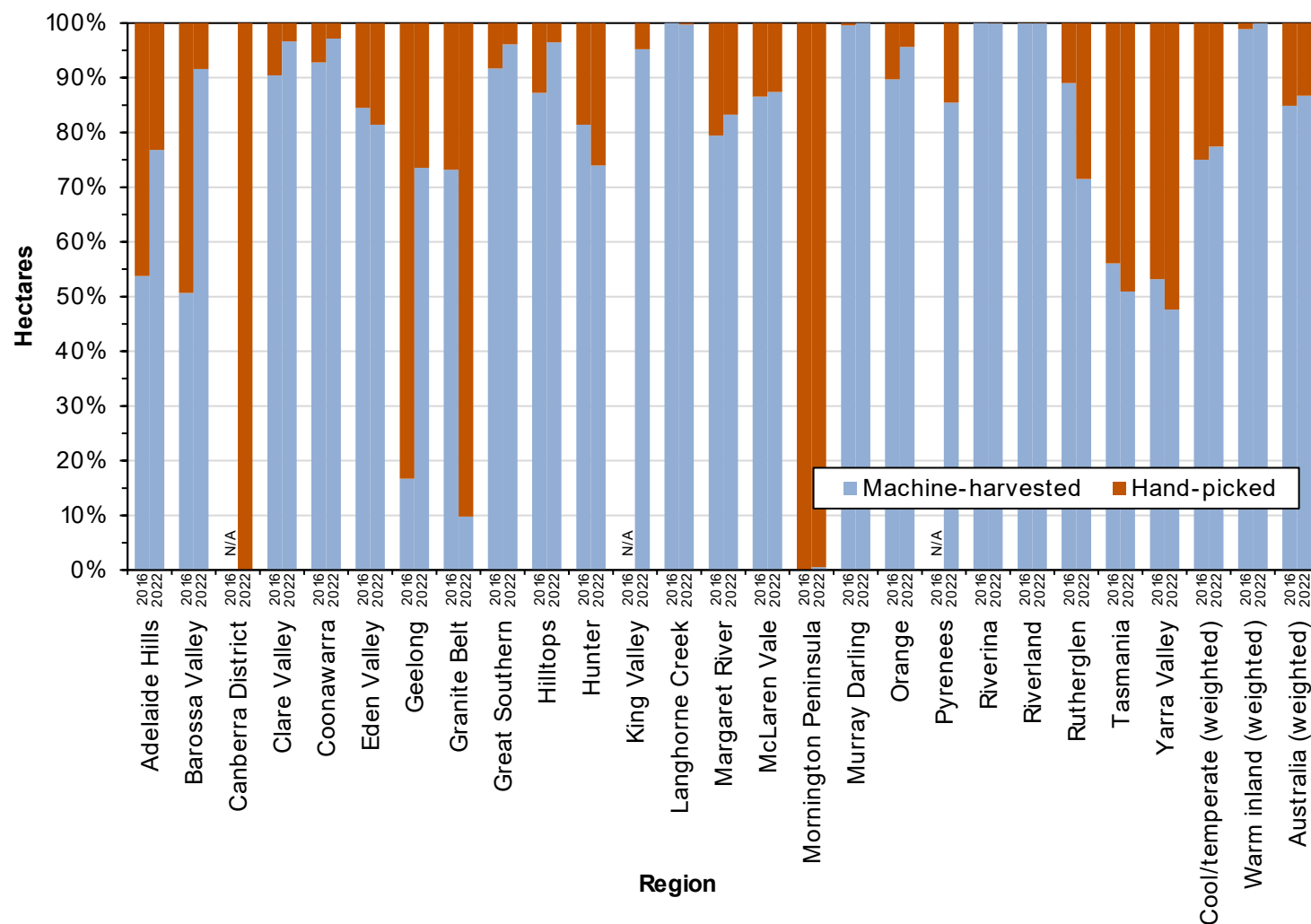
Weighted values for Australia

	2016	2022
All organic wine	1%	2%
Red organic wine	2%	2%
White organic wine	1%	2%

- Winery data is consistent with vineyard data in that only a small proportion of wine production is certified organic.

*This question from the winery survey first asked whether any certified organic wine was made at the site. 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



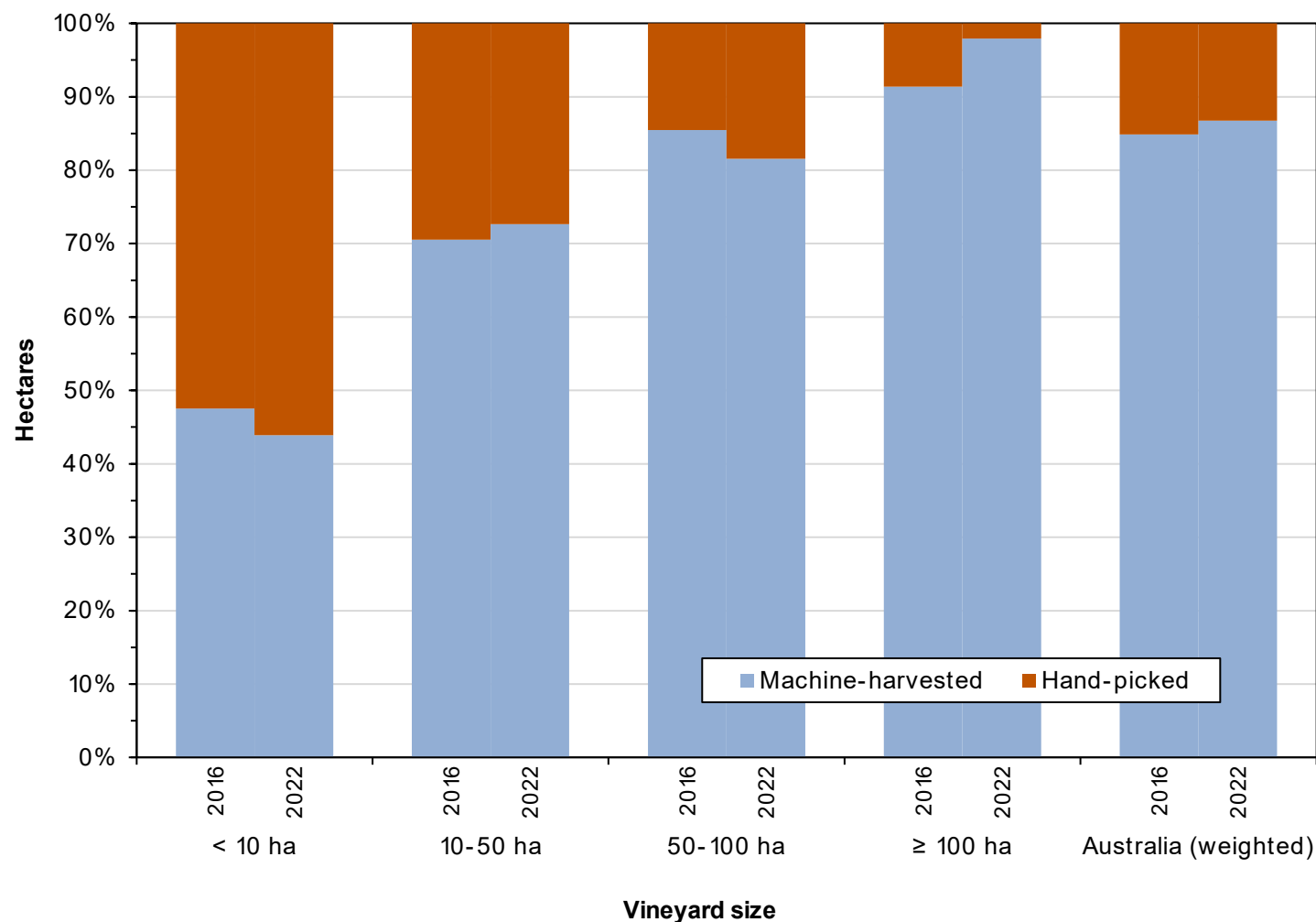
Weighted values for Australia

	2016	2022
Machine All	85%	87%
Machine Red	85%	89%
Machine White	84%	83%

- The level of machine harvesting was similar in 2022 to that in 2016.

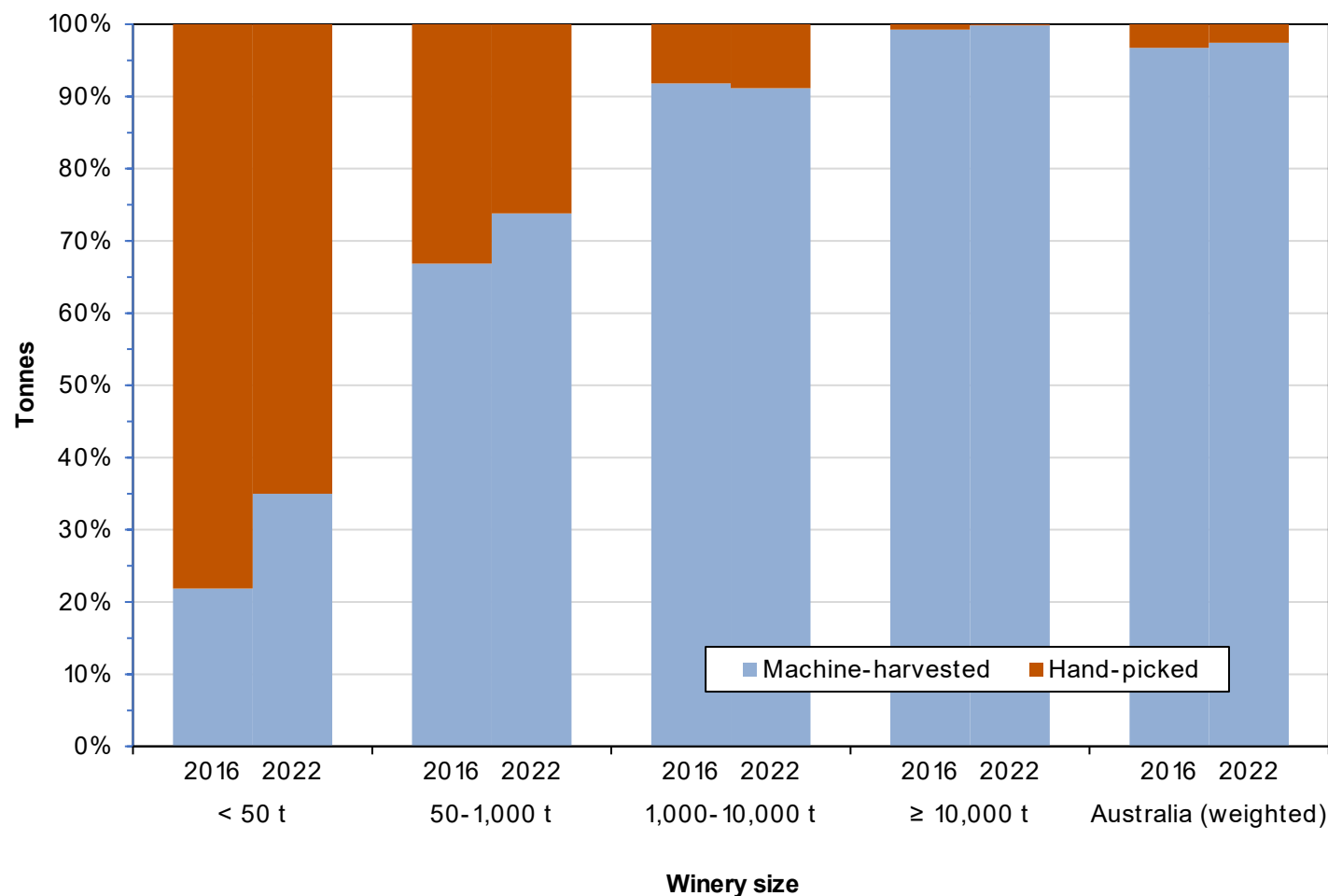
*The question first asked whether grapes were all machine-harvested, all hand-picked or a combination of both. If respondents selected a combination of both, they were prompted to select the % of red and white grapes that were machine-harvested from drop-down boxes to nearest 10%.

Mechanisation of harvesting



- Smaller vineyards hand-picked a larger proportion of their crop than larger vineyards in both 2016 and 2022 surveys.

Mechanisation of harvesting (winery intake tonnage data for comparison)



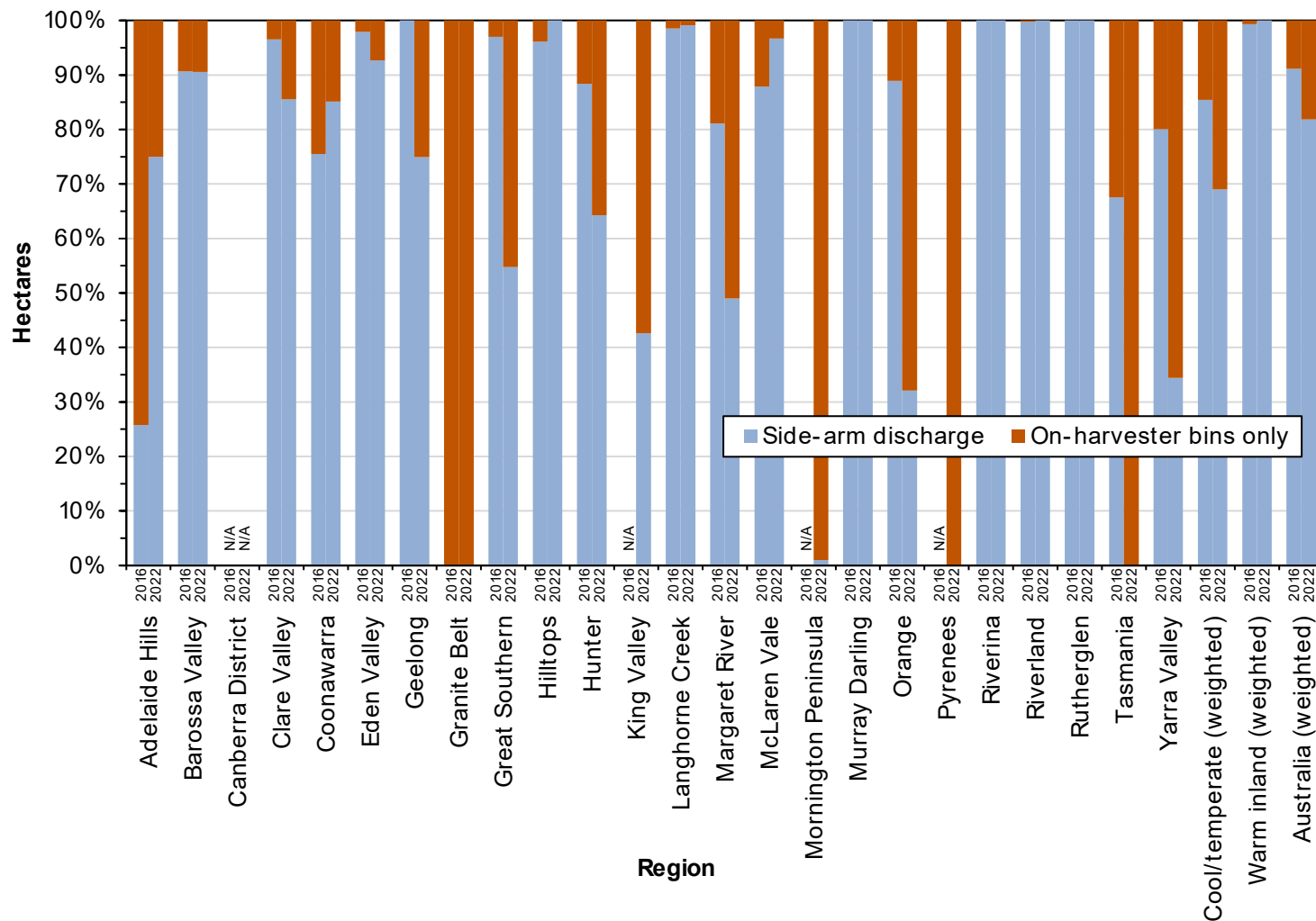
Weighted values for Australia

	2016	2022
Machine All (t)	97%	97%
Machine Red (t)	97%	97%
Machine White (t)	96%	97%

- Corresponding with the vineyard data, the level of machine harvesting reported by wineries was similar in 2022 to 2016.
- More grapes are machine-harvested on a tonnage than area basis because on average the yield is higher in vineyards that tend to be machine-harvested.

*This question from the winery survey 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%.

Side-arm discharge vs on-harvester bins only for machine harvesters



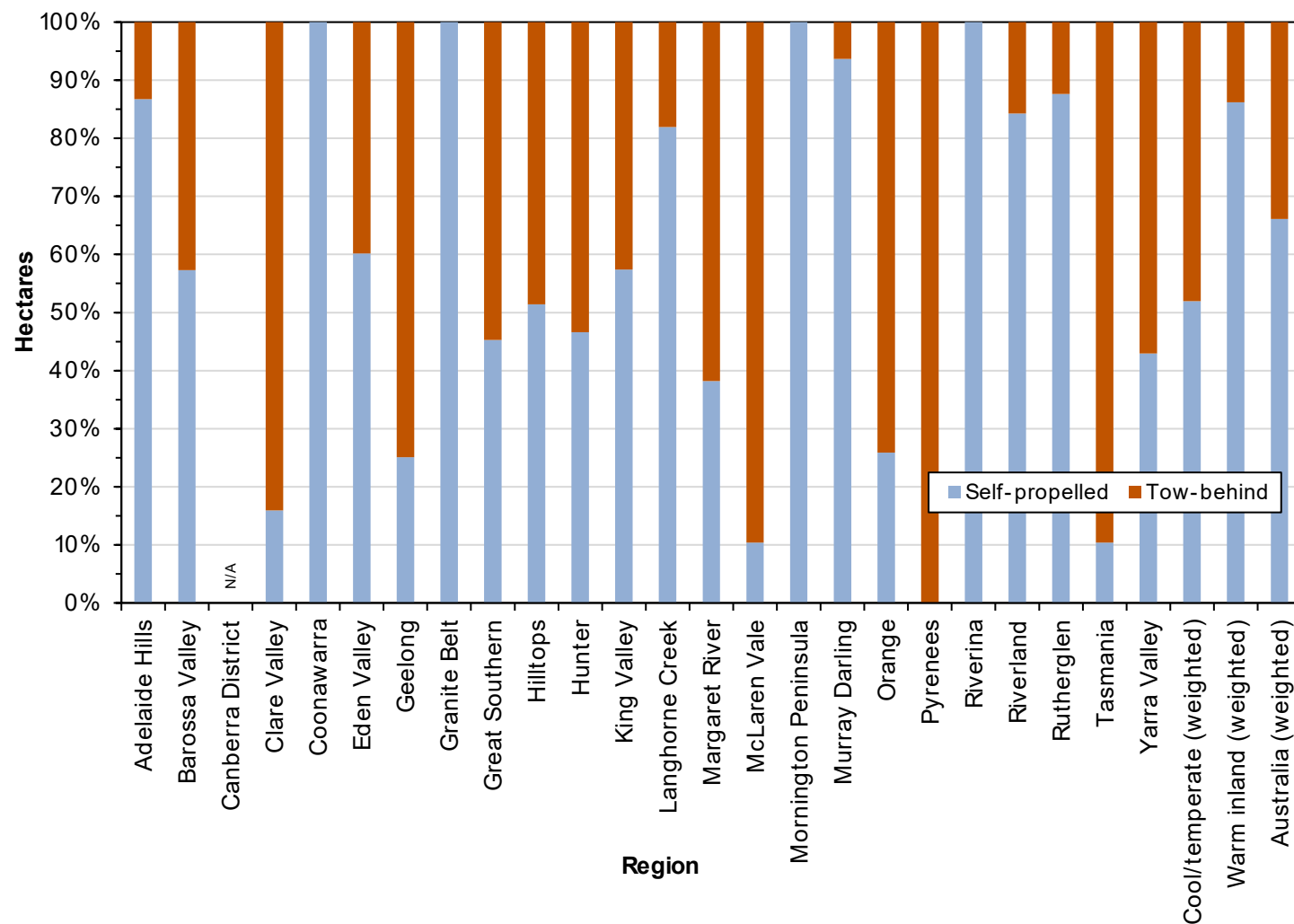
Weighted values for Australia

	2016	2022
Side-arm	91%	82%

- Most machine-harvesting is performed using machines having a side-arm discharge conveyor.
- From 2016 to 2022 the amount of harvesting from machines without a side-arm discharge conveyor increased slightly, likely relating to the lower prevalence of side-arm discharge conveyors on machines with on-board destemmers.

*Vineyards that machine harvested were asked to select the % that was performed using harvesters having a side-arm discharge conveyor versus on-harvester bins only (from a drop-down menu, to the nearest 10%).

Self-propelled vs. tow-behind harvesters



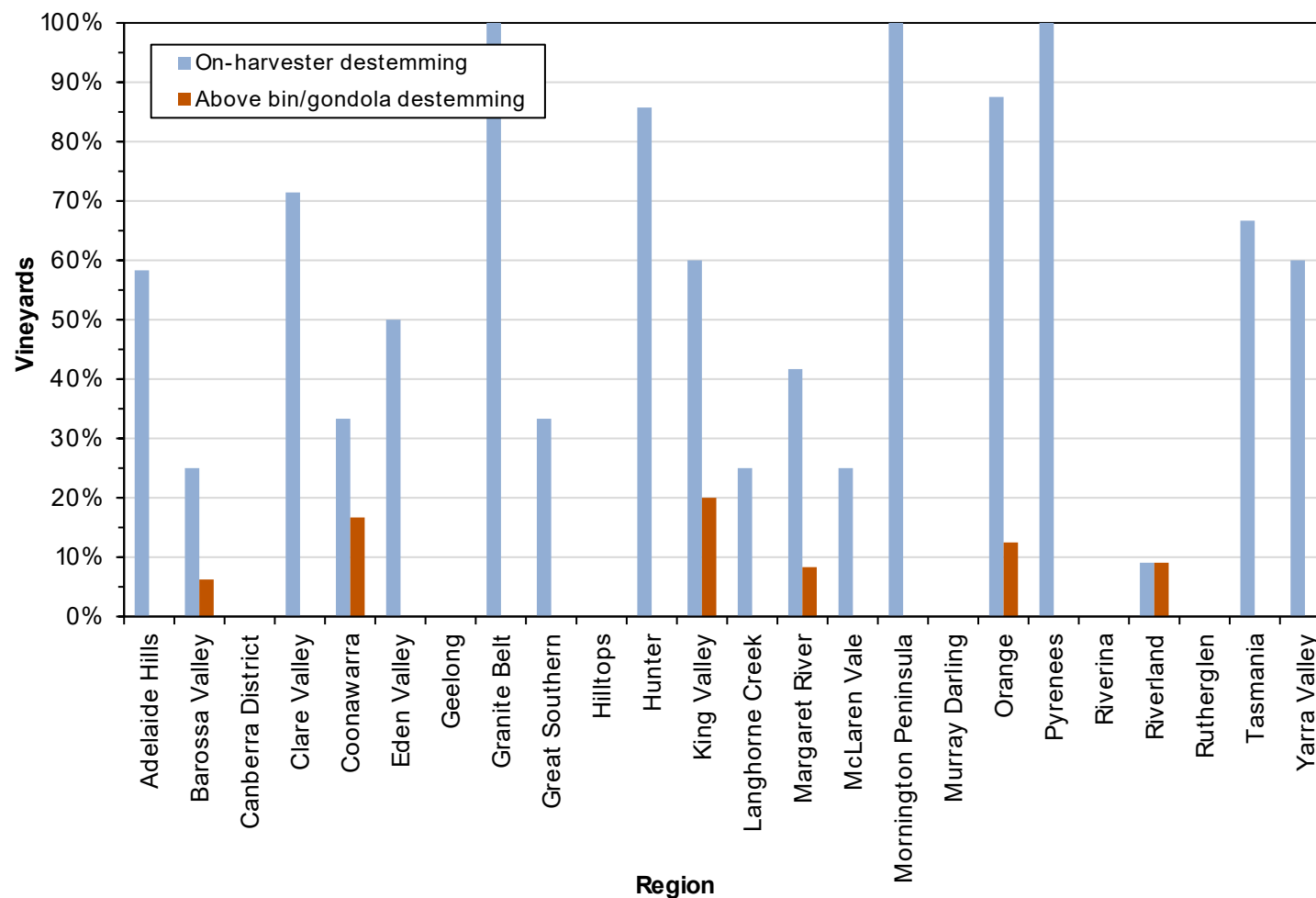
Weighted values for Australia

	2016	2022
Self-propelled	N/A	66%

- Self-propelled harvesters were used to harvest a greater area than tow-behind harvesters.

*Vineyards that machine harvested were asked to select the % that was performed using tractor tow-behind vs. self-propelled harvesters (from a drop-down menu, to the nearest 10%). This question was not asked in 2016. The plot shows data for 2022.

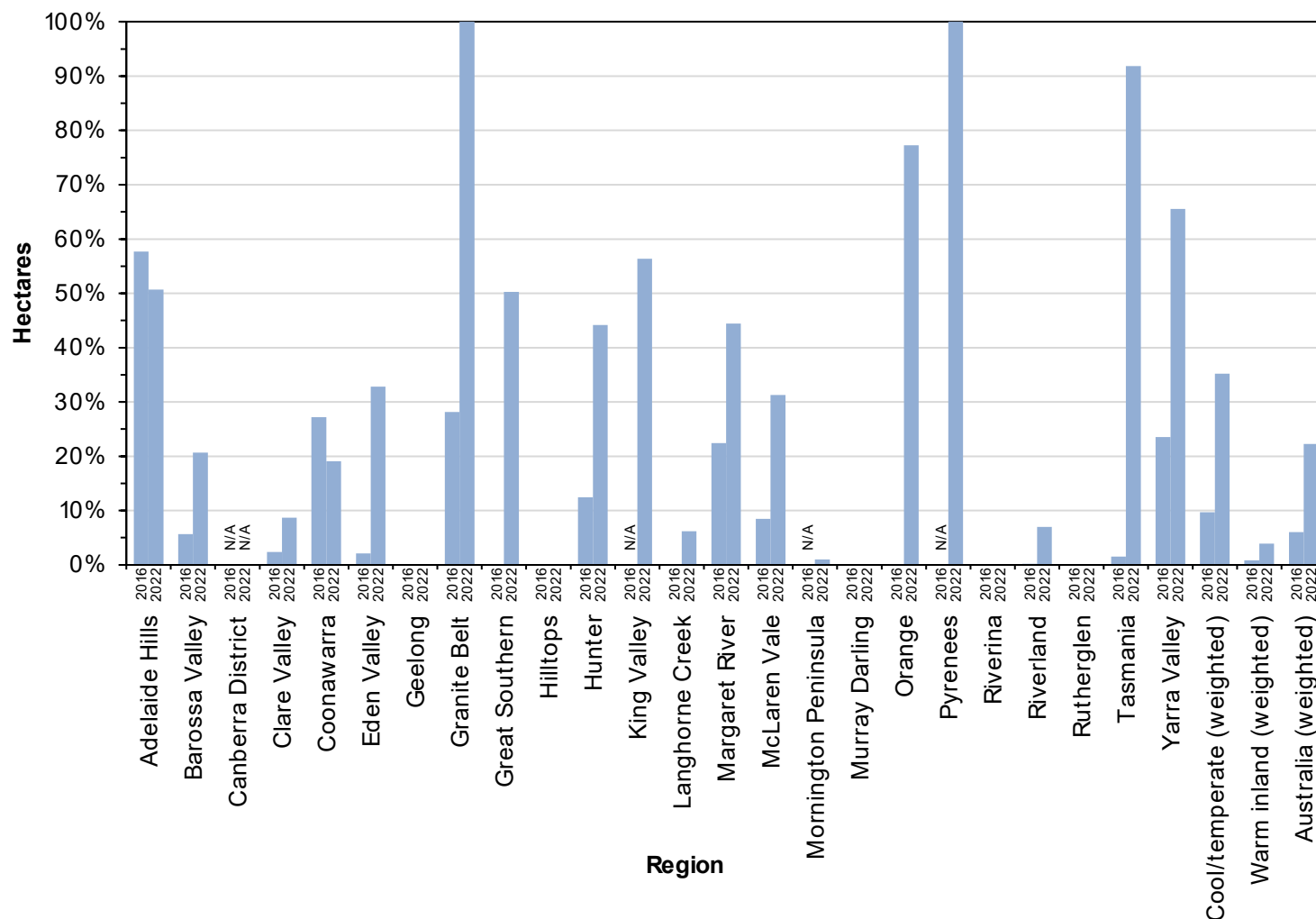
On-harvester or above bin vineyard destemming (used at all)



- Many vineyards are now using on-harvester destemmers for at least some blocks.
- The use of above bin/gondola destemmers is much lower.
- For the 2022 survey, a variation on the 2016 question was used to capture the prevalence of above bin/gondola destemming as opposed to just on-harvester destemming.

*Vineyards that machine harvested were asked to select whether they used on-harvester destemmers or in-field destemmers above picking bins/gondolas. This question was not asked in the same way in 2016. The plot shows data for 2022.

On-harvester or over-bin vineyard destemmer running during machine harvesting



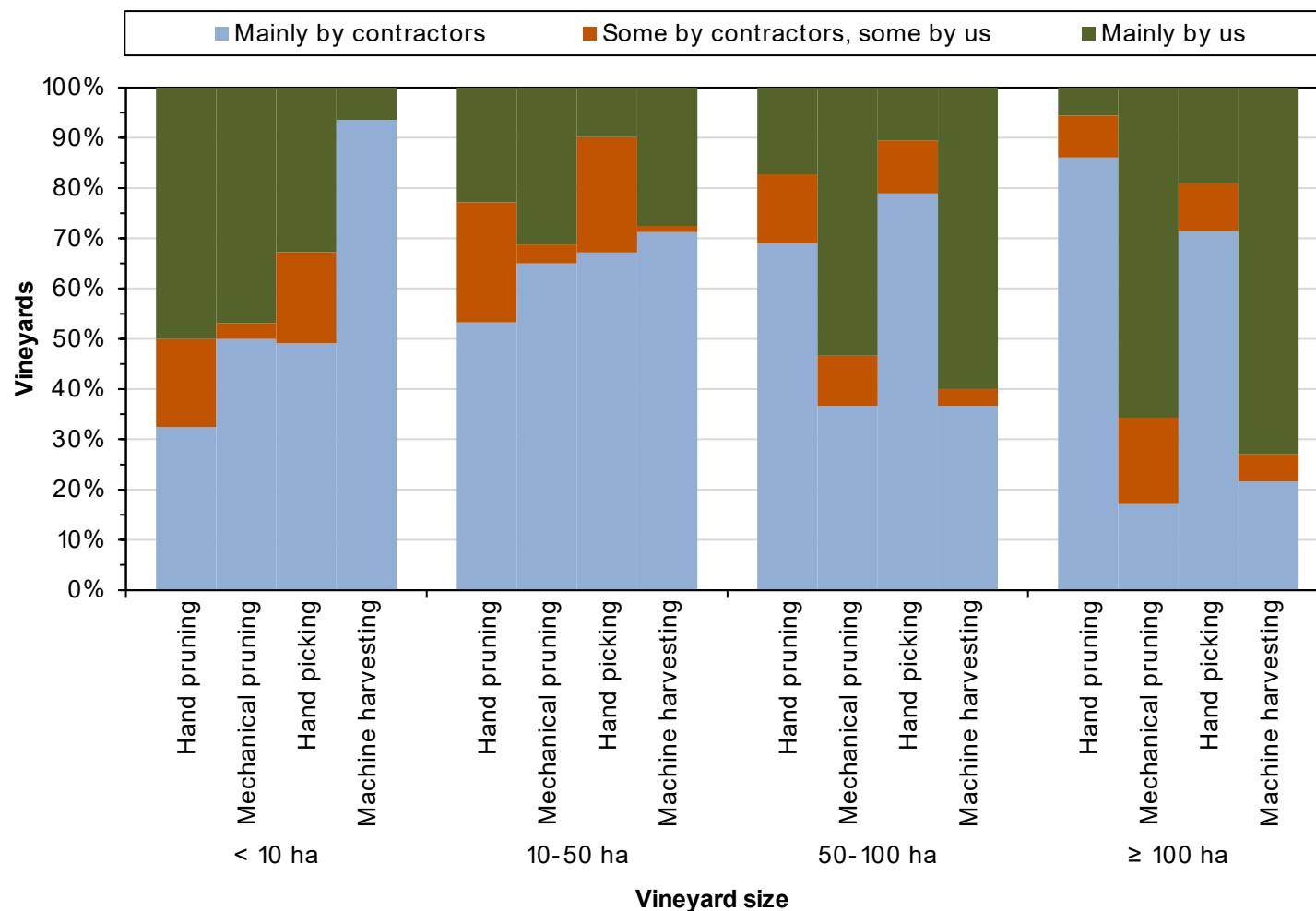
Weighted values for Australia

	2016	2022
Destem All	6%	22%
Destem Red	6%	23%
Destem White	5%	22%

- The amount of destemming performed during harvesting increased considerably between 2016 and 2022, from 6% to 22% of Australian machine-harvesting area.
- The trend applied to both red and white grapes.

*Vineyards that used on-harvester destemmers or in-field destemmers above picking bins/gondolas were asked to select the % that was performed with the on-harvester or over-bin/gondola destemmer running (from a drop-down menu, to the nearest 10%).

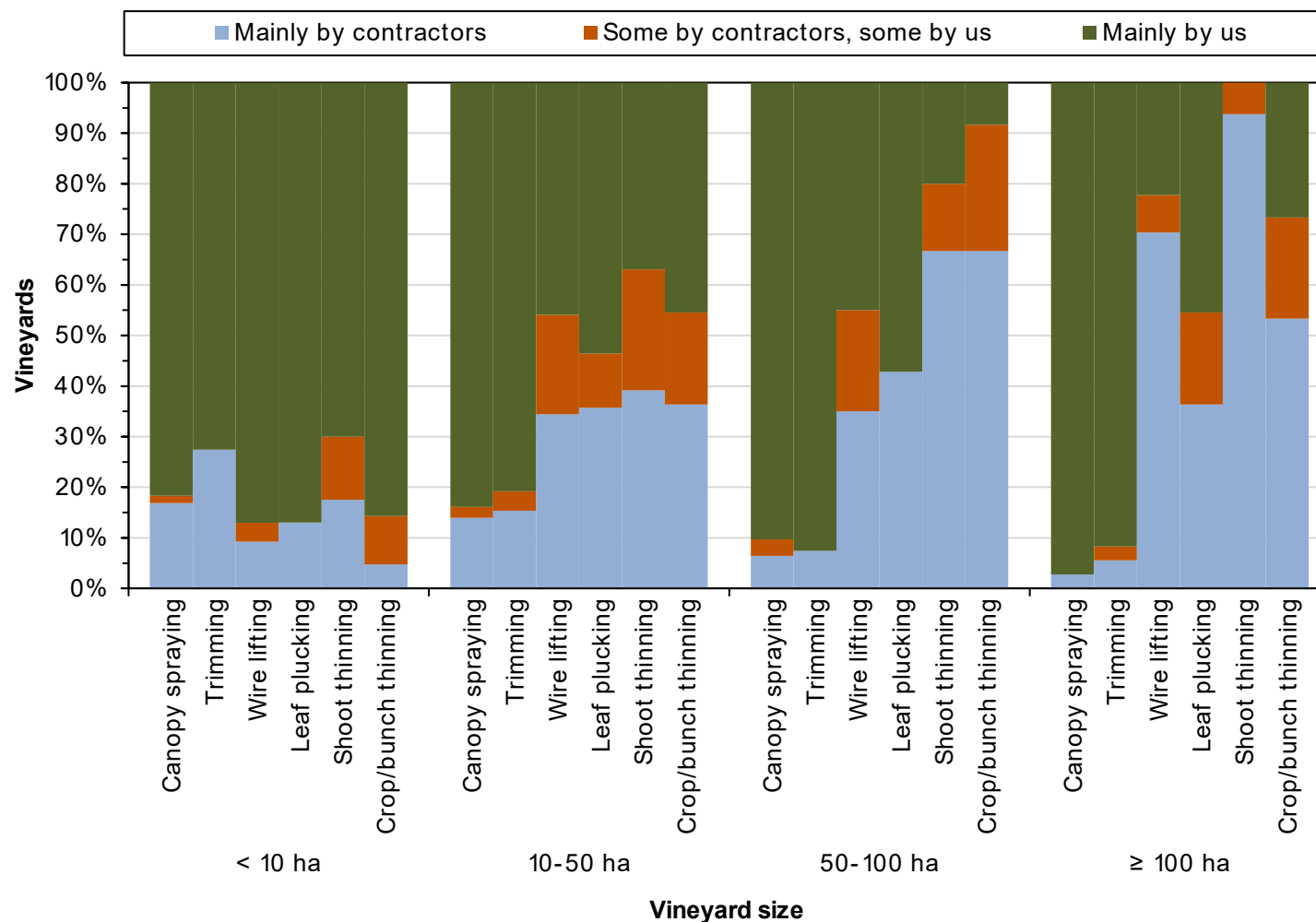
Use of contractors - Pruning and harvesting



- Larger vineyards are more likely to use contractors for manual labour tasks like hand pruning.
- In contrast, they are more likely to perform operations involving expensive machinery like machine-harvesters themselves.

*Vineyards that had previously responded that operations had been performed, were asked if those operations were performed mainly by contractors, mainly by your business or some by contractors and some by your business. Hand pruning included after pre-pruning, and mechanical pruning included all of pruning, pre-pruning and cane removal. This question was not asked in 2016. The plot shows data for 2022.

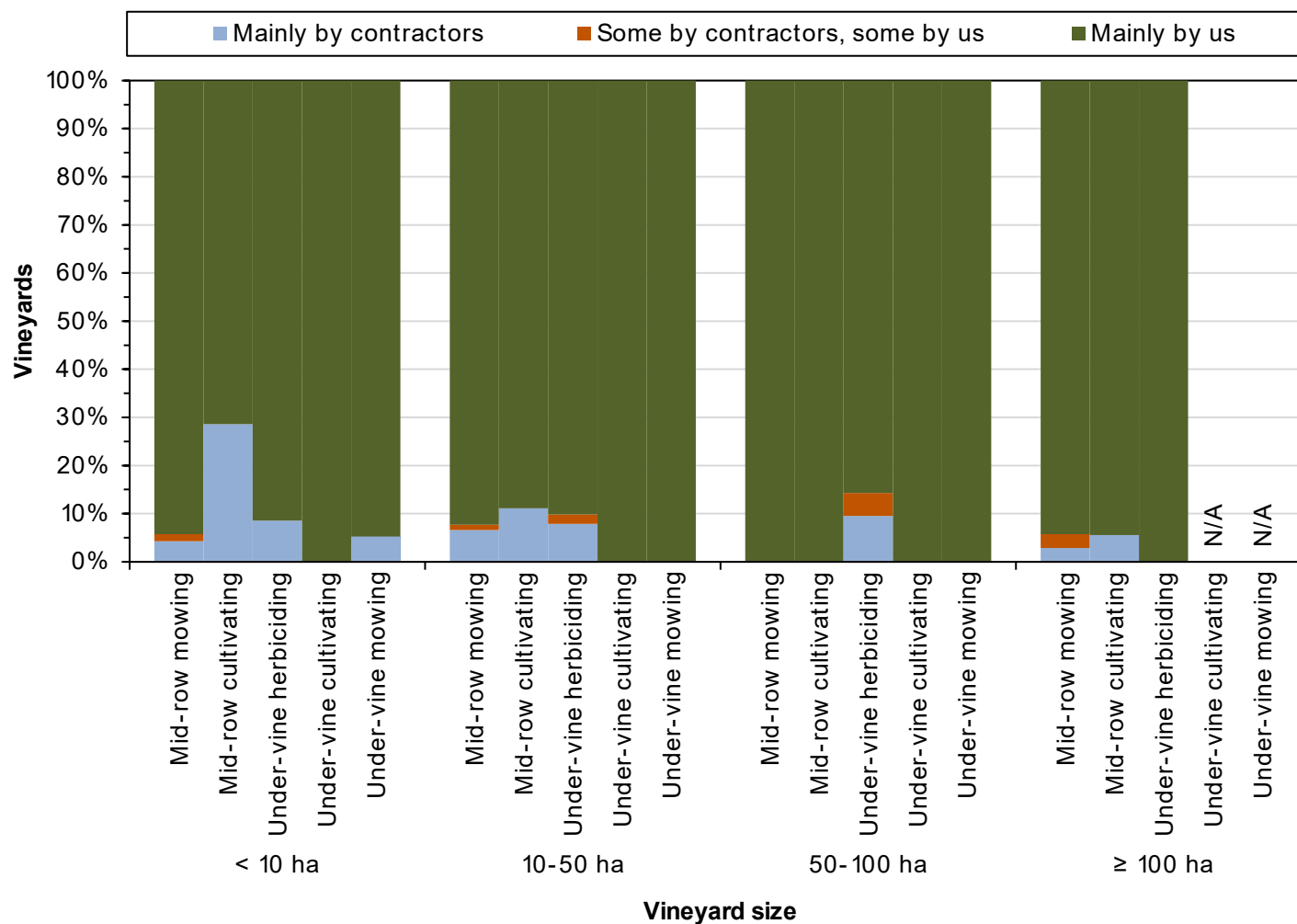
Use of contractors - Canopy management



- Canopy spraying and trimming are performed by most vineyards themselves.
- Manual labour tasks like wire lifting and thinning operations are more likely to be performed by contractors as vineyard size increases.

*Vineyards that had previously responded that operations had been performed, were asked if those operations were performed mainly by contractors, mainly by your business or some by contractors and some by your business. This question was not asked in 2016. The plot shows data for 2022.

Use of contractors – Vineyard floor management



- Vineyard floor management operations are mainly performed by the vineyards themselves even in quite small vineyards.

*Vineyards that had previously responded that operations had been performed, were asked if those operations were performed mainly by contractors, mainly by your business or some by contractors and some by your business. This question was not asked in 2016. The plot shows data for 2022.

New products/techniques with biggest positive impact in the last 5-6 years

2016 survey (1 st edition)	2022 survey (2 nd edition)
1. Multi-row equipment, mainly sprayers (n=29)	1. Biological fungicides for botrytis (n=22)
2. Soil moisture probes & irrigation controls (n=25)	2. Mechanical under-vine management (n=21)
3. Under-vine mulch/compost (n=20)	3. Soil moisture probes & irrigation controls (n=20)
4. Organic practices (n=15)	4. Multi-row equipment, mainly sprayers (n=17)
5. Recycling sprayers (n=12)	5. New/better canopy sprayers (n=15)
6. Klima mechanical cane pruning (n=9)	6. Destemming/sorting harvesting (n=12)
7. Sheep grazing (n=9)	7. Under-vine mulch/compost (n=10)
8. Mechanical under-vine management (n=8)	8. Recycling sprayers (n=9)
9. Pruning wound fungicide sprays (n=8)	9. Cover crops (n=7)
10. Mechanical leaf plucking (n=8)	10. Steel posts (n=6)
11. More cane pruning (n=8)	11. New/more efficient tractors (n=6)
12. New fungicides (n=8 for Revus)	12. Minimising herbicide use (n=6)
13. New/better canopy sprayers (n=7)	13. Organic herbicides (n=5)
14. Destemming/sorting harvesting (n=7)	14. Soil testing (n=5)
15. Seaweed fertilisers (n=7)	15. More cane pruning (n=5)

- Biological fungicides for botrytis were the most cited new product to have a positive impact in the 2022 survey.

(key products like Botector and Serenade Opti were not yet available at the time of the 2016 survey)
- Mechanical under-vine slashing and cultivation equipment featured more prominently in the 2022 than 2016 survey as being impactful changes.
- Soil probes and irrigation controls featured highly in both surveys as did multi-row equipment - mainly canopy sprayers.
- Destemming/sorting harvesting equipment was more commonly nominated as an impactful change in the 2022 survey.

*Respondents were asked which new products or techniques had the biggest positive impact on their operations over the last six years in this 2022 edition of the survey and over the last 5 years in the 2016 edition of the survey. Themes are listed in decreasing order of responses. 71% of survey respondents answered with at least one product/technique for this free-text question in 2022, compared with 45% in 2016, where it was listed as optional, but there were almost twice as many overall survey respondents in 2016 as 2022. How open-text responses are categorised is debatable (e.g. there is some cross-over between multi-row equipment, better sprayers and recycling sprayers), but the general trends remain.

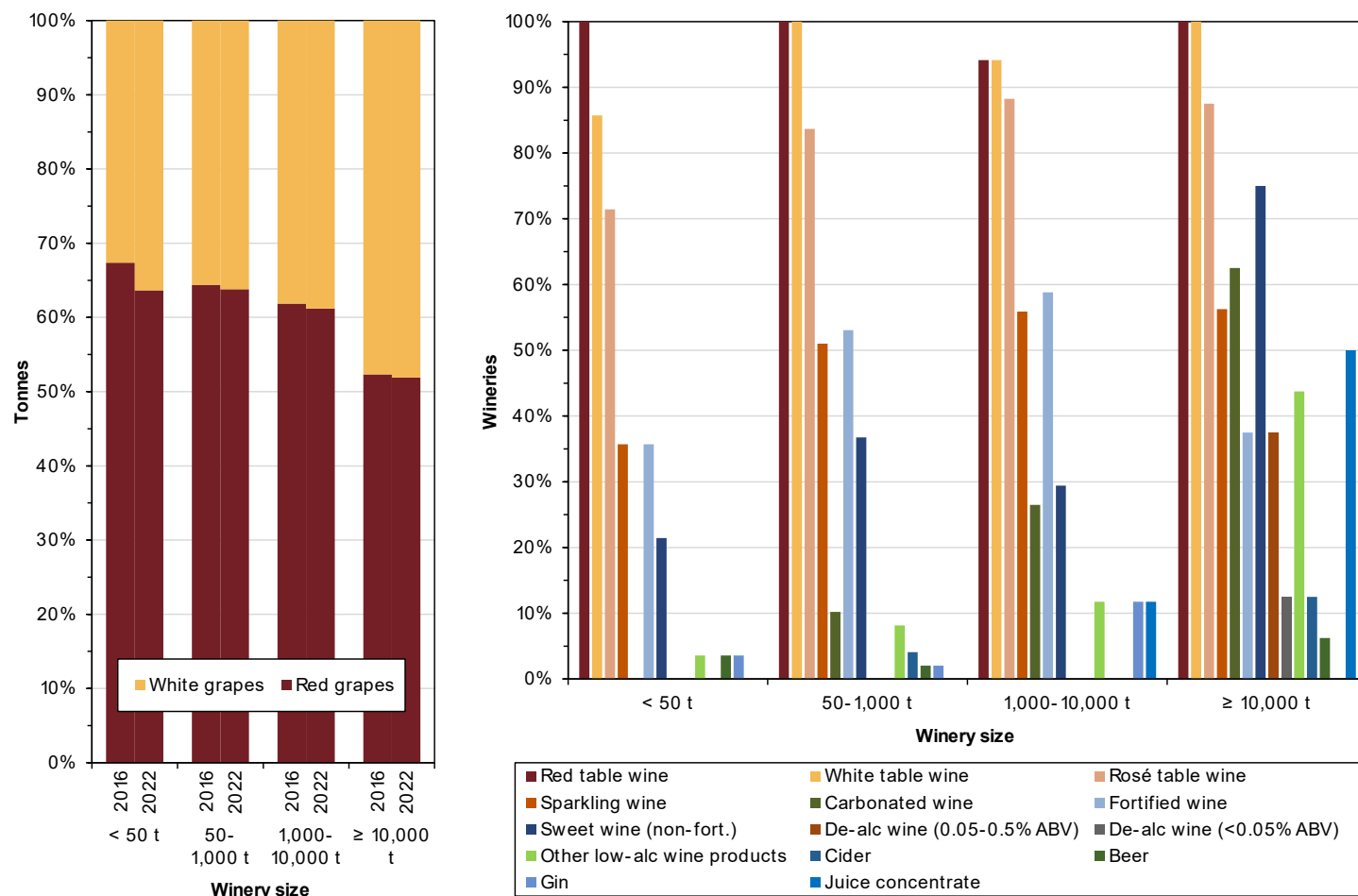
Technical challenges / emerging technologies where you would like support

2022 survey (2 nd edition)
1. Under-vine weed management (n=41)
2. Autonomous tractors and robots (n=21)
3. Electric tractors & robots (n=10)
4. Yield estimation (n=8)
5. Organic/biological control of pests and diseases (n=8)
6. Automation (n=7)
7. Precision Ag, including yield mapping, soil mapping, and variable rate application (n=7)
8. Soil moisture sensors and monitoring (n=7)
9. Botrytis chemicals (n=6)
10. Drones for mapping, spraying and bird management (n=5)
11. Agtech (n=5)
12. Trunk disease / Eutypa dieback management (n=5)
13. Snail management, including organic options (n=5)
14. Weevil management, including organic options (n=5)
15. Grapevine scale / mealybug management (n=4)

- The most common topic respondents wanted help with by far was under-vine weed management.
- Many responses referred specifically to non-chemical weed control and reducing herbicide use or organic control of weeds. Mowing and cultivation (and some concerns about cultivation), under-vine cover cropping, and issues with herbicide resistance were also mentioned.
- Autonomous tractors and robots were the second most common topic mentioned, including 3x with reference to under-vine weeding and 2x with reference to robotic hand pruning.

*Respondents were asked what technical challenges or emerging technologies they would like support on. It was an open-text question and responses have been aggregated into categories as best possible. 61% of respondents wrote at least one topic. This question was new in the 2022 edition.

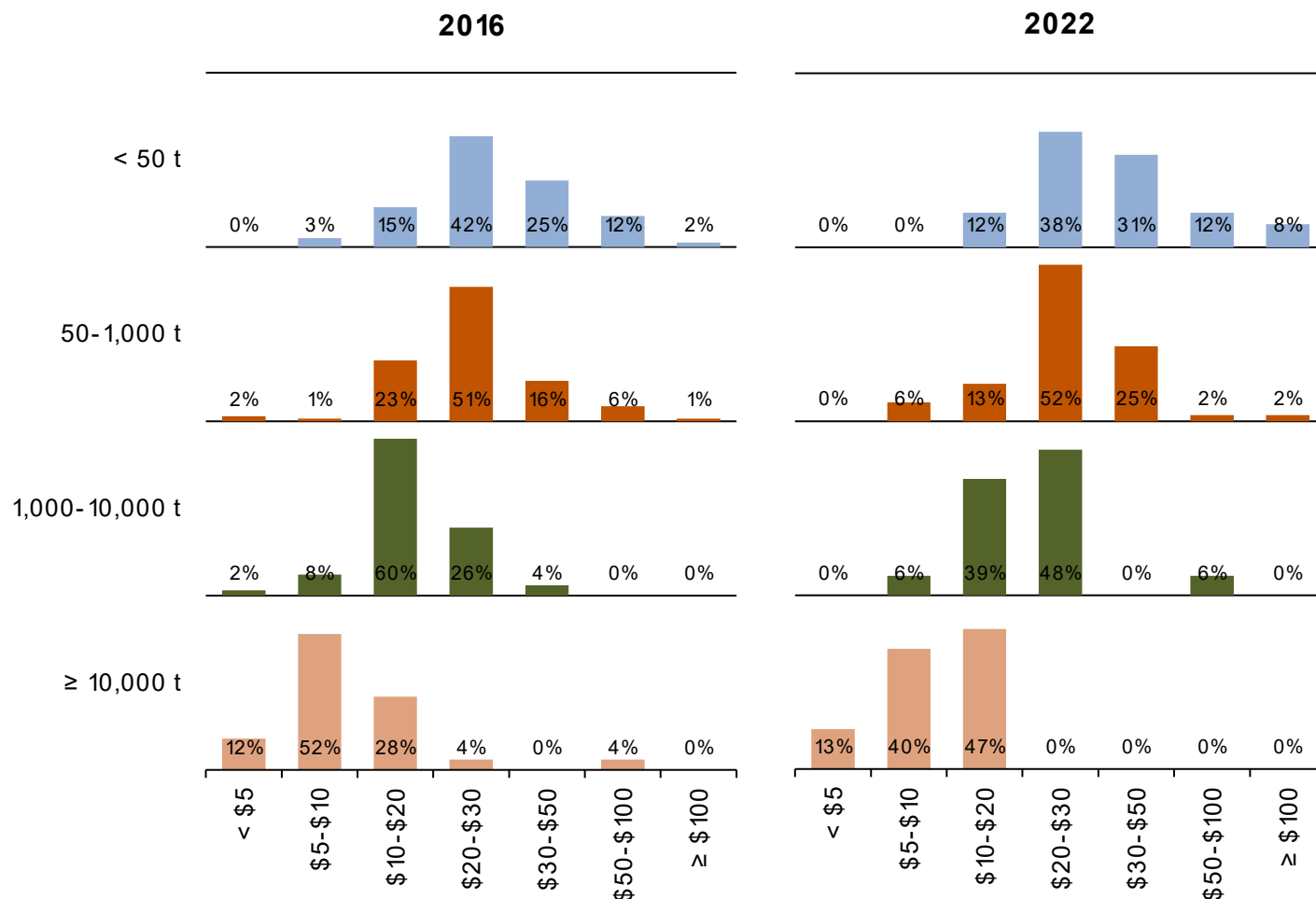
Winery red-white grape intake mix and products (made at all on site)



- There was a similar red-white grape mix in 2022 as in 2016.
- The number of product types increased with winery size in 2022 like it did in 2016 (data not shown).
- Few wineries also made cider, beer and gin.
- De-alcoholised wines and other low alcohol wine products were made predominantly by large wineries.

*If the respondent processed grapes, 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, and whether they had been sent off-site for some processing, e.g. for alcohol removal.

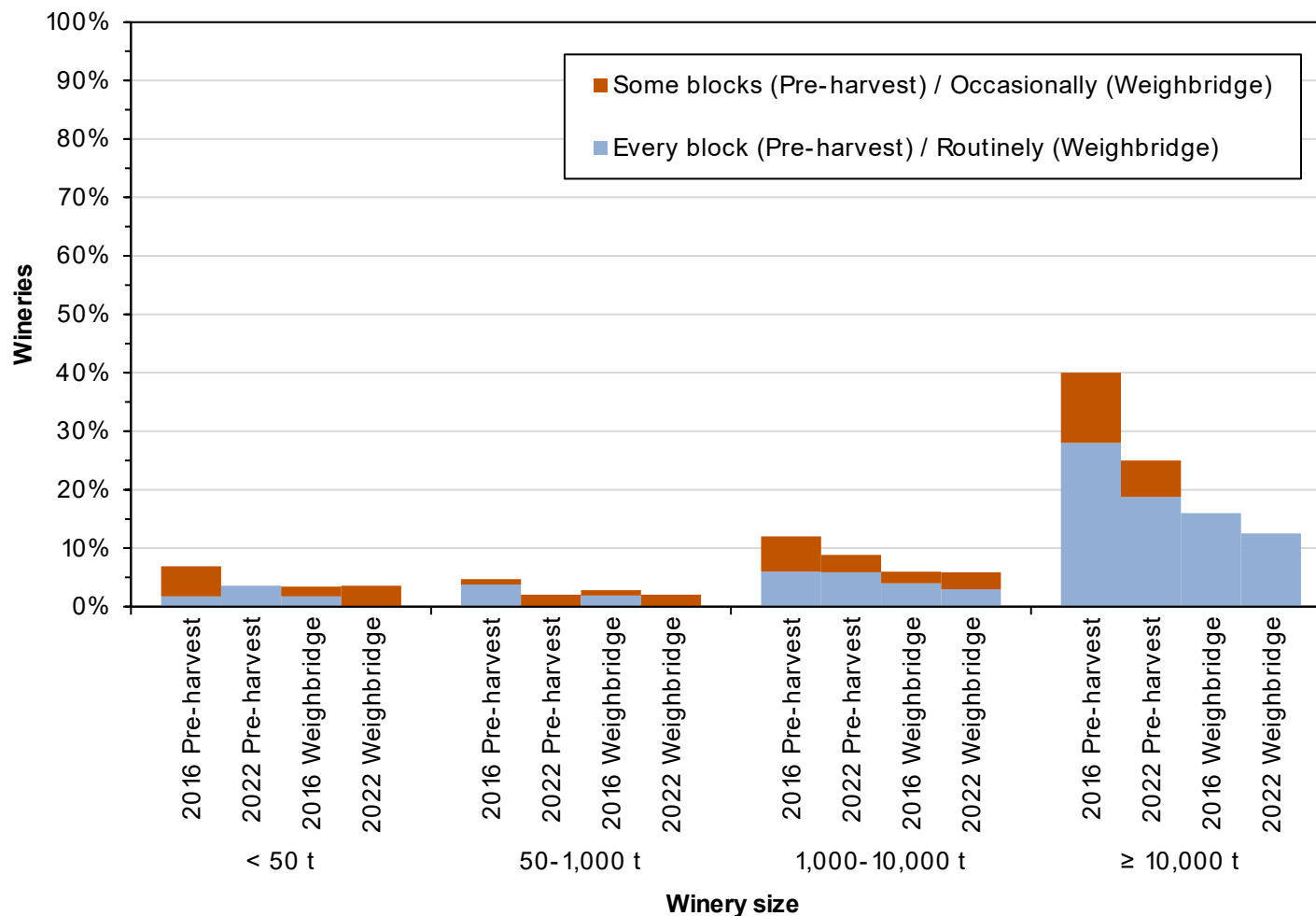
Retail price of largest volume product made at the site (per 750 mL)



- As in 2016, the 2022 data suggests that smaller wineries produce higher priced wines on average.
- For larger wineries there was a general shift upwards in the nominal price between 2016 and 2022 surveys, with the most common bracket for 1,000 – 10,000 t wineries being \$20-\$30 in 2022 versus \$10-\$20 in 2016, and for ≥ 10,000 t wineries being \$10-\$20 versus \$5-\$10 in 2016.
- While in 2022 the largest volume product for all ≥ 10,000 t wineries was < \$20, as in 2016, there was a split in these wineries with regards to the highest value product made on site (data not shown) with it being < \$30 for 60% of wineries and > \$50 for the other 40% of wineries, reflecting that some large wineries focus on modestly priced wines, while others produce both these and luxury 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.

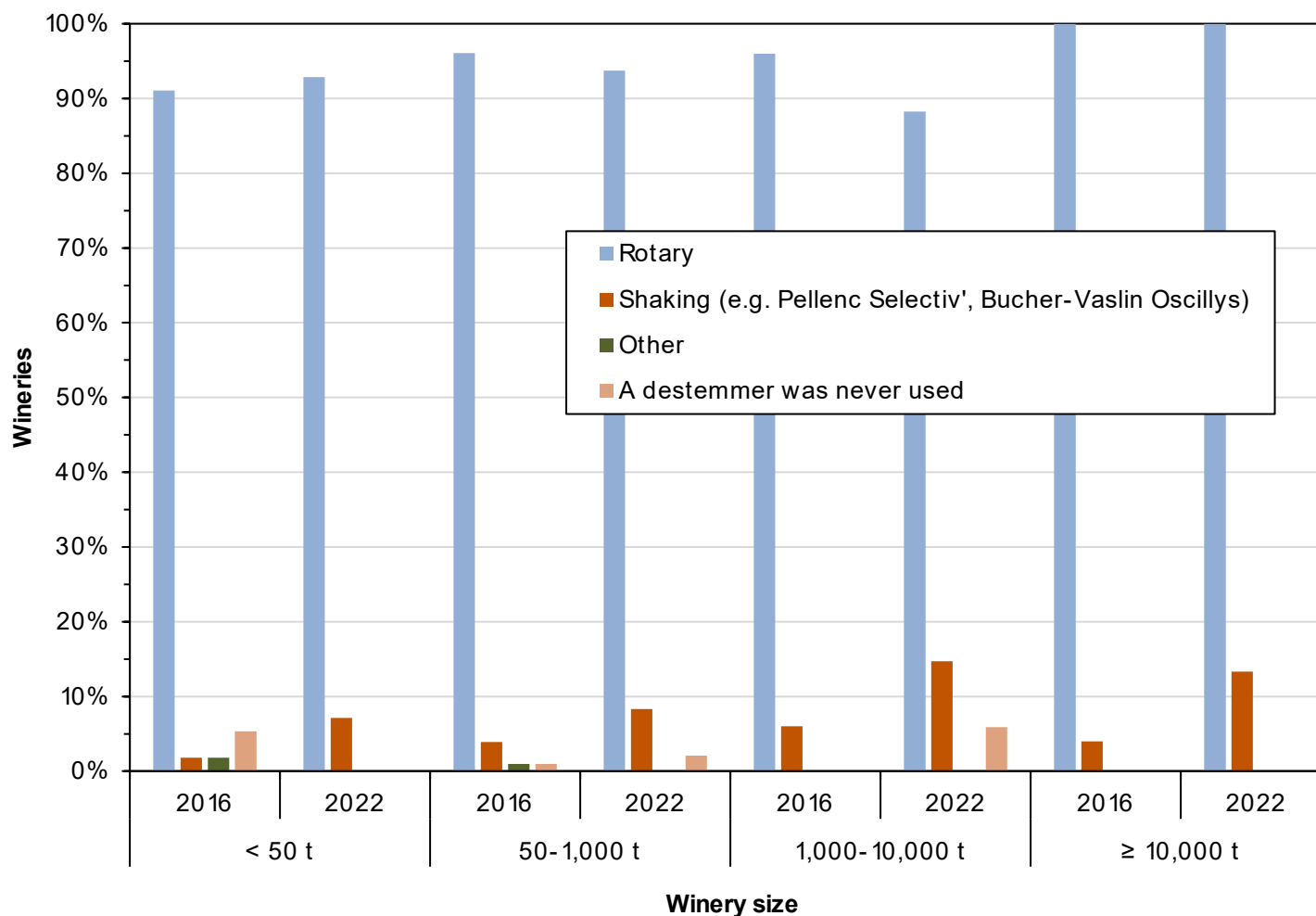
Pre-harvest / weighbridge measurements of red grape colour, phenolics, or tannin



- Colour measurements were more commonly adopted by larger wineries.
- Prevalence of measurements was slightly lower in 2022 than in 2016.

*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.

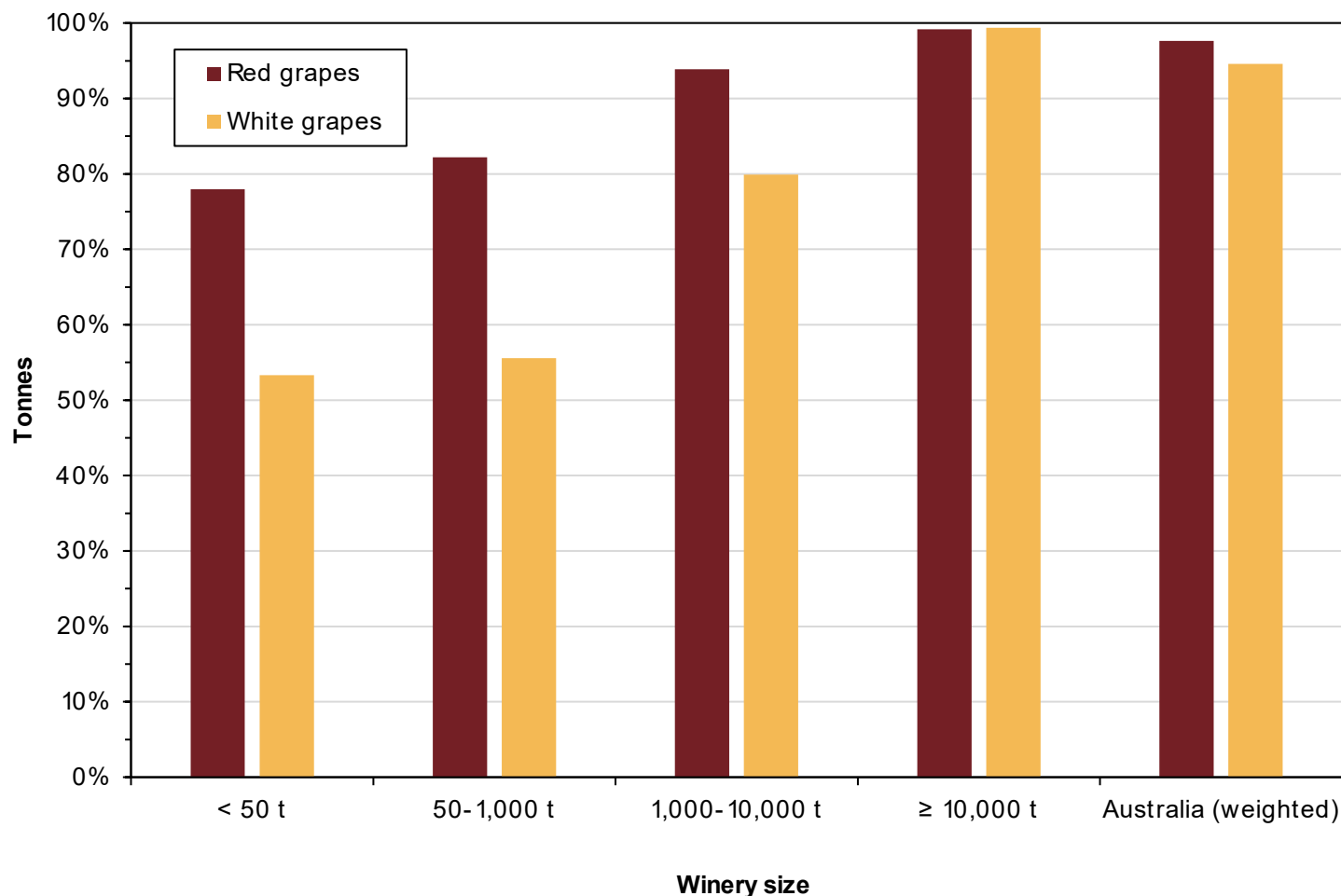
Winery destemming equipment (used at all)



- Rotary destemmers were the predominant destemmer type used by wineries.
- Shaking destemmers were the next most common type of destemmer and the number of wineries using these increased in wineries of all sizes between 2016 and 2022.

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

Destemmed at the winery



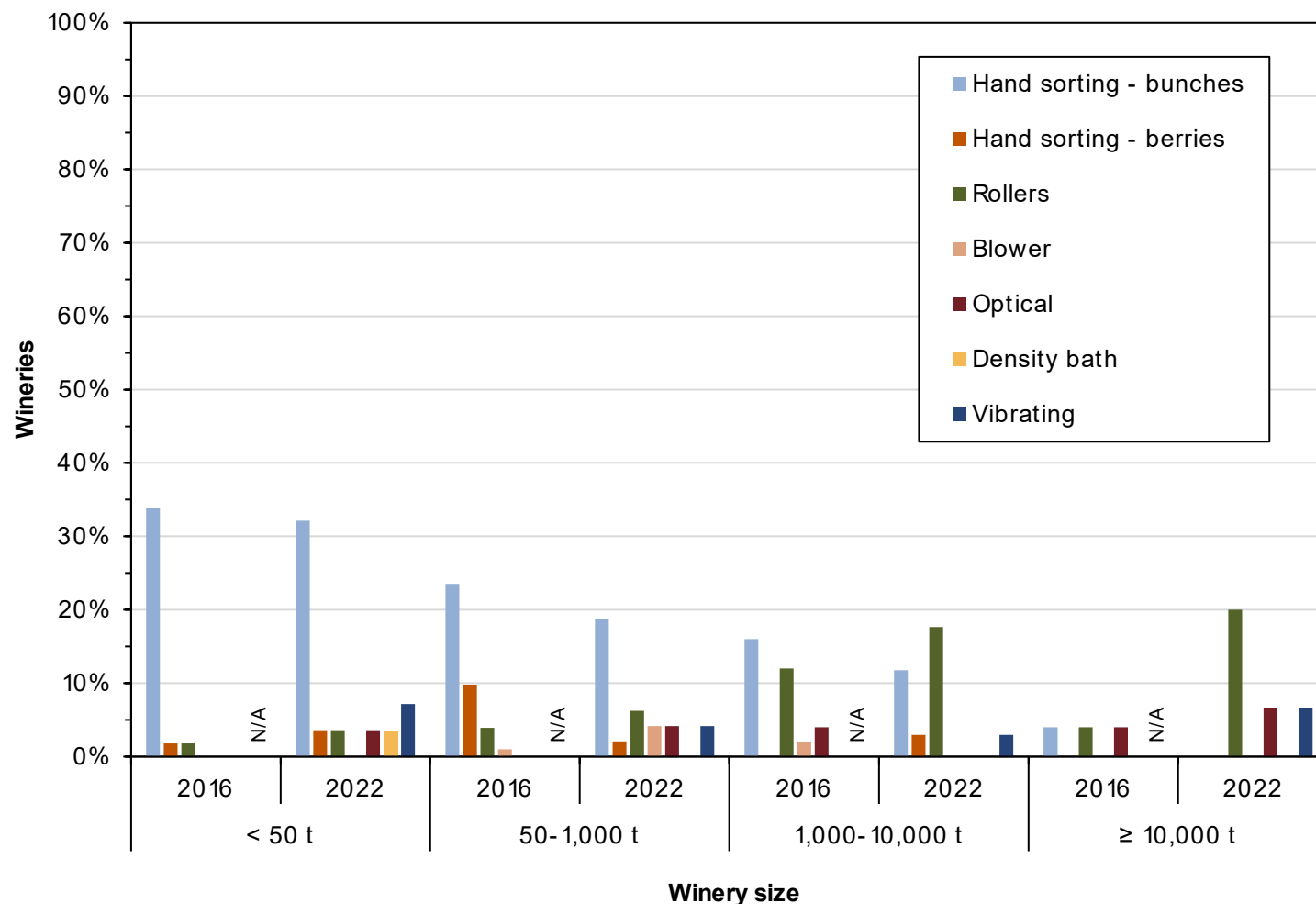
Weighted values for Australia

	2016	2022
Destem All	N/A	96%
Destem Red	N/A	98%
Destem White	N/A	95%

- Most grapes were destemmed.
- Smaller wineries were more likely to not destem than larger wineries.
- White grapes were more likely to not be destemmed than red grapes.
- Some grapes may have already been harvested using a harvester with a destemmer (see page 73).
- Improvements in question structure mean that the data from this 2022 survey is likely more accurate for smaller wineries than it was in the 2016 survey.

*Respondents that selected that they used a destemmer at the winery, 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. If the winery selected that they had not used a destemmer the percentage was set to 0%.

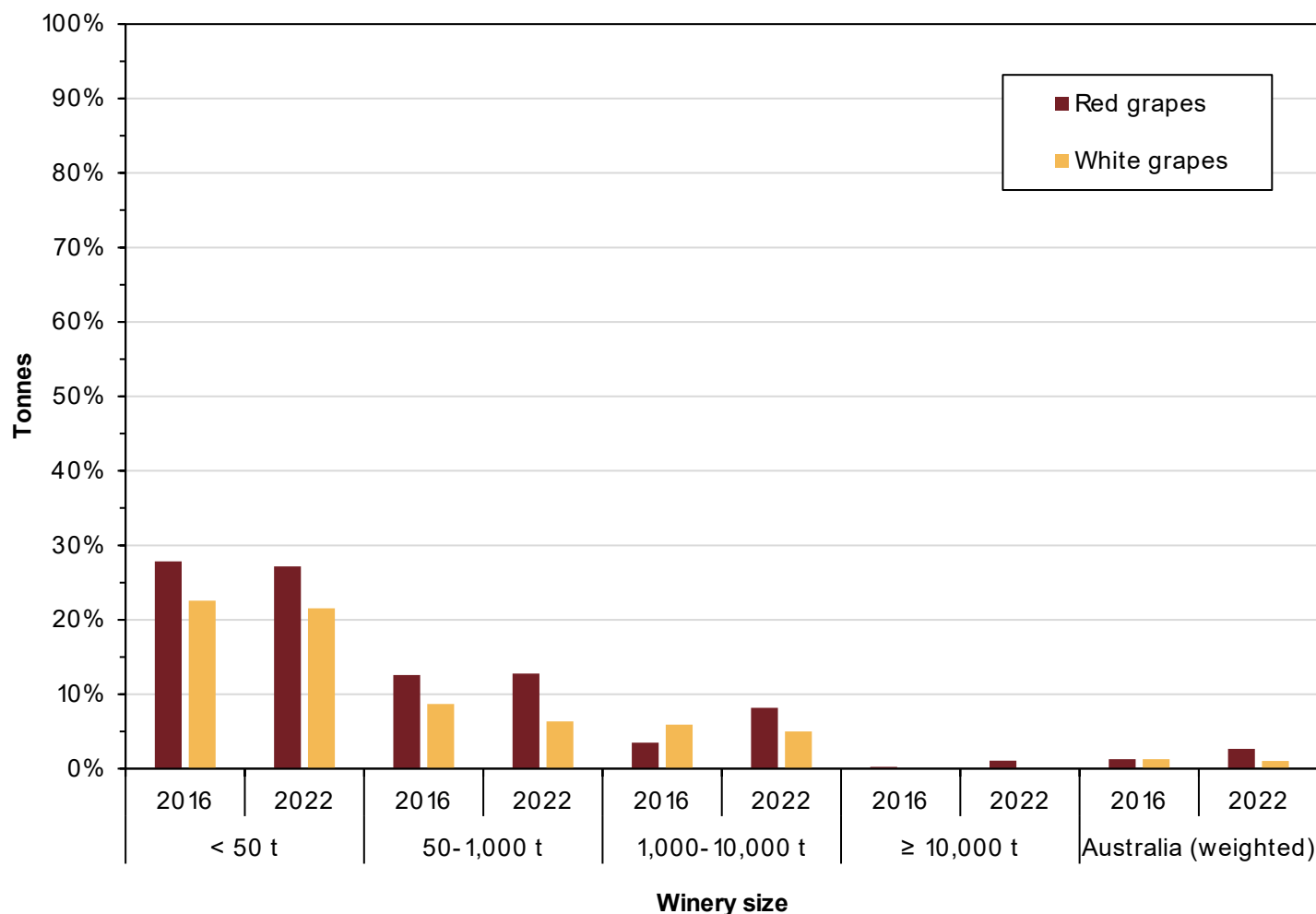
Winery sorting techniques/equipment (used at all)



- Hand sorting of bunches was the most widely used sorting technique and was more commonly performed in smaller wineries.
- Roller sorting was the most common mechanical sorting technique and the proportion of wineries using roller sorters increased between 2016 and 2022.

*Respondents were first asked whether any sorting was performed. If they answered yes, they were then asked to select all the sorting techniques used. Vibrating sorting was added as an option in the 2022 survey.

Sorted at the winery



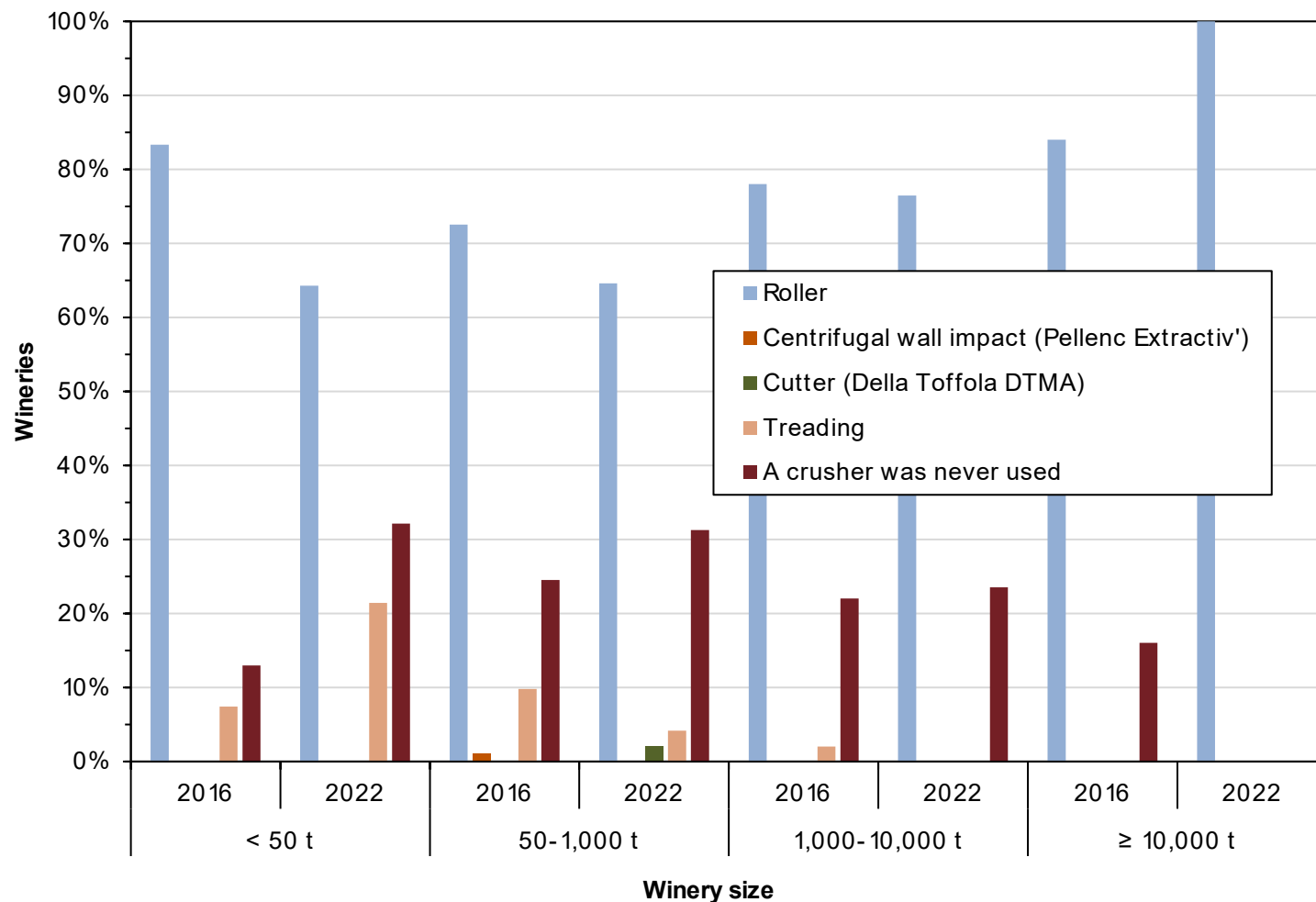
Weighted values for Australia

	2016	2022
Sorted All	1%	2%
Sorted Red	1%	3%
Sorted White	1%	1%

- Smaller wineries sorted a greater proportion of their intake than larger wineries.
- The amount of winery sorting was possibly slightly higher in 2022 compared with 2016.
- Apart from sorting in the winery, some sorting would have been performed in the vineyard during hand-picking and via rollers on some brands of destemming machine harvesters (see page 73).

*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.

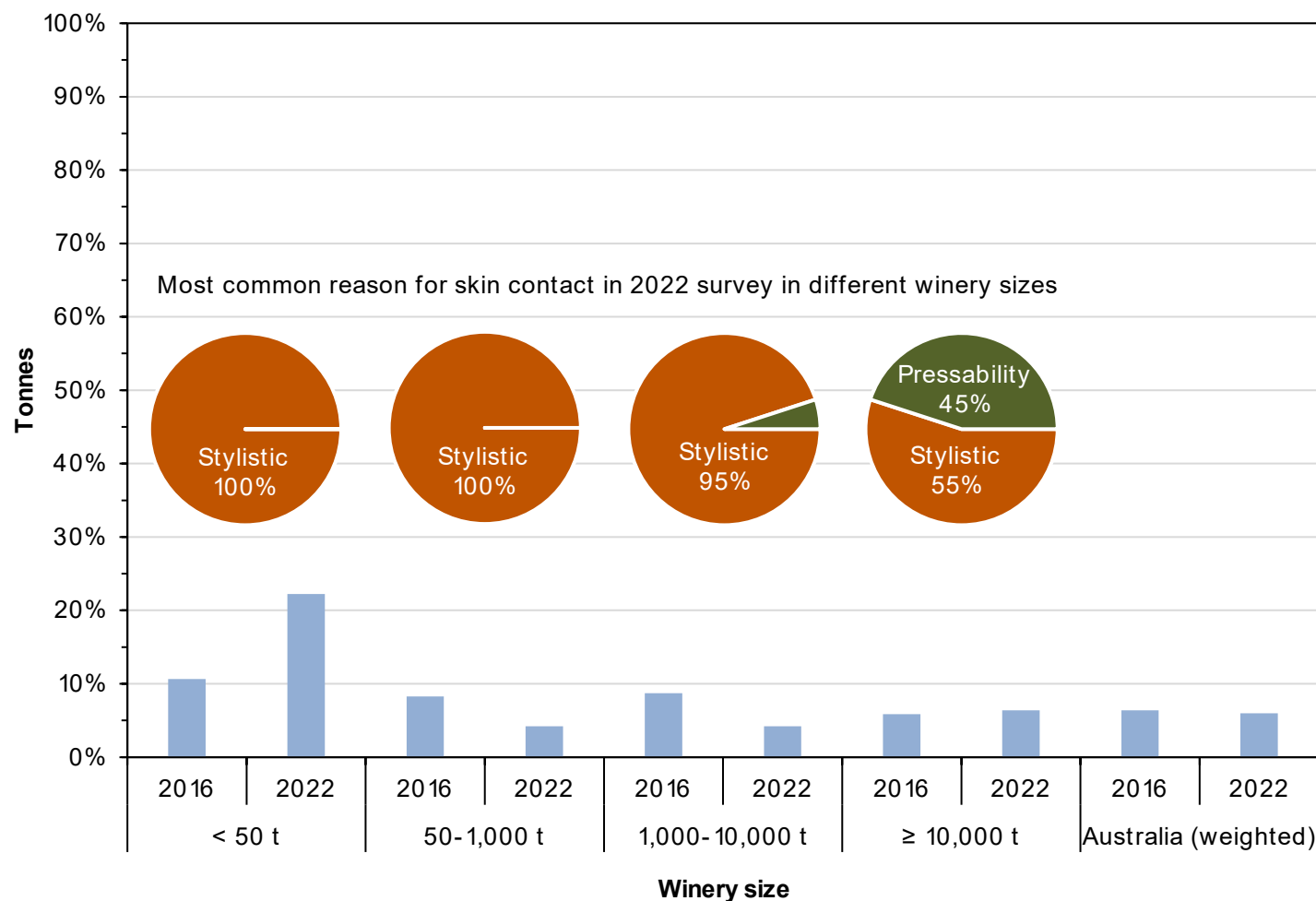
Crushers (used at all)



- Roller crushers were the predominant crusher type in use.
- Uptake of secondary processing equipment that aims to further cut/macerate skins after primary crushing has been very low.
- It is important to note that even without an explicit crusher, some degree of crushing will occur during machine harvesting, destemming and pumping.

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

Intentional white grape skin contact after crushing



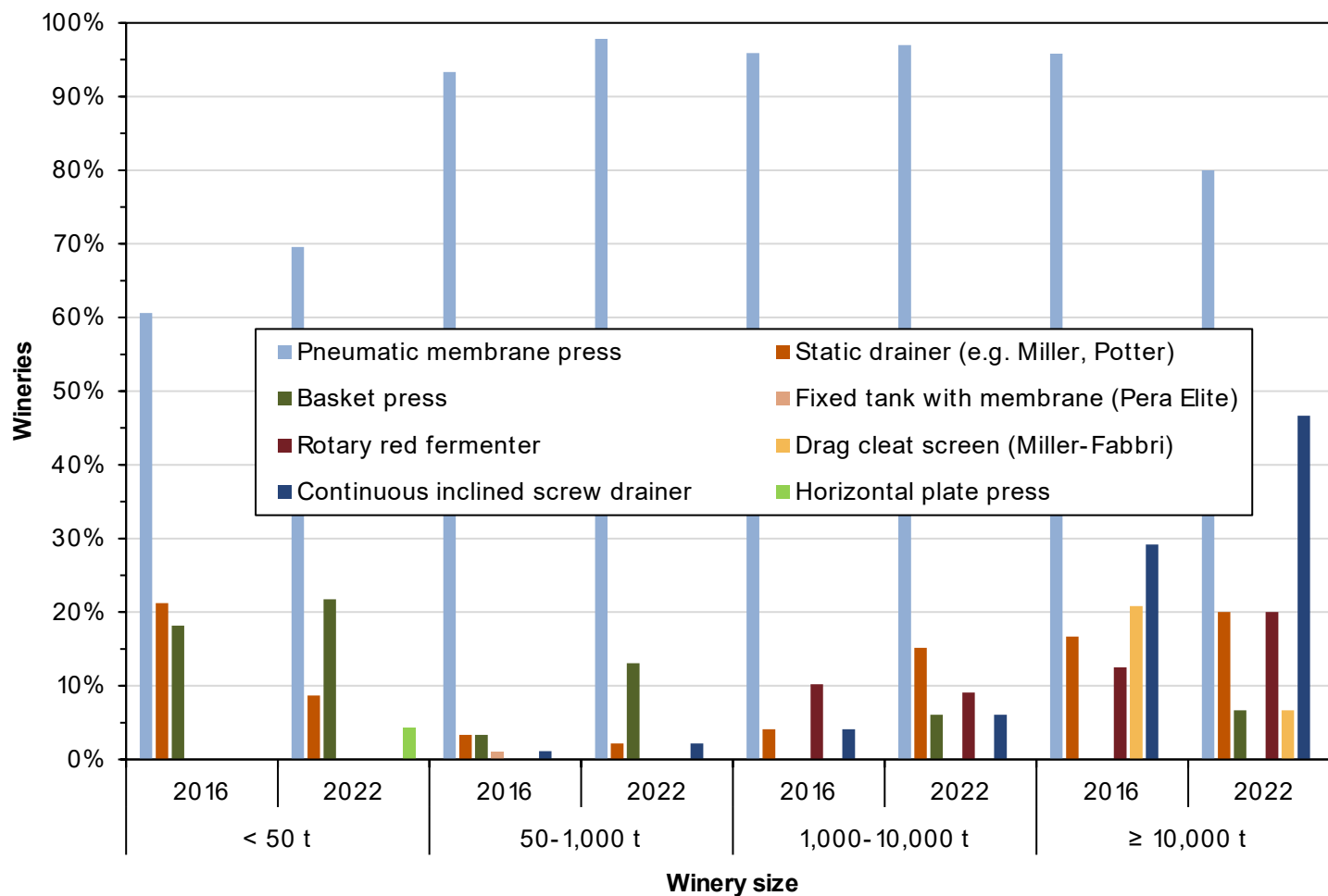
Weighted values for Australia

	2016	2022
Skin contact	6%	6%

- Many wineries performed small quantities of intentional skin contact after crushing.
- In the 2022 survey, a follow-up question was added on the most common reason for intentional skin contact.
- For small wineries the most common reason for skin contact was stylistic, while for larger wineries it was sometimes about pressability (consistent with 2016 survey follow-up discussions where making Gordo easier to press was mentioned).

*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. In the 2022 survey they were further asked to select whether the skin contact was mostly for stylistic or pressability reasons.

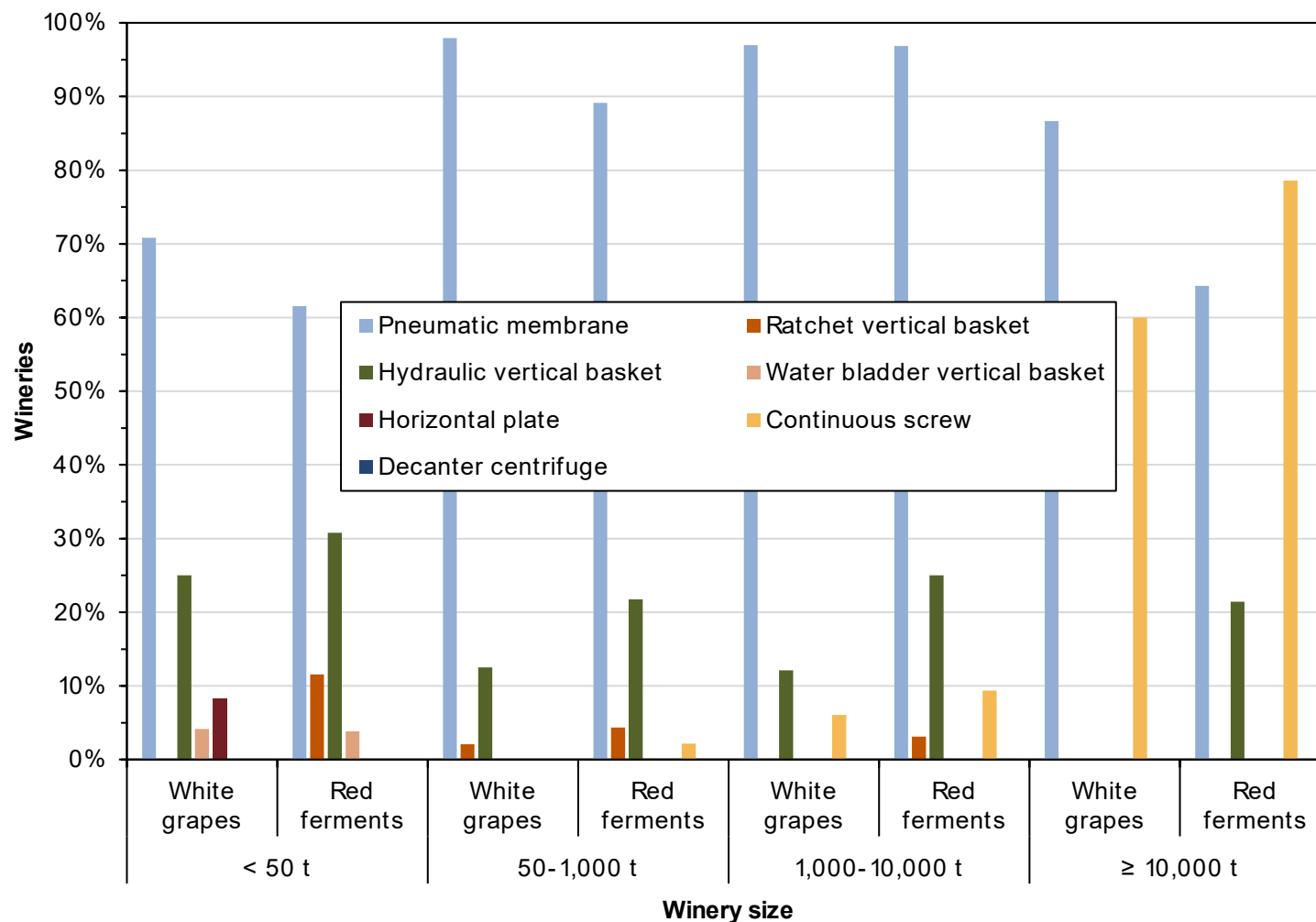
White juice draining equipment (used at all)



- Membrane presses were the dominant equipment used for white juice draining in wineries of all sizes.
- While the data shows some differences in equipment types used in large wineries between 2016 and 2022, these reflect different wineries responding rather than any technology adoption shifts.

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

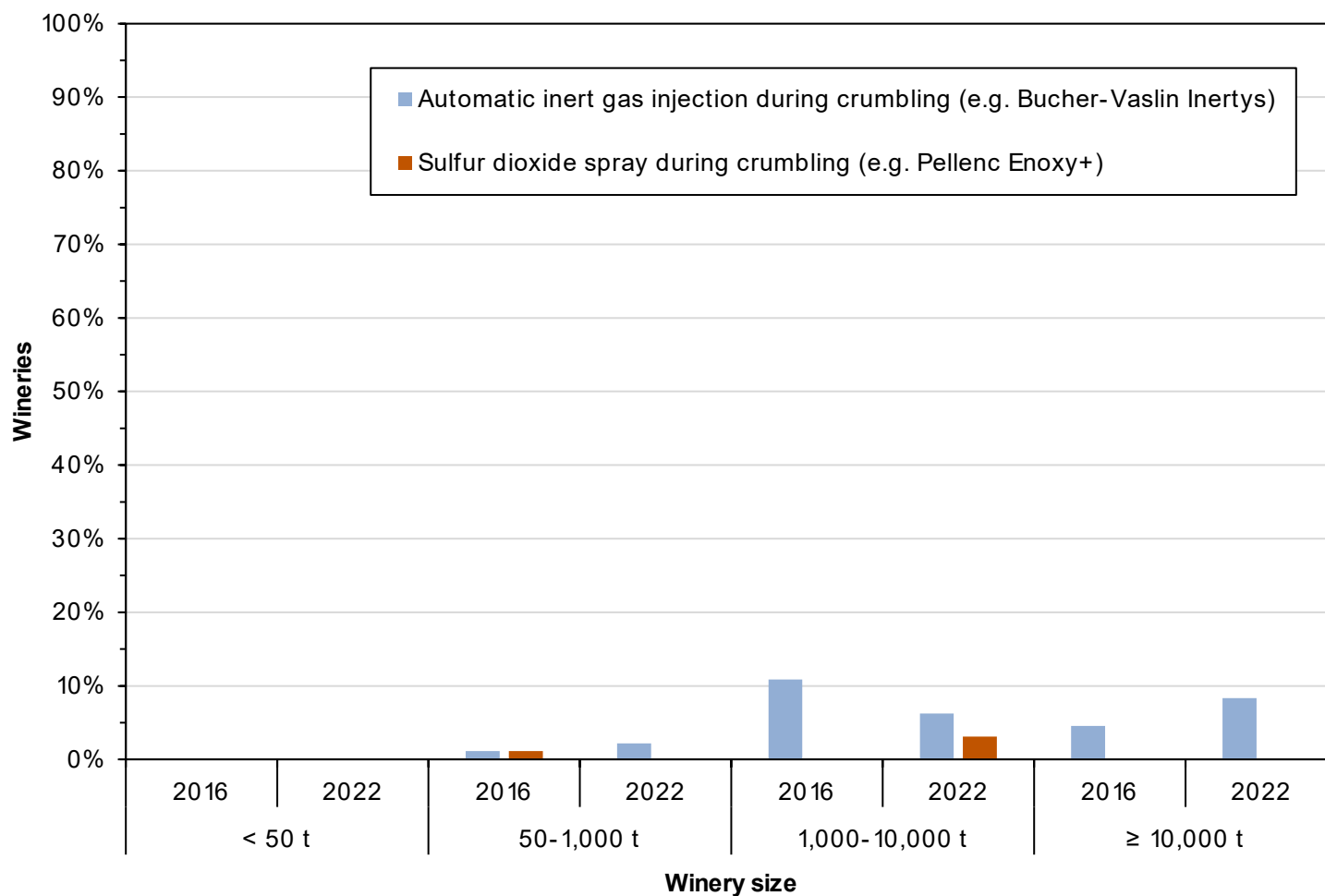
Pressing equipment for white grapes and red ferments (used at all)



- Pneumatic membrane presses were the most common press type in all winery size categories.
- Hydraulic vertical basket presses were more commonly used for red than white production.
- Continuous screw presses were used in many very large wineries.
- Decanter centrifuges were not used as a press substitute by any winery.
- The relative use of continuous screw presses to membrane presses in the 2022 survey was higher than in 2016 in very large wineries, but this is a consequence of different wineries responding, rather than a real change (the trend is away from continuous screw presses towards membrane presses when funds are available for equipment investment).

*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. Only the 2022 data is presented. A similar question was asked in 2016, but the distinction between different styles of basket presses was not as clear as it could be, so they were aggregated together in reporting. The wording was improved in the 2022 survey.

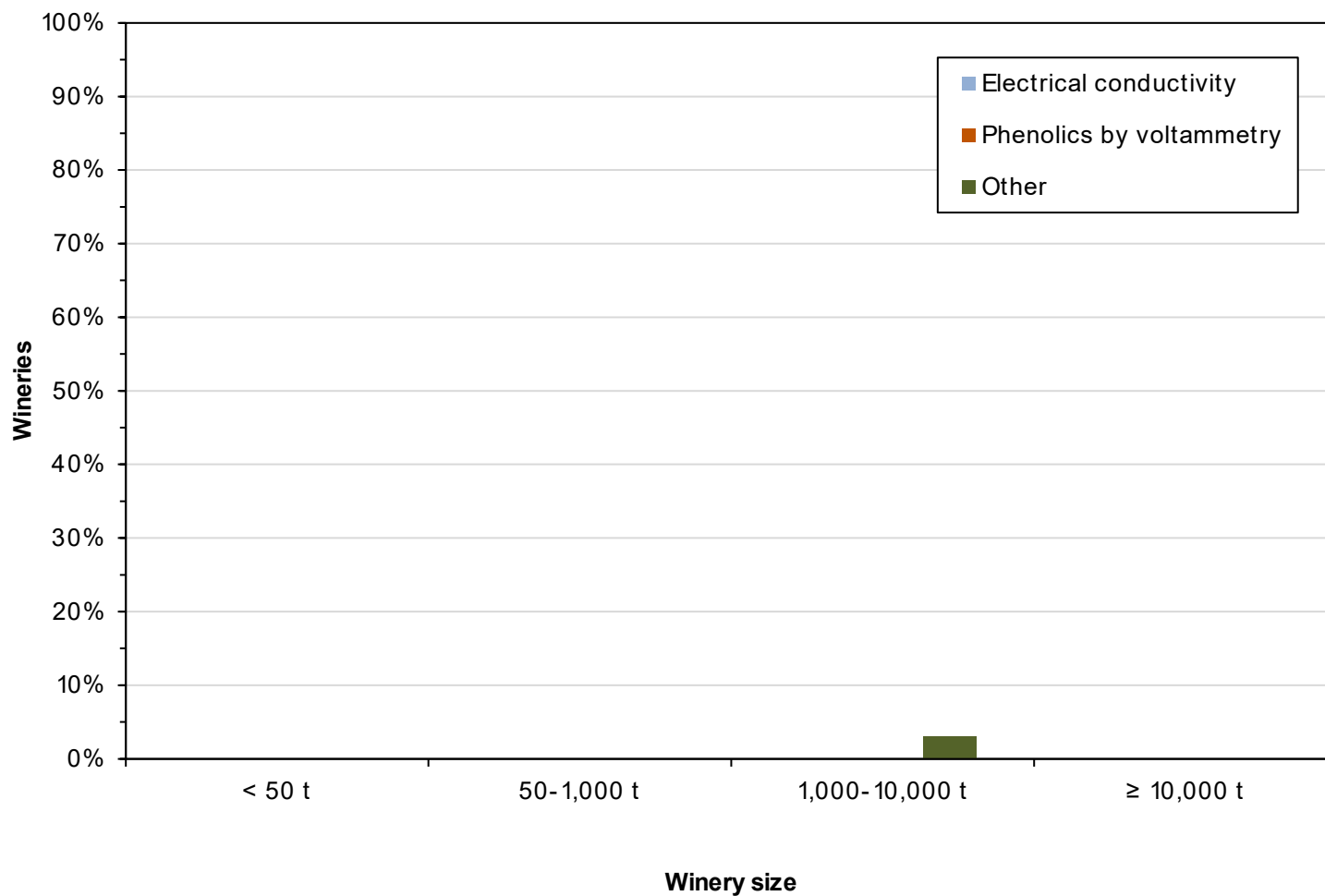
Oxidation prevention systems on membrane presses for white grapes (used at all)



- A small number of wineries had a press fitted with a system to inject inert gas during crumbling.
- Adoption levels in 2022 were similar to what they were in 2016.

*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 systems to prevent oxidation during crumbling and to select the systems used from a list.

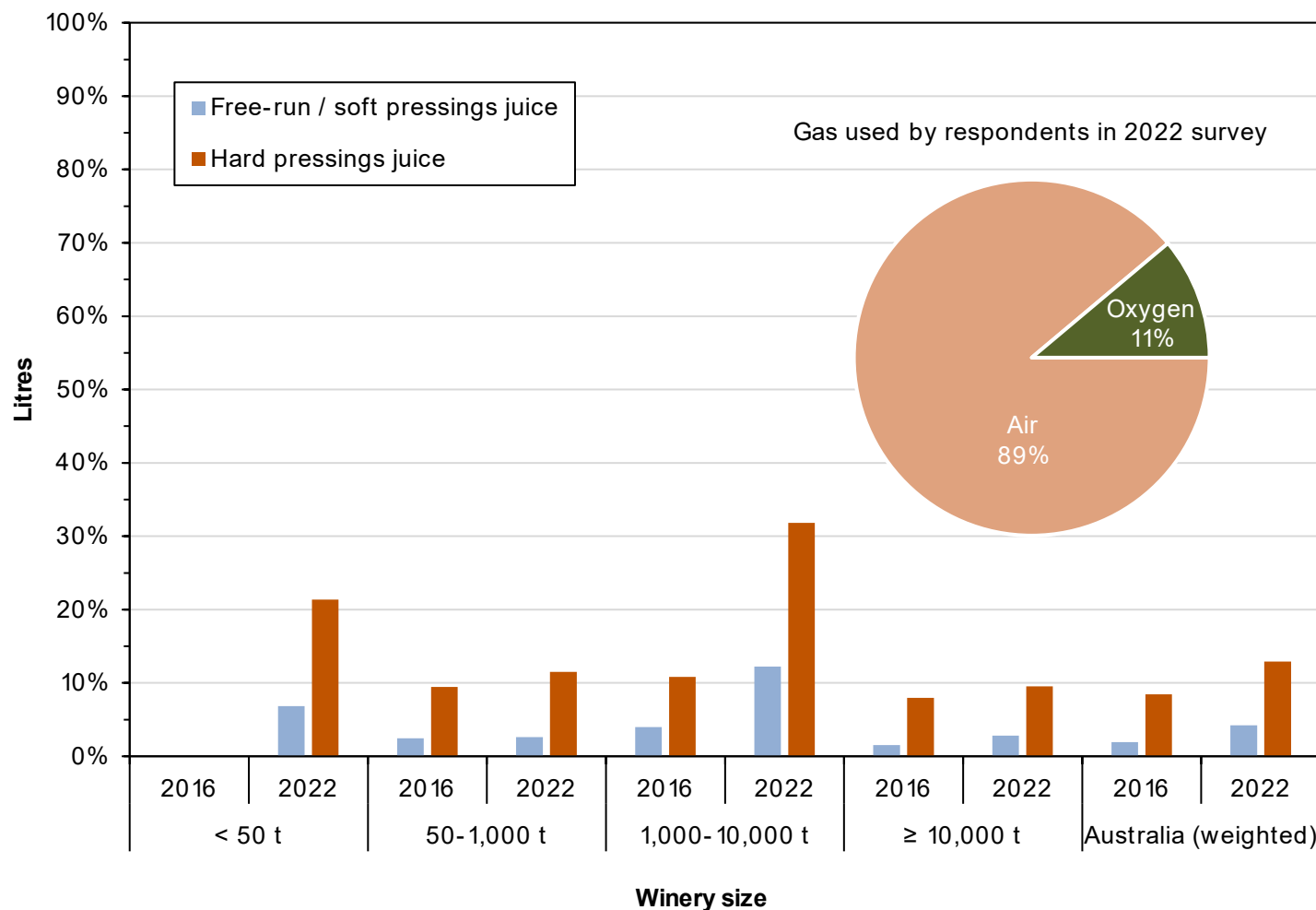
In-line or at-line analytical instruments to aid white press cut decisions (used at all)



- There was very low adoption of analytical instruments to aid in making press cut decisions.
- The single 'Other' response noted was a pH meter.

*Respondents that had selected that they used a membrane press to press white grape material were asked whether any in-line or at-line analytical instruments were used to aid decisions on press cuts, excluding flow meters. This question was not asked in 2016. The plot shows data for 2022.

Hyperoxidation of white juice



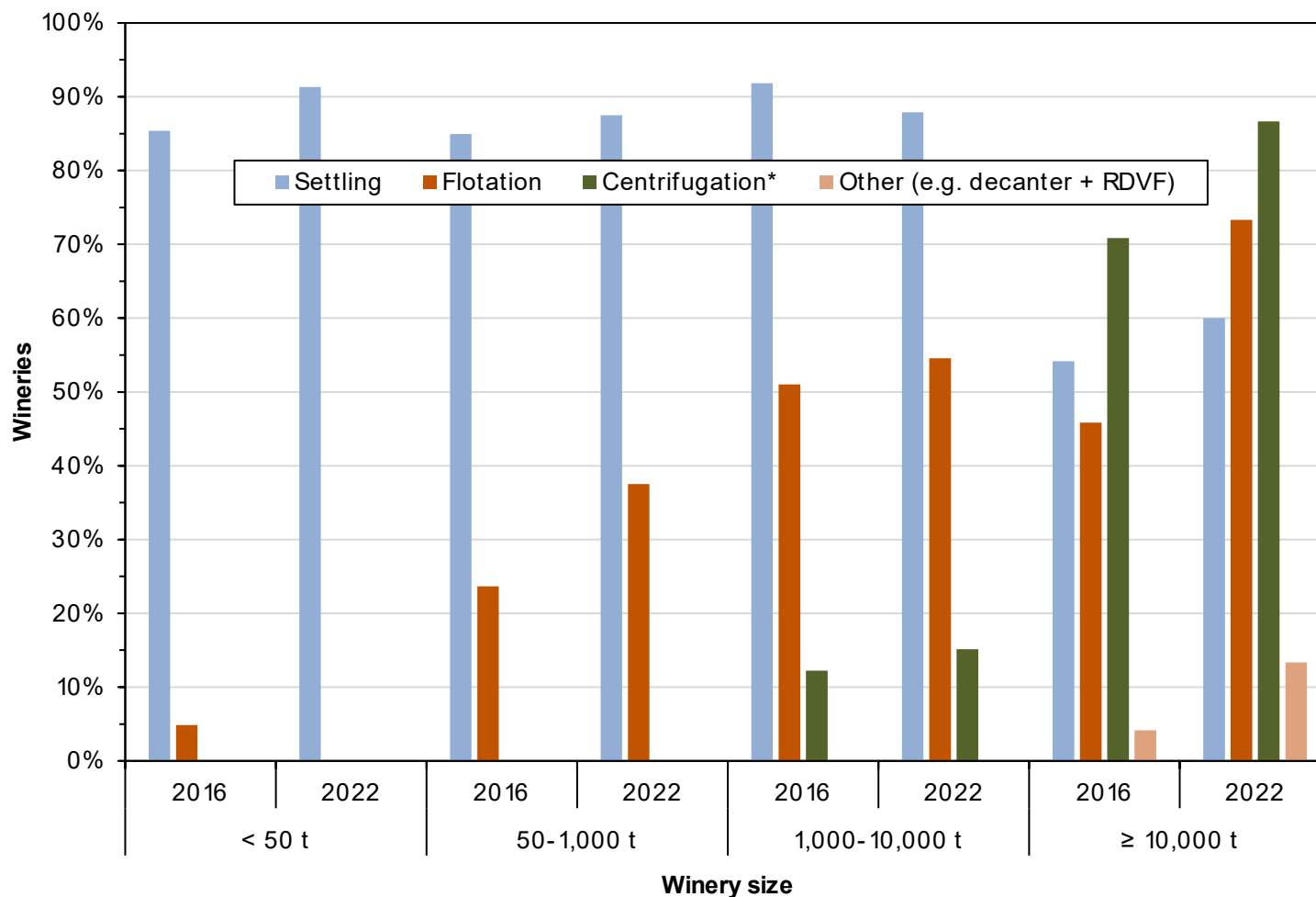
Weighted values for Australia

	2016	2022
Hyperoxidation FR/SP	2%	4%
Hyperoxidation HP	8%	13%

- Hyperoxidation was more commonly performed on harder pressings juices.
- Between 2016 and 2022 there likely has been an increase in the use of hyperoxidation in 1,000 - 10,000 t wineries.
- A question on whether air or near pure oxygen was used for hyperoxidation was added in the 2022 survey, and most used air.
- It wasn't captured in this survey, but a few wineries have since started processing some heavy pressings juices by ultrafiltration instead of using hyperoxidation or fining.

*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 of intake that was white grapes. In the 2022 survey, those performing hyperoxidation were also asked whether they used air/compressed air or near pure oxygen.

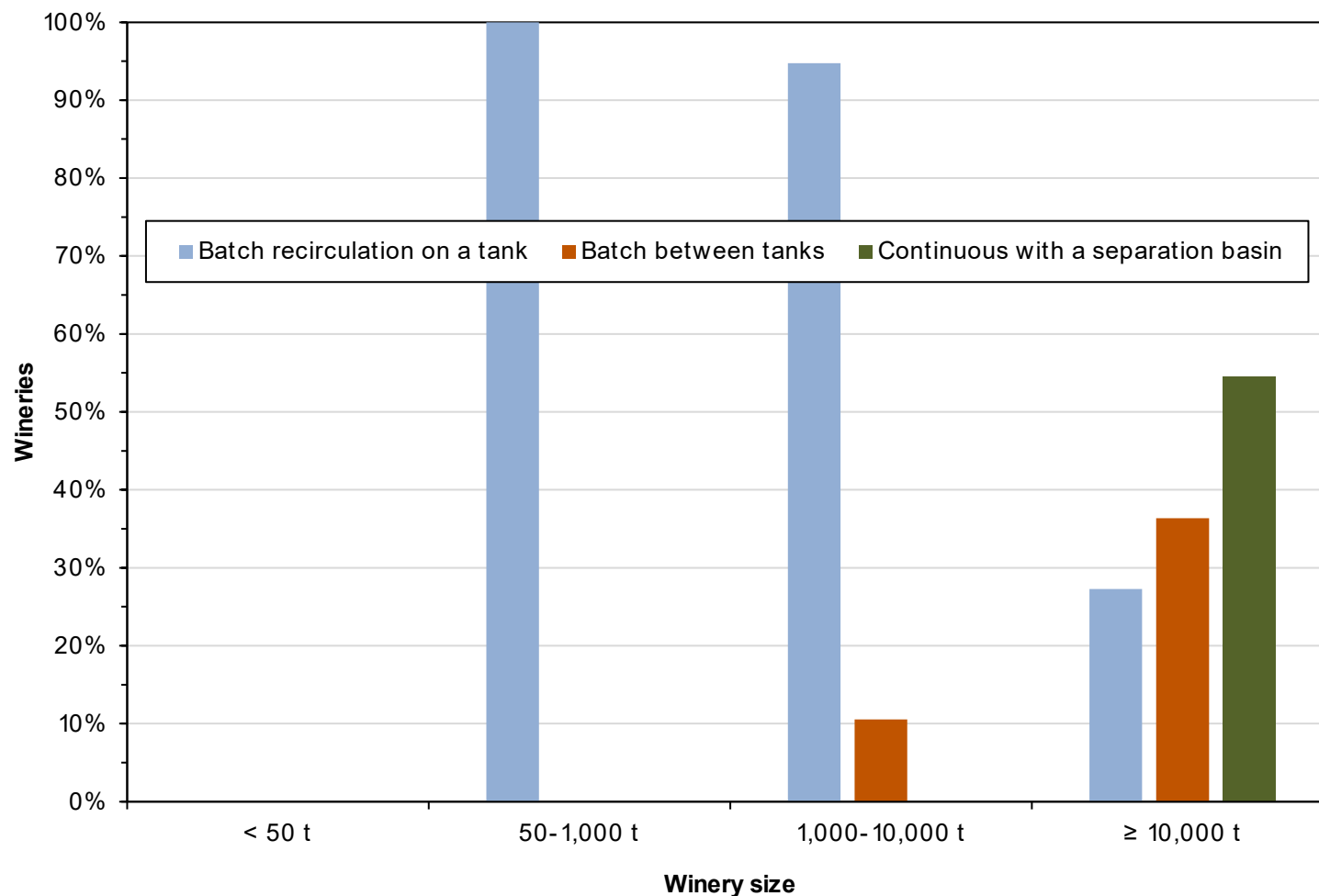
White juice clarification techniques (used at all)



- Cold settling is the classic method used to clarify white juice.
- Larger wineries are more likely to use faster alternatives like centrifugation and flotation.
- Centrifugation was often used in large wineries. The asterisk in the chart denotes that it is often employed in conjunction with an additional flotation or settling step, most commonly flotation on the centrifuge outlet.
- The flotation in the plot refers to single-stage flotation (without centrifugation), and adoption of flotation increased between 2016 and 2022.
- In the 2016 survey, flotation was the practice 2nd most nominated to have had a positive impact on operations in recent years, and this was again the case in the 2022 survey (see page 187).

Respondents were asked to select from a list all methods or combinations of methods used to clarify white juice prior to fermentation. Wineries using any of disc-stack centrifugation followed by flotation, disc-stack centrifugation followed by settling, settling then disc-stack centrifugation, and centrifugation alone, have been aggregated in the plot as centrifugation.

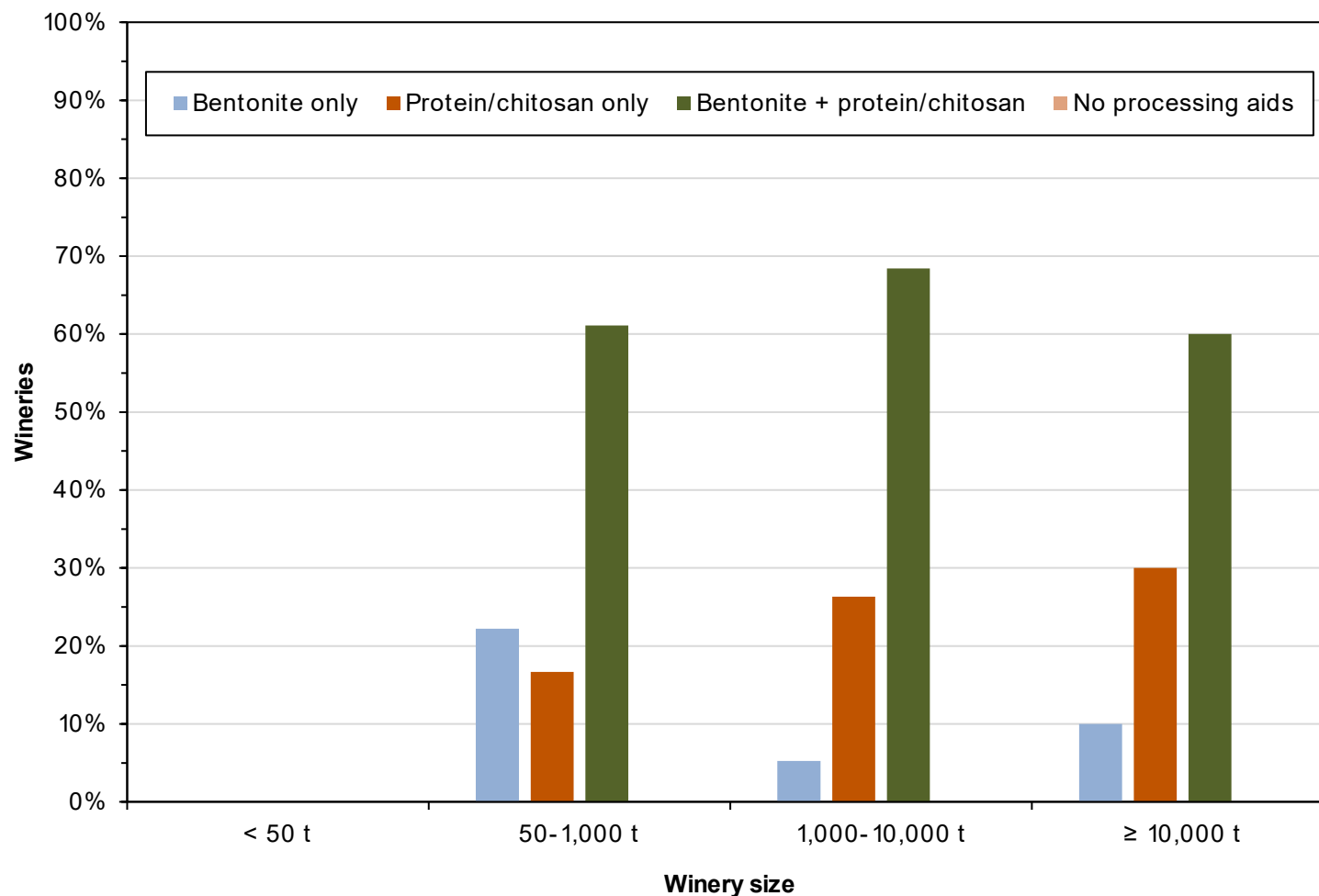
Flotation - Types of flotation equipment in wineries using flotation (used at all)



- Flotation systems operating by batch recirculation on a winery tank with later underneath racking (e.g. Juclas EasyFloat) were most common in all but very large wineries.
- Large wineries have increasingly adopted continuous flotation systems with a separation basin.
- Some older batch flotation systems operating tank to tank are also still used in large wineries.
- The specific type of flotation system was a new question in the 2022 survey.

¹Respondents that had selected that they used (single-stage) flotation were asked in the 2022 survey to select which styles of flotation equipment were used at the site. This question was not asked in 2016. The plot shows data for 2022.

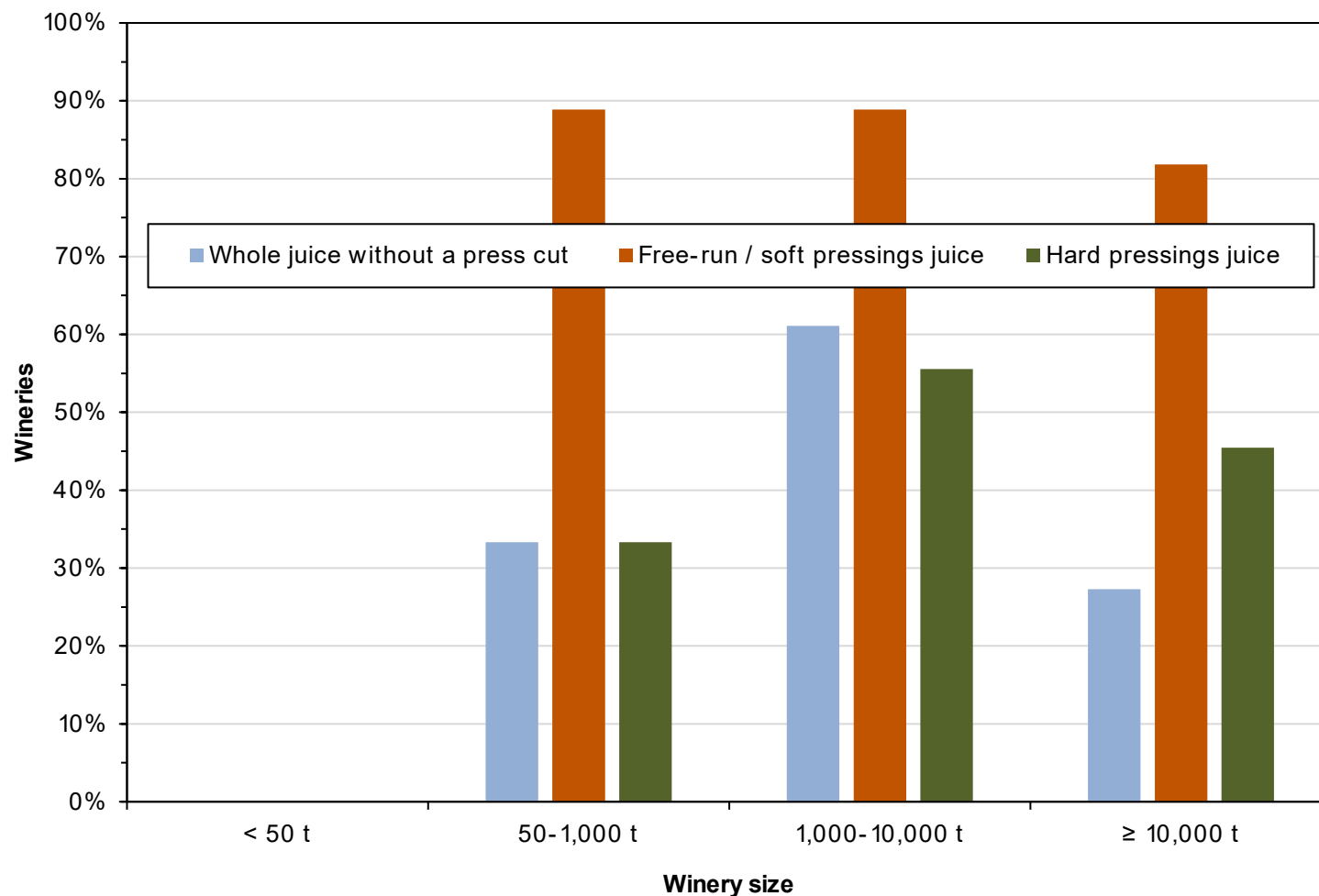
Flotation - Most common processing aid combination and gas used



- Bentonite together with a protein/chitosan was the most common processing aid combination used for flotation.
- No wineries commonly performed flotation without processing aids. This contrasts with flotation on the outlet of centrifuges, which is usually performed without processing aids at that point (notably, larger solids have already been removed by the centrifuge).
- Nitrogen was the dominant gas used for flotation. In 2022, only 11% of respondents ever used air, and of that 11% no winery used air more than they did nitrogen, matching 2016 survey data.

*Respondents that had selected that they used flotation were asked in the 2022 survey to select what combination of processing aids was most commonly used for flotation from the options shown. Respondents were also asked to select what % of flotation was performed using nitrogen versus compressed air to the nearest 10%. This question was not asked in 2016. The plot shows data for 2022.

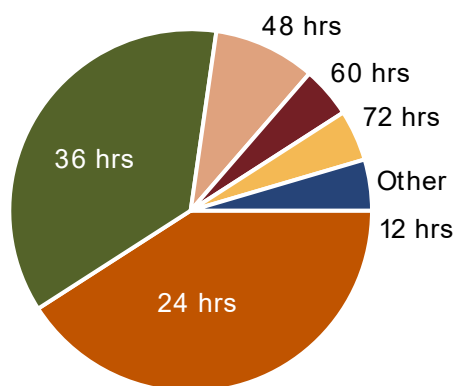
Flotation - Juice fractions (processed at all)



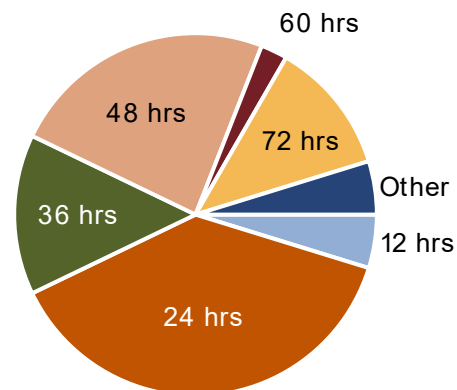
- Wineries commonly used flotation on free-run / soft pressings juice.

¹Respondents that had selected that they used flotation were asked in the 2022 survey to select which juice fractions they typically use flotation on. This question was not asked in 2016. The plot shows data for 2022.

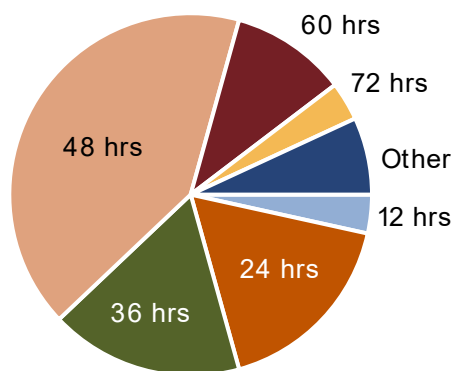
Cold settling - Most common settling time before racking



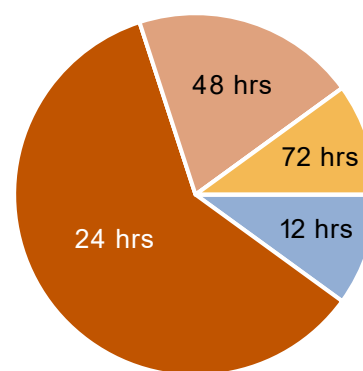
< 50 t



50-1,000 t



1,000-10,000 t

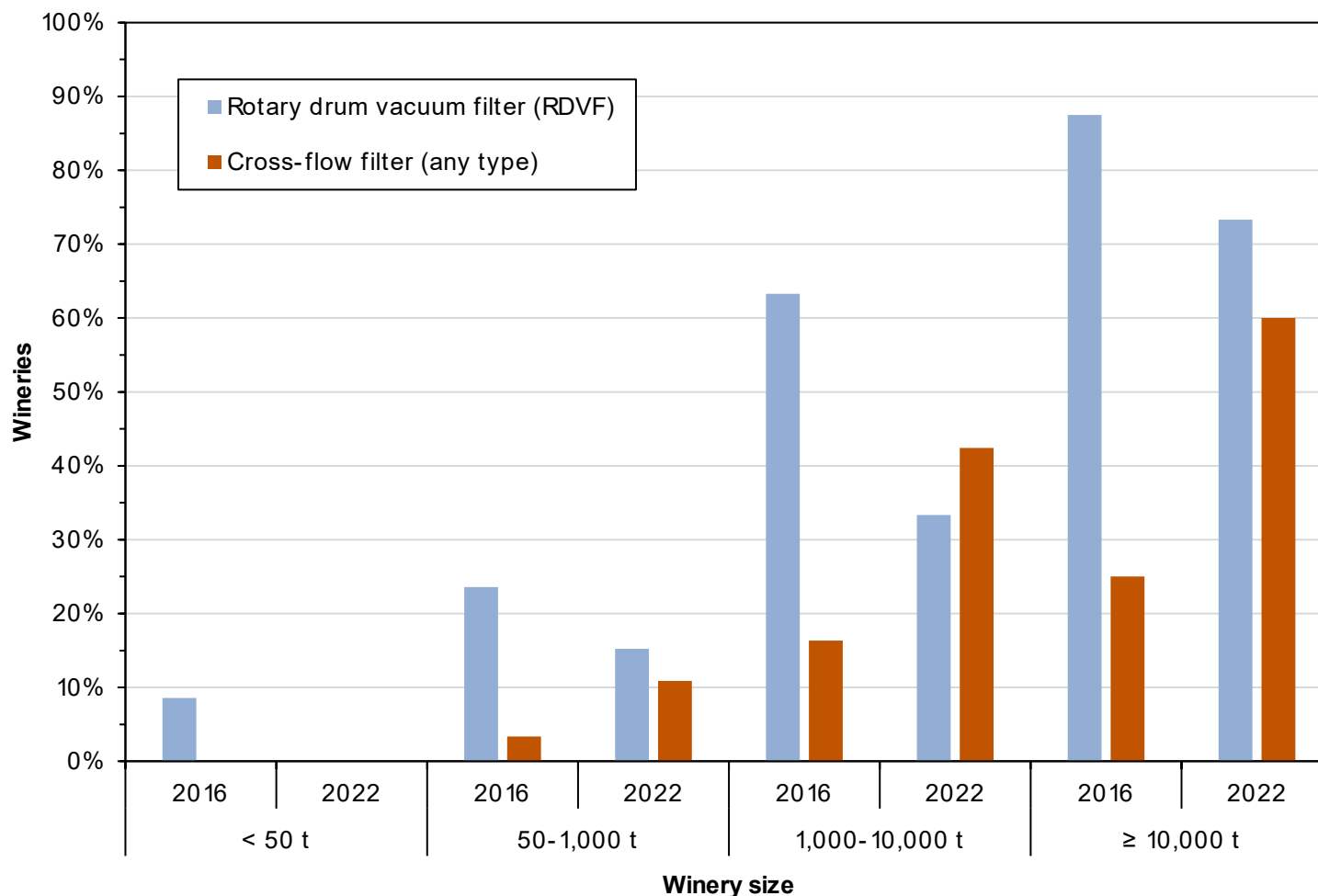


≥ 10,000 t

- Wineries most commonly racked juice 24-48 hrs after tank-filling.

*Respondents that had selected that they used settling, were asked in the 2022 survey to select the most common time between tank filling and juice racking from the options shown. This question was not asked in 2016. The plot shows data for 2022.

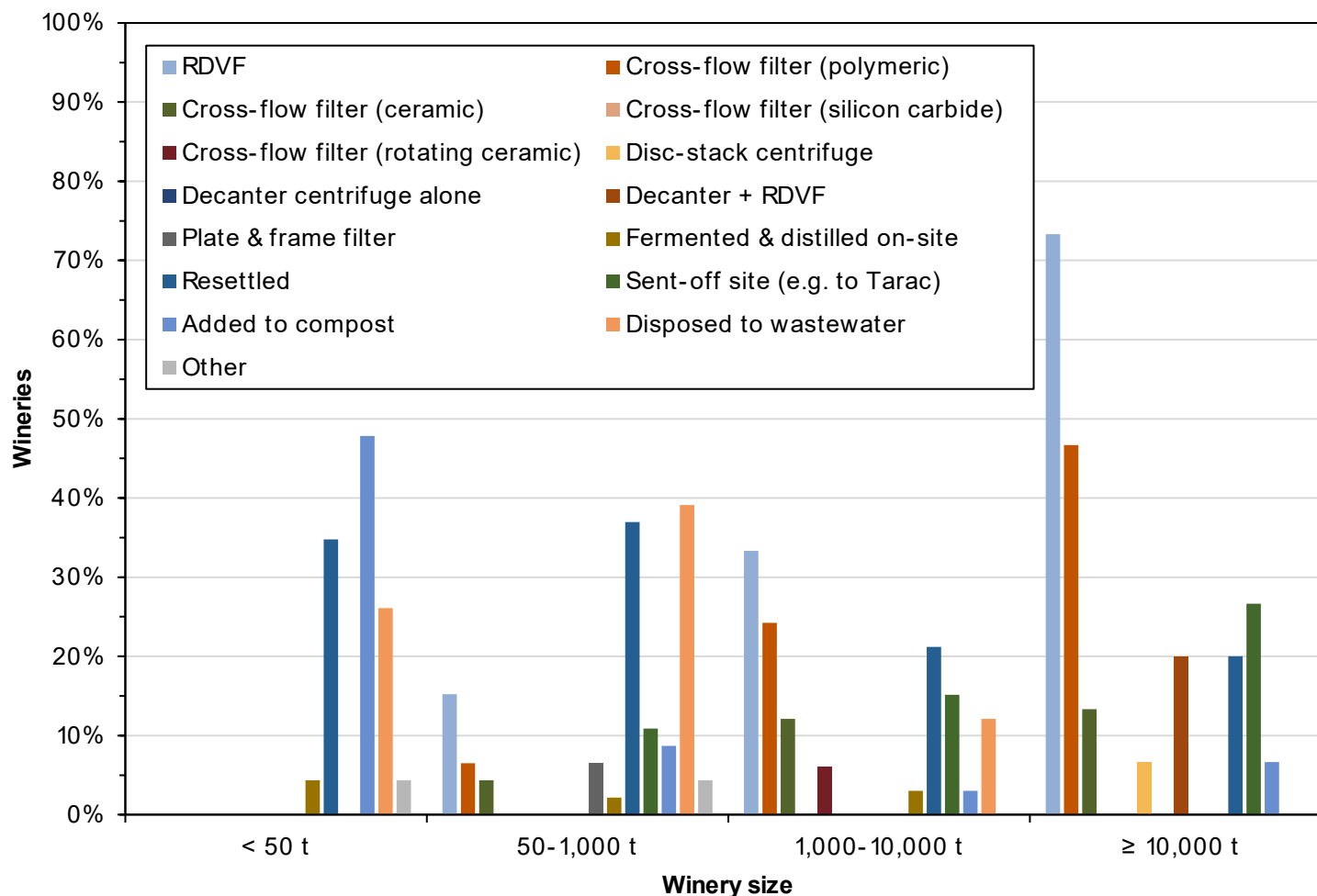
White juice lees/floats/desludge recovery by RDV or cross-flow filters (used at all)



- Between 2016 and 2022 there was a clear increase in the use of cross-flow filters for processing white juice lees.
- As with most technologies, larger wineries were earlier adopters.
- The increase in cross-flow filters was accompanied by a reduction in the use of rotary drum vacuum filters (RDVF), although these remain an important technology.
- A detailed breakdown of all technologies used for processing white juice lees materials in 2022 is provided on the next page, including the use of cross-flow filters with different types of membranes.
- Cross-flow filtration was by far the most commonly nominated new practice to have a positive impact mentioned in 2022, as it had been in 2016, but in 2022 there was a greater focus on lees than wine (see page 187).

*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. In the 2022 survey, the details on some options were expanded to collect information on topics like different cross-flow membrane filter materials, but all cross-flow filters have been aggregated into a single category in this plot to allow comparison between 2016 and 2022.

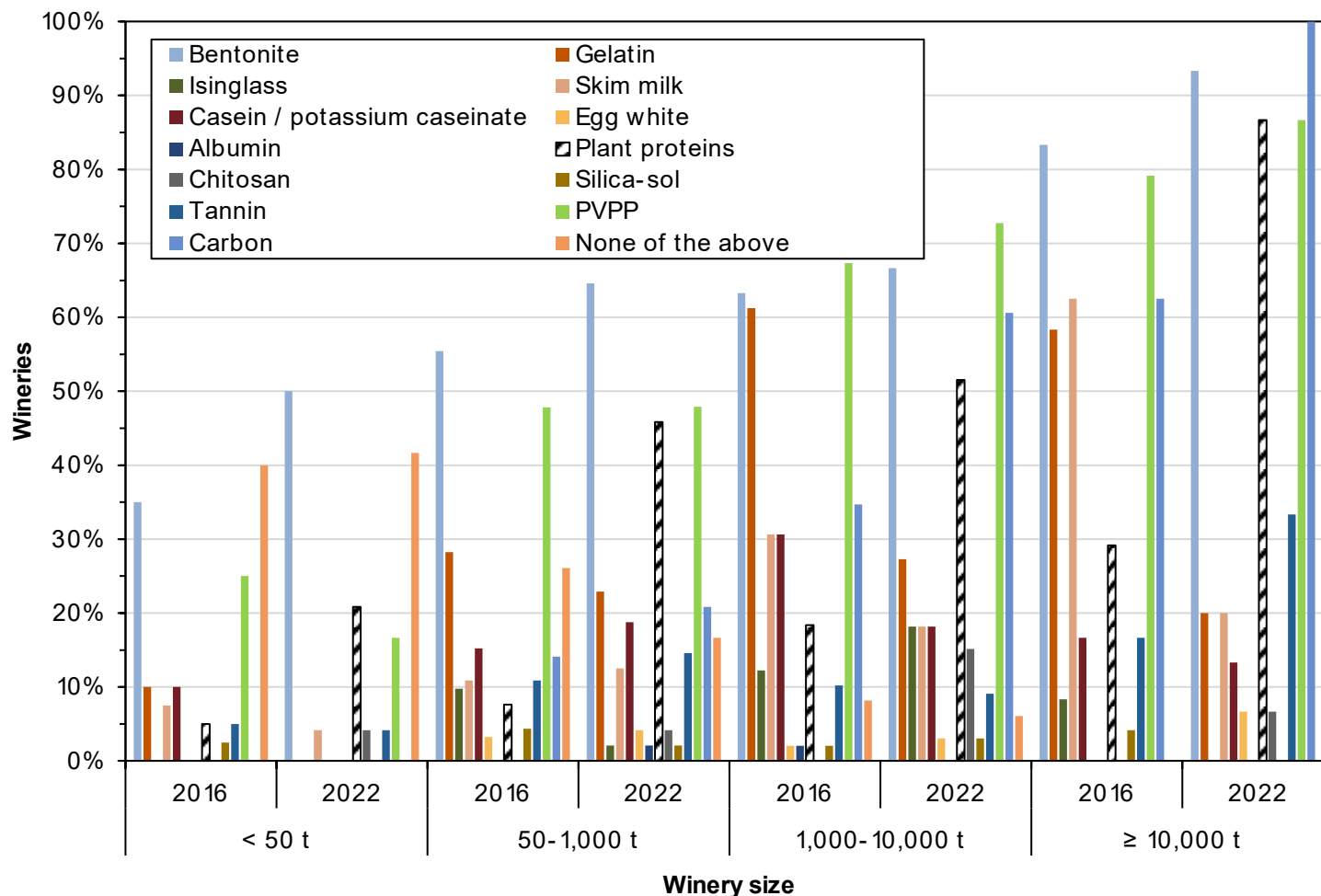
White juice lees/floats/desludge recovery by all techniques (used at all)



- Cross-flow filters with polymeric membranes were more commonly used than those with ceramic membranes for processing white juice lees and no respondents used filters with silicon-carbide membranes.
- Smaller wineries were less likely to use recovery equipment, but more likely to use practices like resettling.

*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. Plot shows data from the 2022 survey, which included more detailed questions on cross-flow filter membrane materials and disposal methods than the 2016 survey.

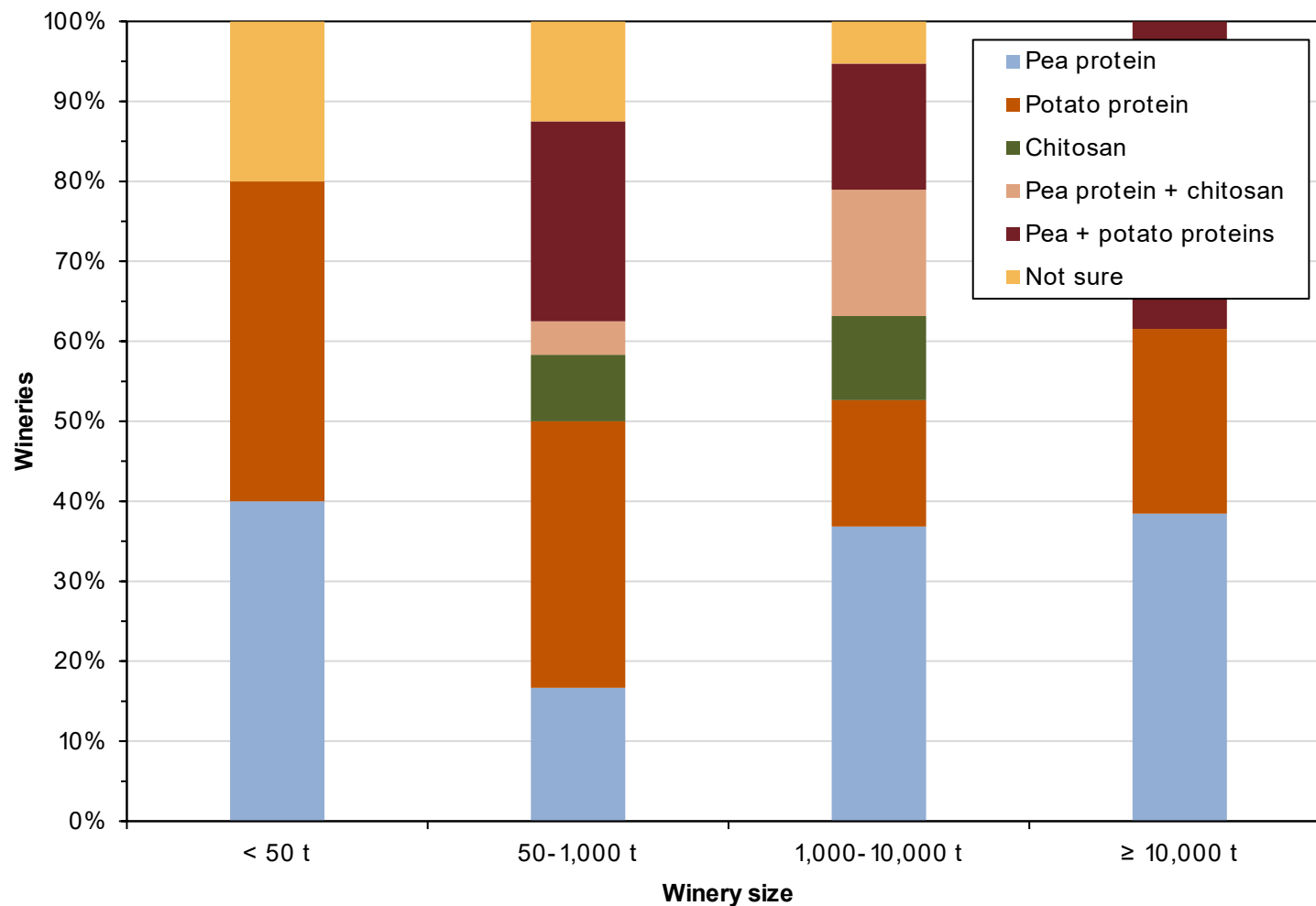
Processing aids for white juice (used at all)



- There was a major shift away from animal-derived proteins between 2016 and 2022, with use of gelatin and skim milk falling dramatically.
- The number of wineries using plant proteins increased to replace them.
- This appears to be driven by a desire for wines that can be labelled as vegan-friendly.
- See pages 148-150 for data on processing aids used on wine and wineries that are exclusively vegan.

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

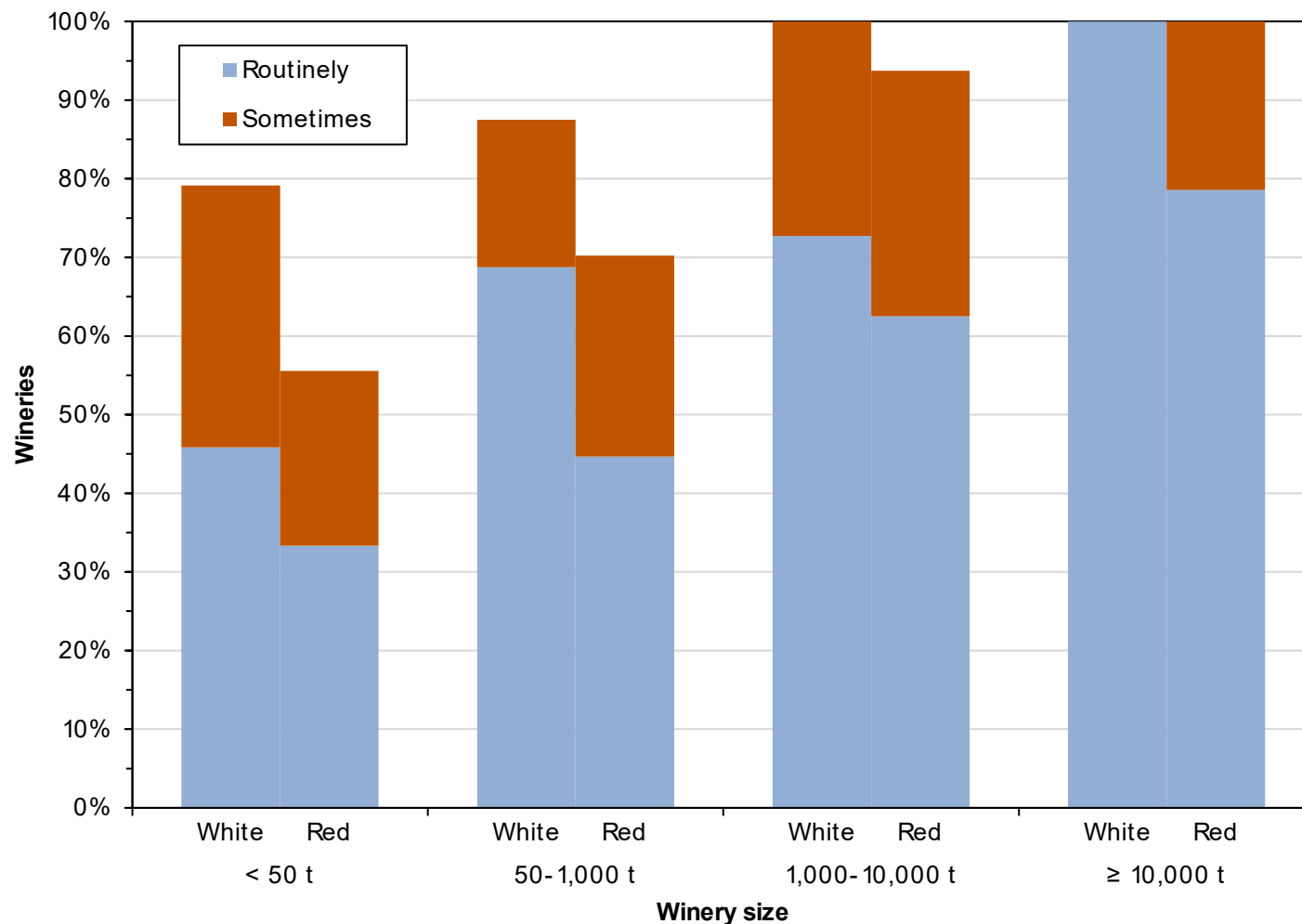
Characteristics of most common plant protein or chitosan used on white juice



- A range of plant proteins and blends were used.
- Pea proteins alone or in blends were common across winery sizes.
- Smaller wineries were slightly more likely than larger wineries to use a potato protein.
- 1 winery mentioned using a yeast protein extract in a comment, which may not fit well in the categories offered in the question.

*Respondents that had selected that they used plant proteins or chitosan were asked to select the most common type from the options shown. This question was not asked in 2016. The plot shows data for 2022.

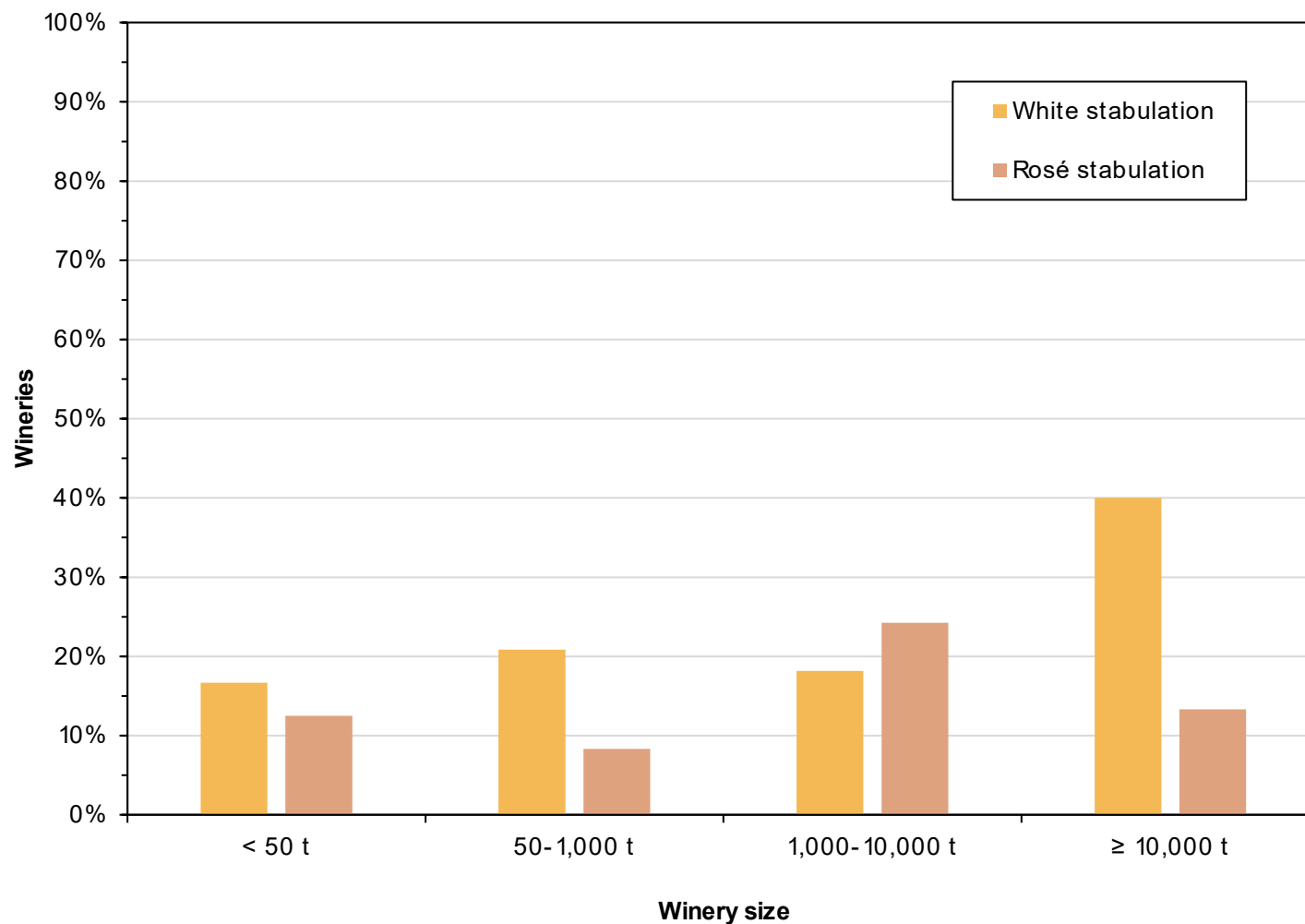
Enzymes added to white and red grapes/must/juice/ferments



- Most wineries used enzymes for both red and white wine production.
- Enzymes were used slightly more often for whites than reds, likely because of their key role in aiding white juice clarification.

*Respondents were asked to select whether enzymes were added to white grapes, must or juice and to any red grapes, must or ferments, routinely, sometimes or not added. This question was not asked in the same way in 2016.

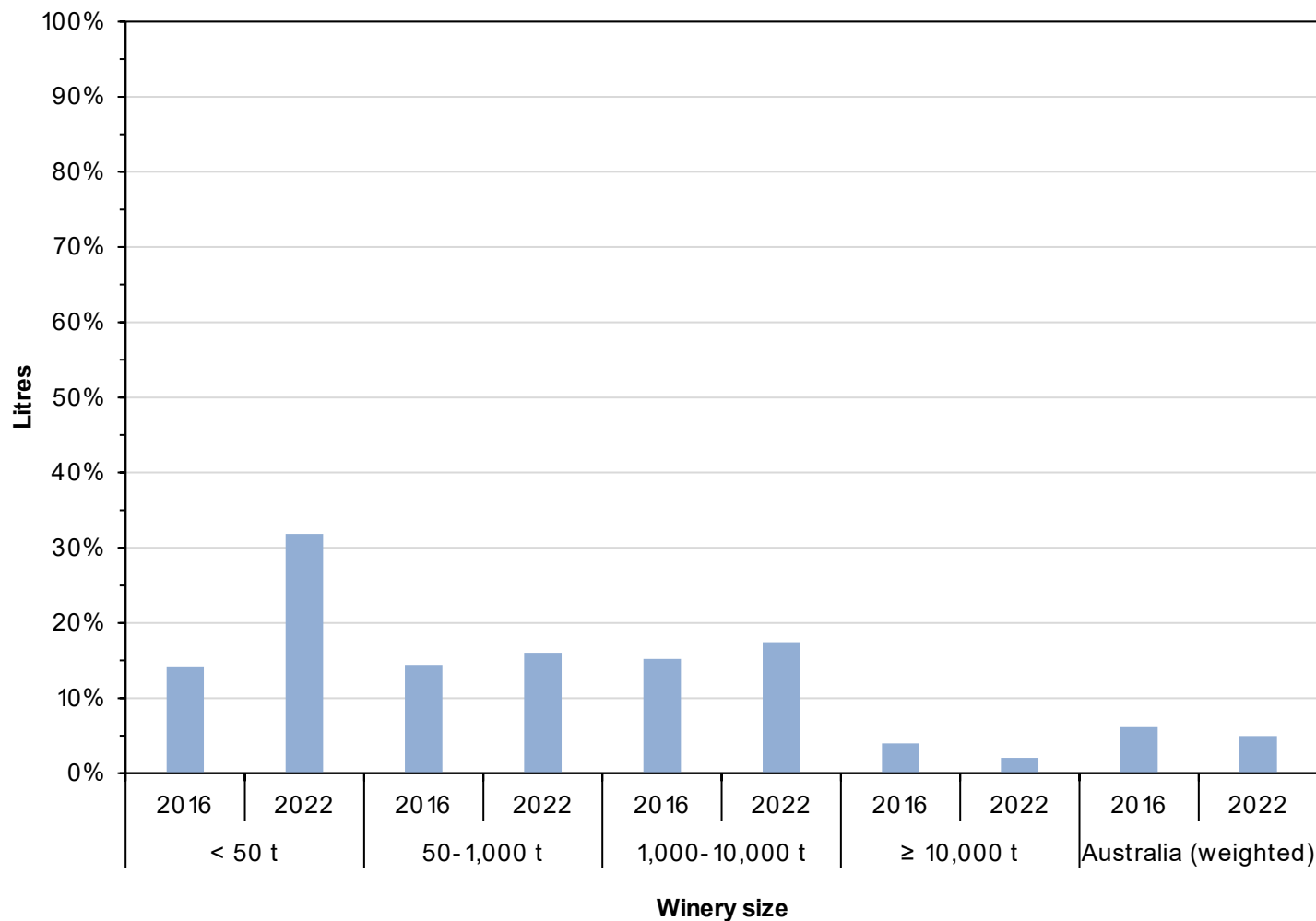
White or rosé juice/lees stabulation (used at all)



- Stabulation was defined as maintaining juice on lees at cold temperatures for 5 days or more with intermittent mixing to enhance extraction of aroma precursors.

*Respondents were asked whether any white or rose juice/lees stabulation was performed, and whether it was white, rosé or both. This question was not asked in 2016. The plot shows data for 2022.

White ferments without specific juice clarification



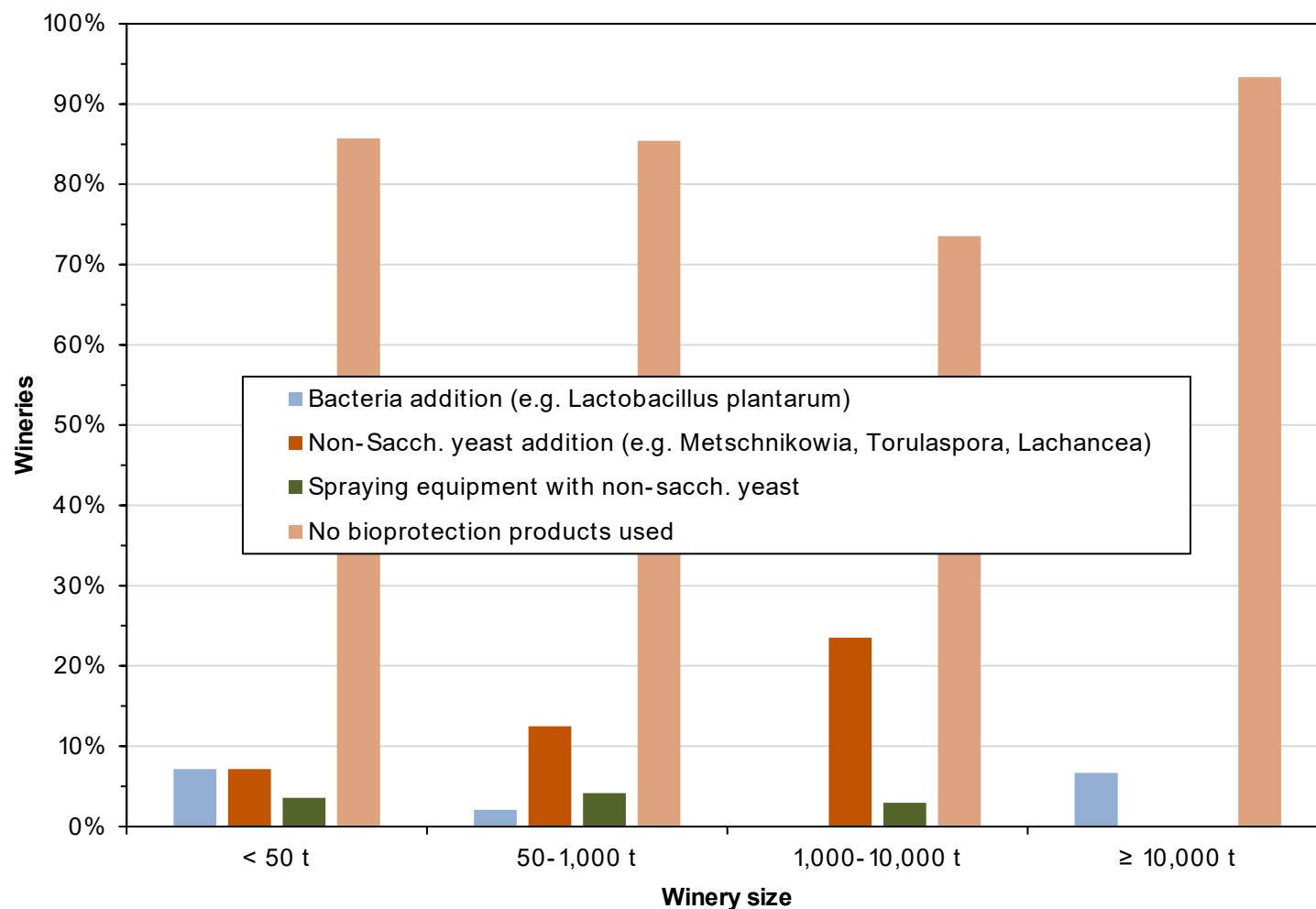
Weighted values for Australia

	2016	2022
Not clarified	6%	5%

- A small proportion of ferments were performed on unclarified juice.
- Chardonnay was mentioned in several comments relating to ferments on unclarified juice.

*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.

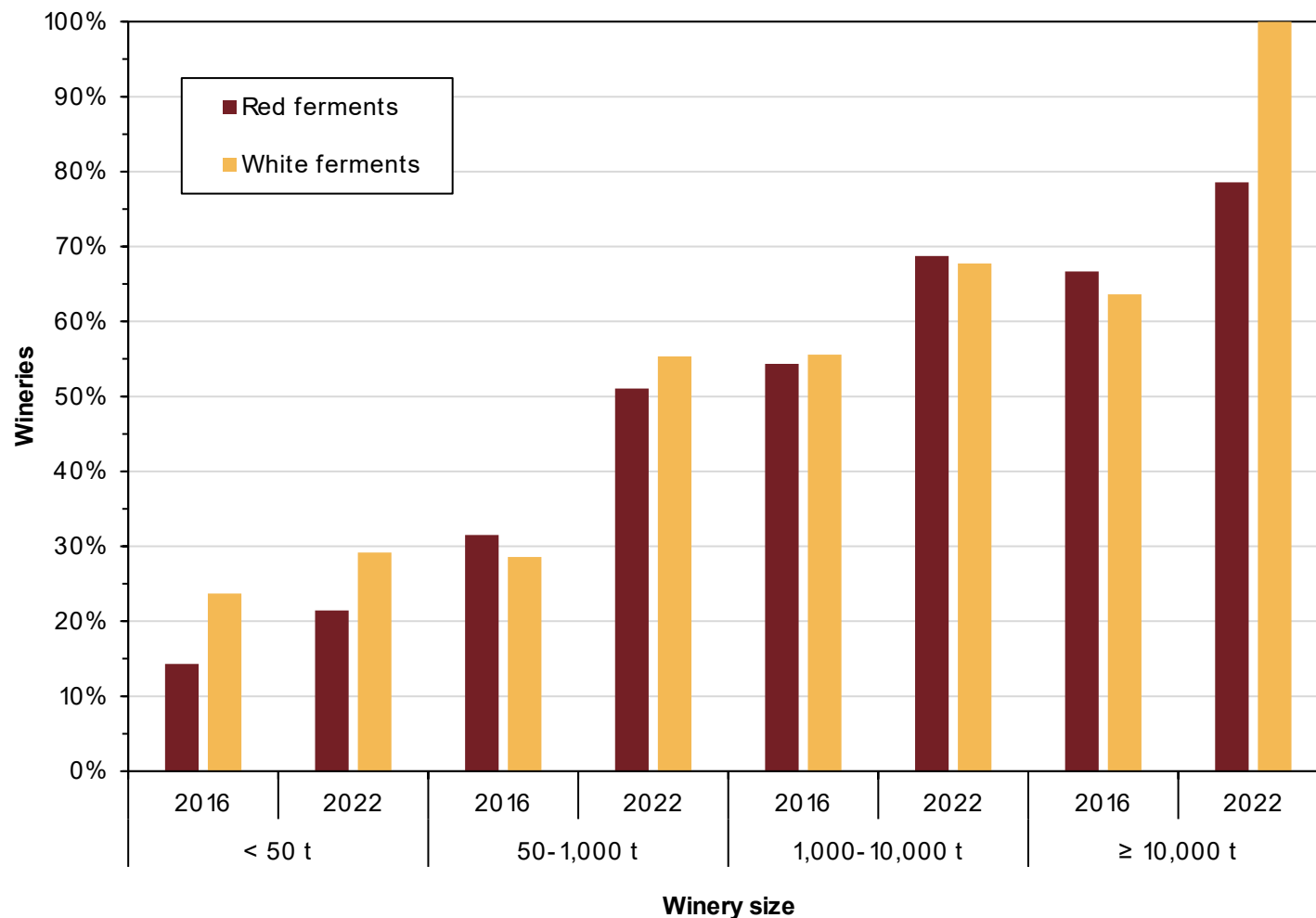
Bioprotection products before alcoholic fermentation (used at all)



- Only a small number of wineries used bioprotection products.
- Medium-sized wineries were the largest adopters with the addition of non-*Saccharomyces* yeasts being the most common approach.
- See page 113 for further information on the use of non-*Saccharomyces* yeast and page 132 on the use of *Lactobacillus plantarum* bacteria.

*Respondents were asked to select which pre-alcoholic fermentation bioprotection strategies were used at the site or supplying vineyards. This question was not asked in 2016. The plot shows data for 2022.

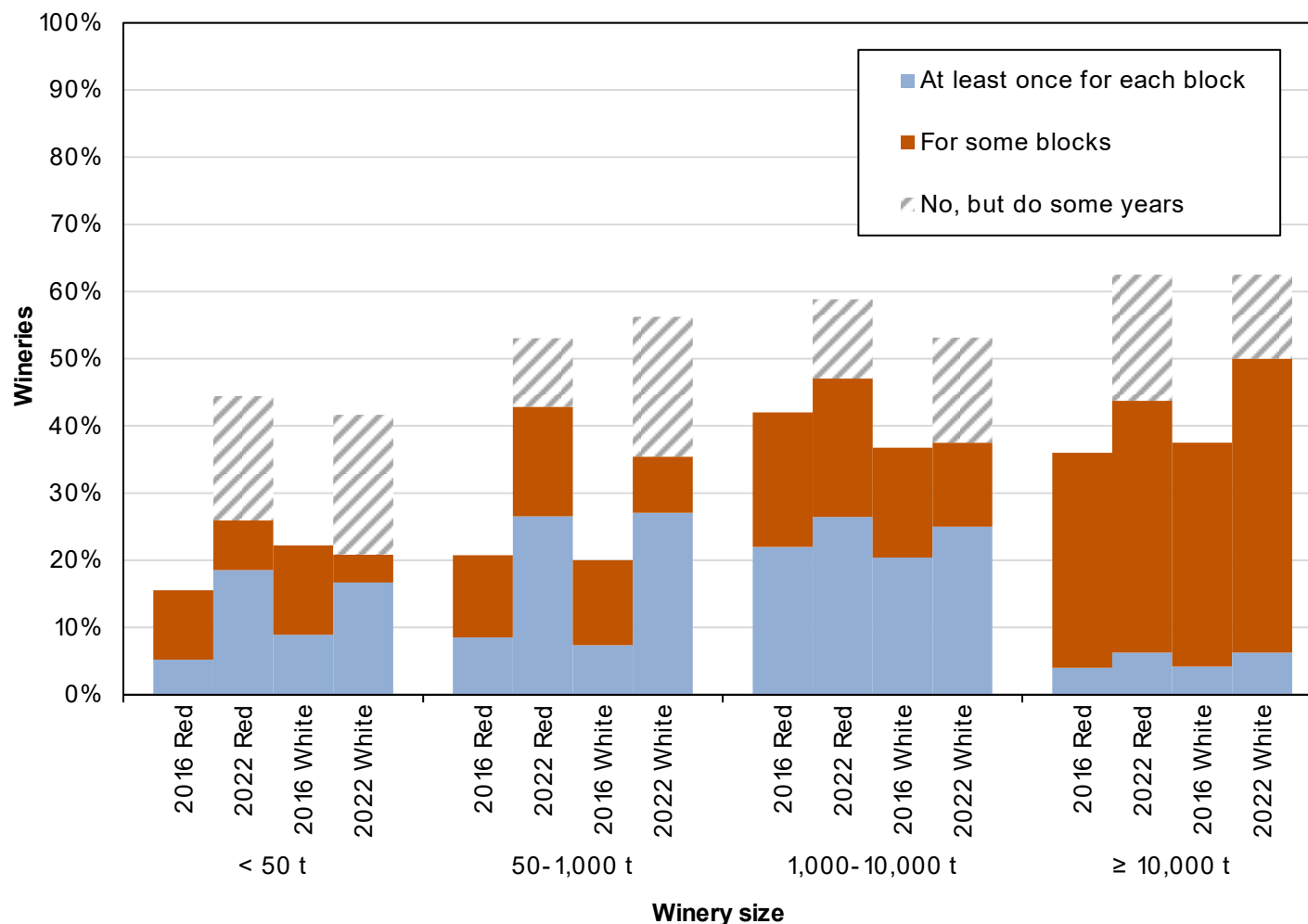
Nitrogen addition rates adapted based on grape/juice YAN measurements



- YAN measurements were more commonly performed by larger wineries.
- The fraction of wineries adjusting nitrogen addition rates based on YAN measurements increased noticeably between 2016 and 2022 in wineries of all sizes.

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

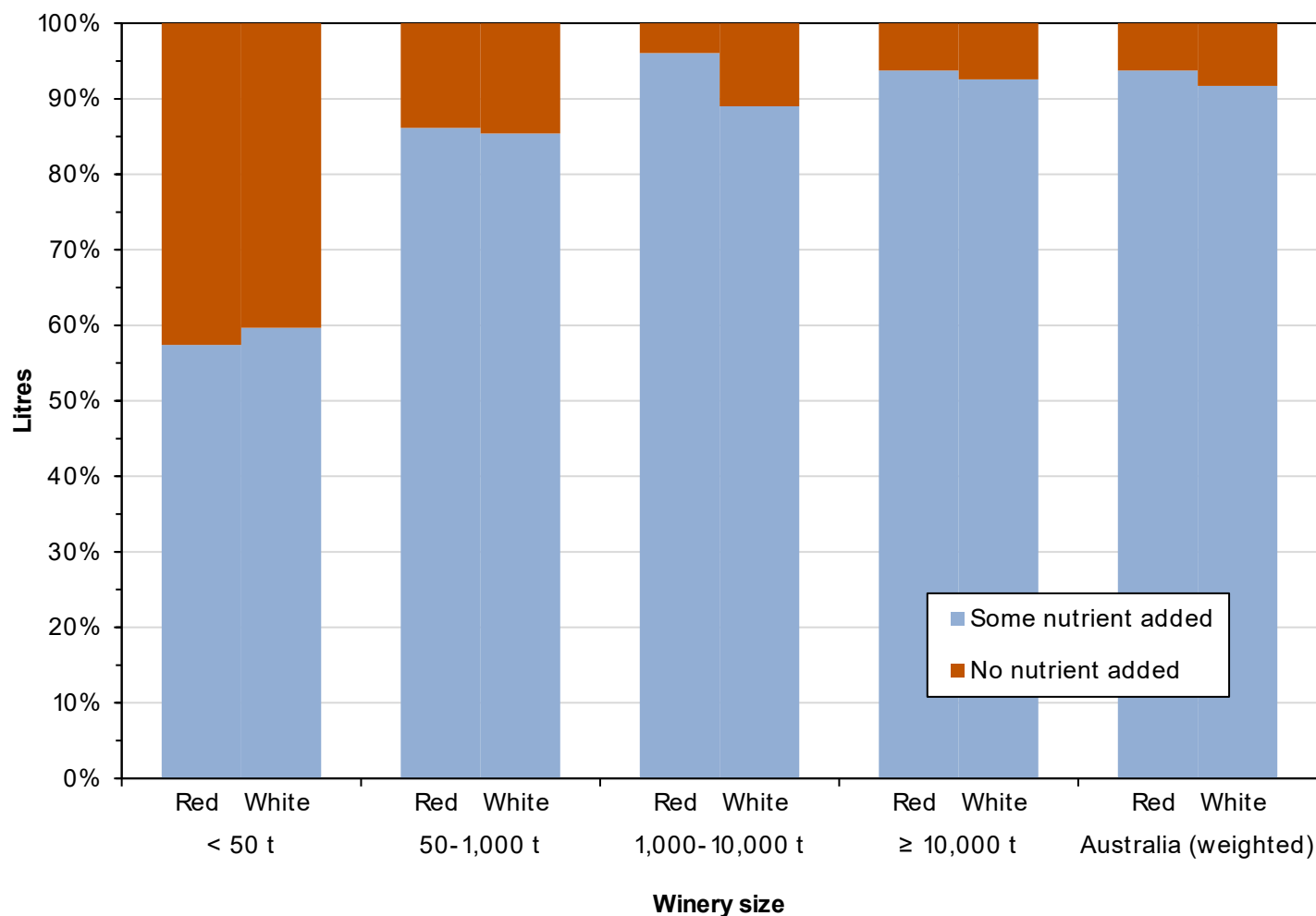
Perform pre-harvest measurements of YAN



- In line with general data on adapting nutrition levels based on YAN, the prevalence of pre-harvest YAN measurements also increased between 2016 and 2022
- In the 2022 survey question, instead of just having a single No option like in the 2016 survey, No was divided into those that do it in some years and those that never do it, to try and account for seasonal variability. Those wineries that didn't perform pre-harvest YAN measurements in 2022 but do in some years are included in the hatched areas.

*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. In 2016, there was a single No option for the question, but in 2022 this was broken up into No - but we do in some years and No - we never do.

Ferments receiving at least one addition of a nutrient



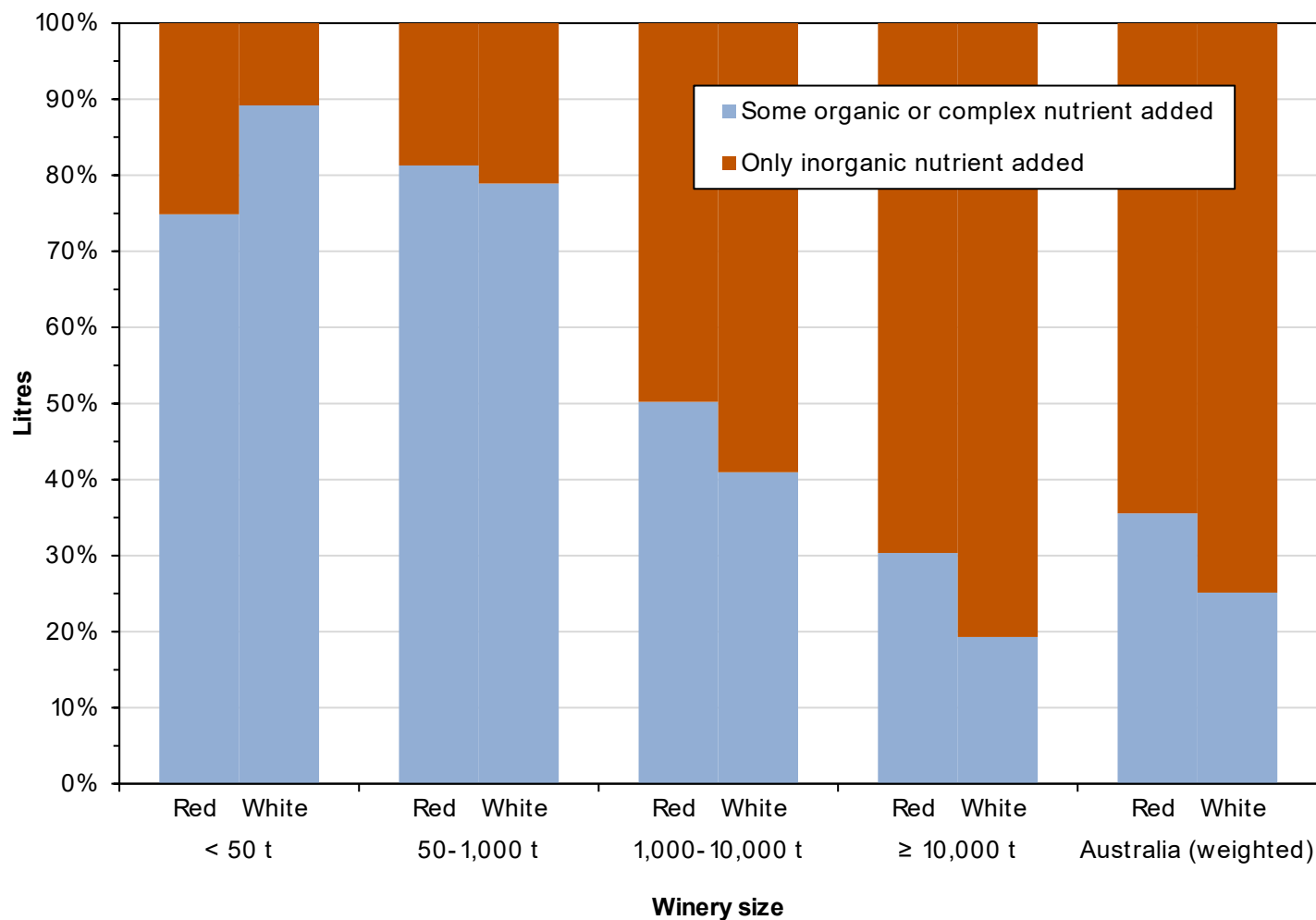
Weighted values for Australia

	2016	2022
Nutrient All	N/A	93%
Nutrient Red	N/A	94%
Nutrient White	N/A	92%

- Most ferments received some addition of nutrients.
- Only very small wineries often didn't add any nutrients.

*Respondents were asked, excluding nutrients added during yeast rehydration or in propagators, what percentage of ferments would receive at least one addition of a nutrient (DAP, ammonium bisulfite, organic or complex nutrients) to the nearest 10% by volume. Volumes receiving some nutrient and no nutrient were estimated based on this, the winery intake tonnage and fractions of red and white grapes. This question was not asked in 2016. The plot shows data for 2022.

Ferments receiving nutrients that receive at least some organic or complex nutrient



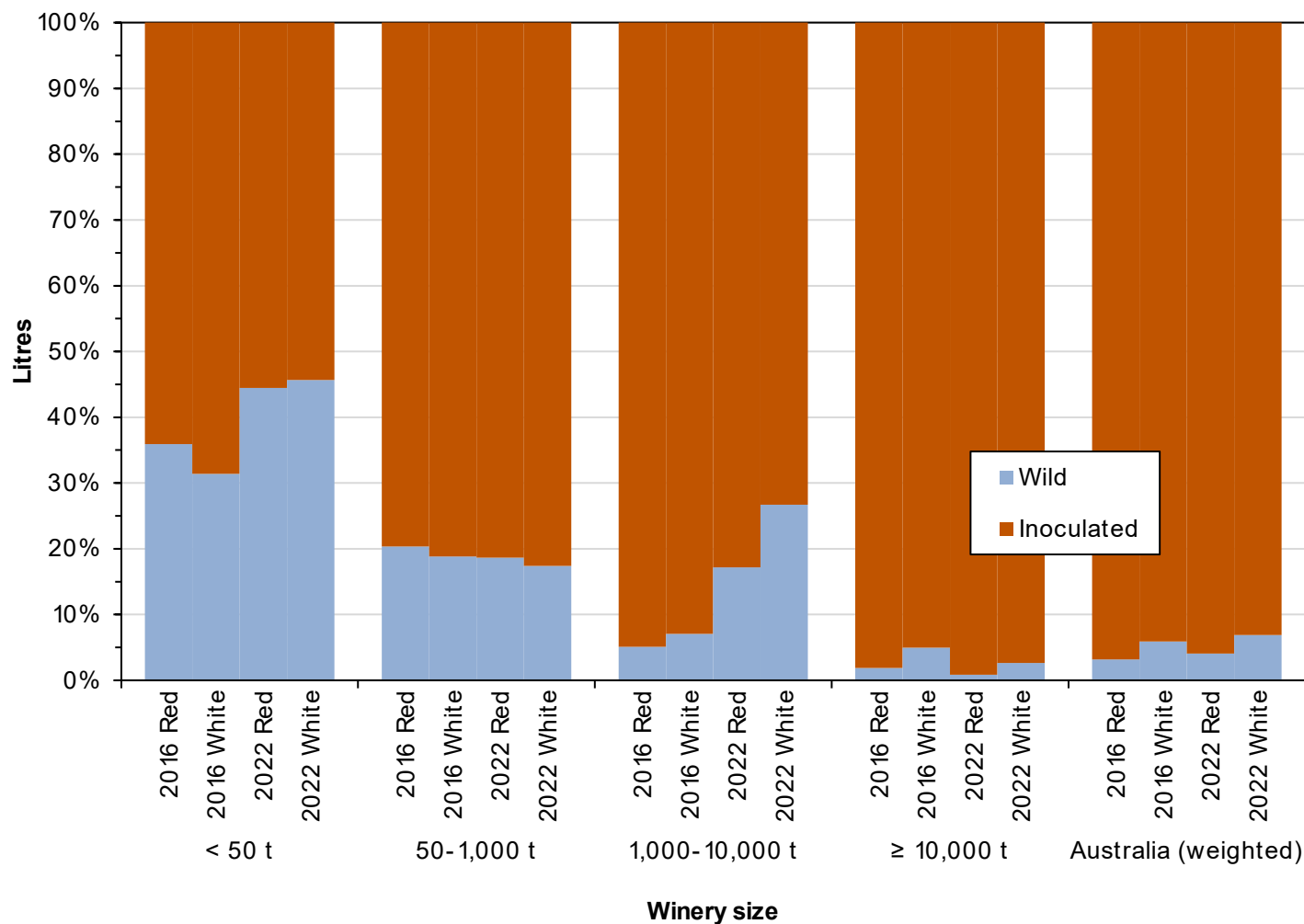
Weighted values for Australia

	2016	2022
Organic Nutrients All	N/A	31%
Organic Nutrients Red	N/A	36%
Organic Nutrients White	N/A	25%

- Ferments at large wineries were more likely to rely solely on inorganic nutrients like DAP, but many ferments did receive some organic or complex nutrients.

*Respondents were asked for those ferments receiving a nutrient addition, what percentage of ferments would receive only inorganic nutrients (DAP, ammonium bisulfite), versus at least some organic or complex nutrients to the nearest 10% by volume. Volumes receiving at least some organic or complex nutrient versus only inorganic nutrient were estimated based on this, the winery intake tonnage and fractions of red and white grapes. This question was not asked in 2016. The plot shows data for 2022.

Wild or inoculated primary ferments



Weighted values for Australia

	2016	2022
Wild All	4%	5%
Wild Red	3%	4%
Wild White	6%	7%

- Wild ferments were more commonly performed in smaller wineries than larger wineries.
- Some differences between 2016 and 2022 are partly explained by some wineries on the edges of size categories crushing slightly less in 2022 and shifting category rather than a real change in practices.

*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.

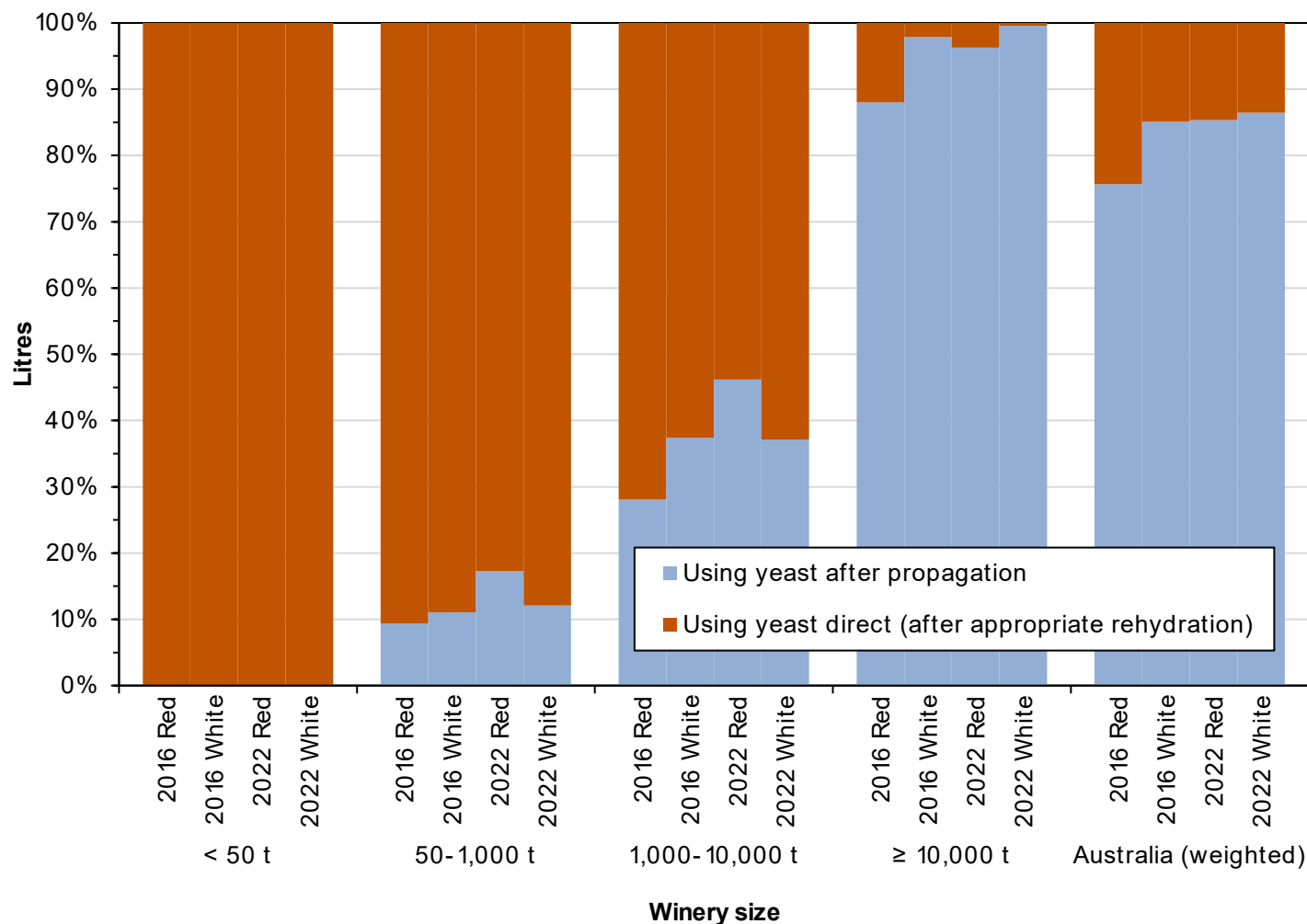
Most common yeast inoculation strains in Australia (in top 2 for wine colour at each winery)

	Red wine		White wine	
	2016	2022	2016	2022
1.	Enoferm BDX (n=26)	Enoferm BDX (n=15)	Lalvin QA23 (n=55)	Lalvin QA23 (n=39)
2.	Enoferm Syrah (n=22)	Zymaflore FX10 (n=13)	Zymaflore X5 (n=34)	Lalvin EC1118 (n=27)
3.	Lalvin RC212 (n=22)	Lalvin Rhône 2323 (n=12)	Lalvin EC1118 (n=32)	Lalvin DV10 (n=14)
4.	Zymaflore FX10 (n=22)	Zymaflore RX60 (n=10)	Lalvin CY3079 (n=22)	Zymaflore X5 (n=9)
5.	Lalvin Clos (n=18)	Lalvin EC1118 (n=10)	Lalvin DV10 (n=13)	Lalvin CY3079 (n=8)
6.	Lalvin EC1118 (n=17)	Lalvin Rhône 2226 (n=9)	Zymaflore VL3 (n=10)	IOC 18-2007 (n=7)
7.	Lalvin Rhône 2323 (n=15)	Lalvin Clos (n=8)	IOC 18-2007 (n=9)	Zymaflore Delta (n=5)
8.	Lalvin ICV D254 (n=14)	Lalvin RC212 (n=7)	Zymaflore X16 (n=6)	Zymaflore VL3 (n=4)
9.	Lalvin Rhône 2226 (n=13)	Lalvin ICV D254 (n=7)	Lalvin ICV D47 (n=5)	Maurivin PDM (n=4)
10.	Maurivin AWRI 796 (n=12)	Maurivin AWRI 796 (n=6)	Zymaflore CH9 (n=5)	Zymaflore CH9 (n=3)
11.	Zymaflore RX60 (n=12)		Zymaflore VL1 (n=5)	Enoferm T306 (n=3)

- The most common yeast strains were similar in 2016 and 2022, with the greatest number of wineries using Enoferm BDX and Lalvin QA23.
- Unlike in 2016, the total volume fermented across the industry has been excluded as it is heavily influenced by just a few wineries, particularly in relation to red wine, where there is not a standout like there is with QA23 for white wines.
- The number of respondents in 2022 for some yeasts was lower than in 2016 because of the smaller number of survey responses, rather than because these yeasts were used less (see page 10 for response rates).

*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. The number of wineries listing a strain has been used to rank them (n gives the actual number of respondents using each strain as one of their top two).

Propagation of yeast for inoculated primary ferments



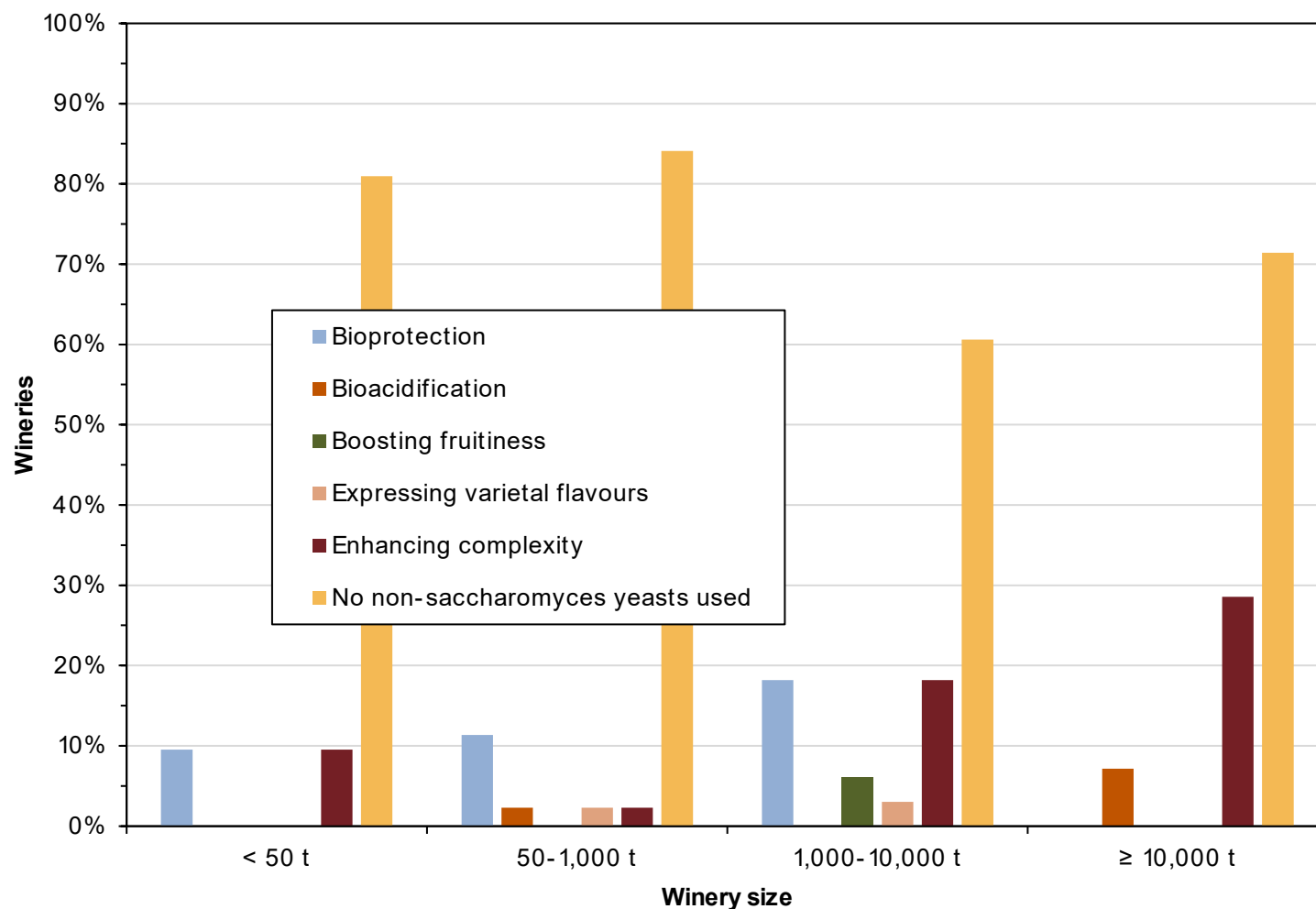
Weighted values for Australia

	2016	2022
Propagated All	80%	86%
Propagated Red	76%	85%
Propagated White	85%	86%

- The use of propagation increases with winery size.
- General trends were similar in the 2016 and 2022 surveys.

*Respondents that inoculated ferments were first asked whether they used yeasts directly from the supplier, or by propagating yeasts up to larger quantities in the winery. 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.

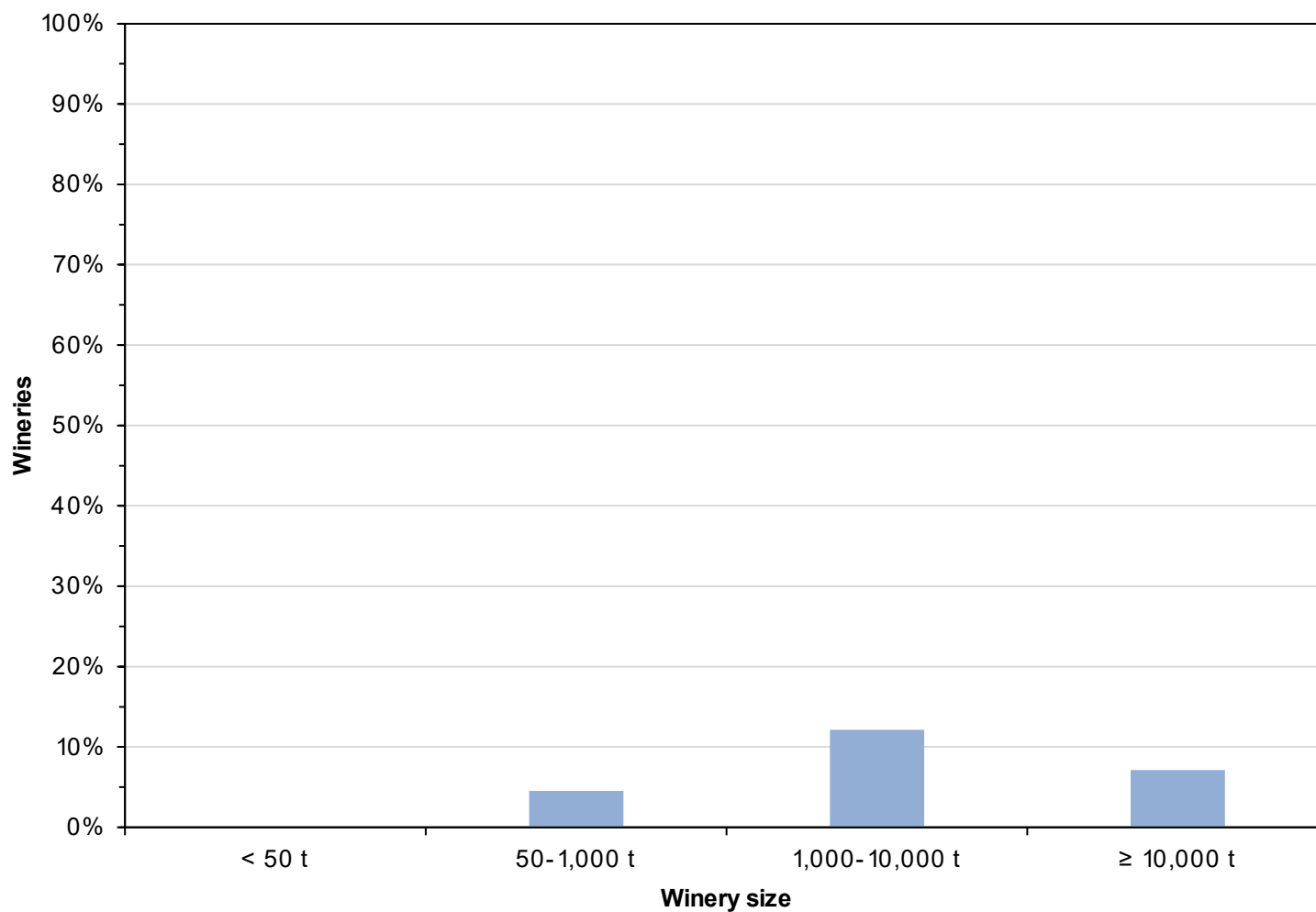
Non-*Saccharomyces* yeast inoculation and purpose (used at all)



- Non-*Saccharomyces* yeasts were not widely used.
- The main reasons for using them were bioprotection and enhancing complexity.
- See page 105 for further information on the use of bioprotection products.

*Respondents were asked whether any grapes, juice or equipment were inoculated with non-*Saccharomyces* yeast at the winery or supplying vineyards and for what purpose they were added. This question was not asked in 2016. The plot shows data for 2022.

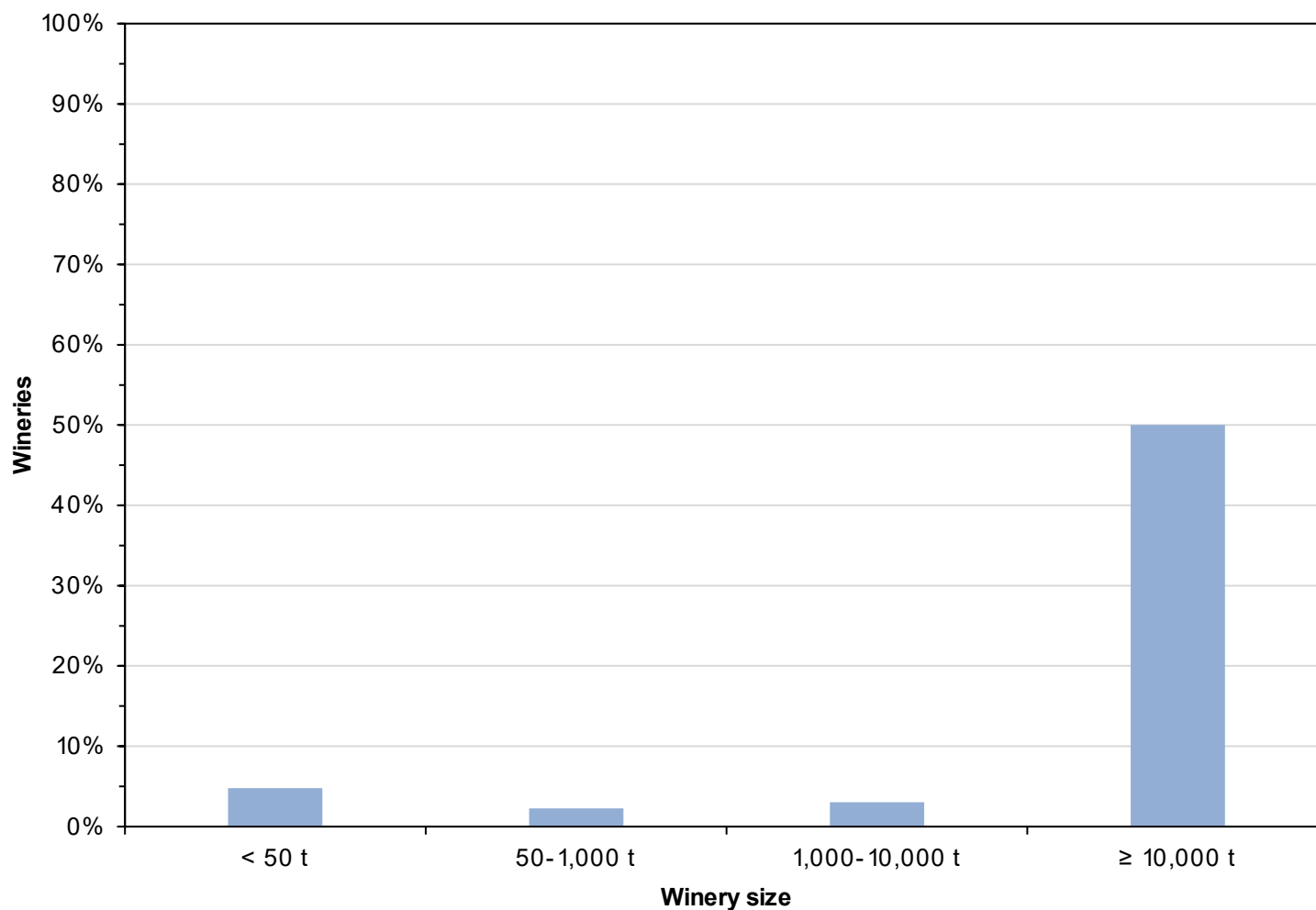
Yeast added dry without rehydration (used at all)



- A small number of wineries added yeasts dry to juice without prior rehydration as is now being marketed for some yeasts by suppliers.

*Respondents were asked whether active dry yeasts were always rehydrated in water first or were sometimes added dry to juice. This question was not asked in 2016. The plot shows data for 2022.

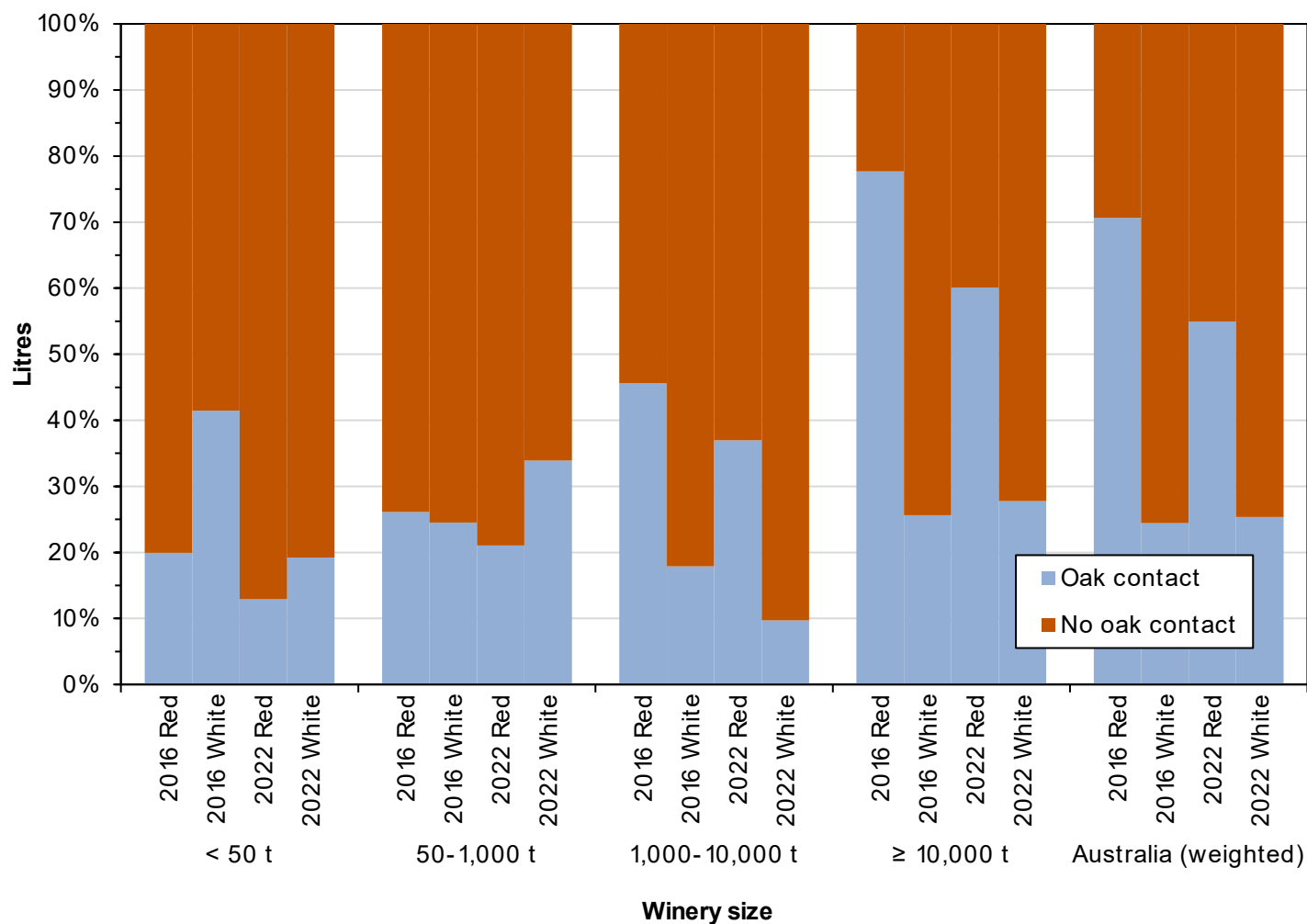
Yeast rehydrator typically used



- Automated yeast rehydrators (e.g. Juclas EasyFerm) were commonly used in large wineries, but not smaller wineries.

*Respondents were asked whether an automated yeast rehydrator was typically used to rehydrate active dry yeast. This question was not asked in 2016. The plot shows data for 2022.

Ferments with oak contact



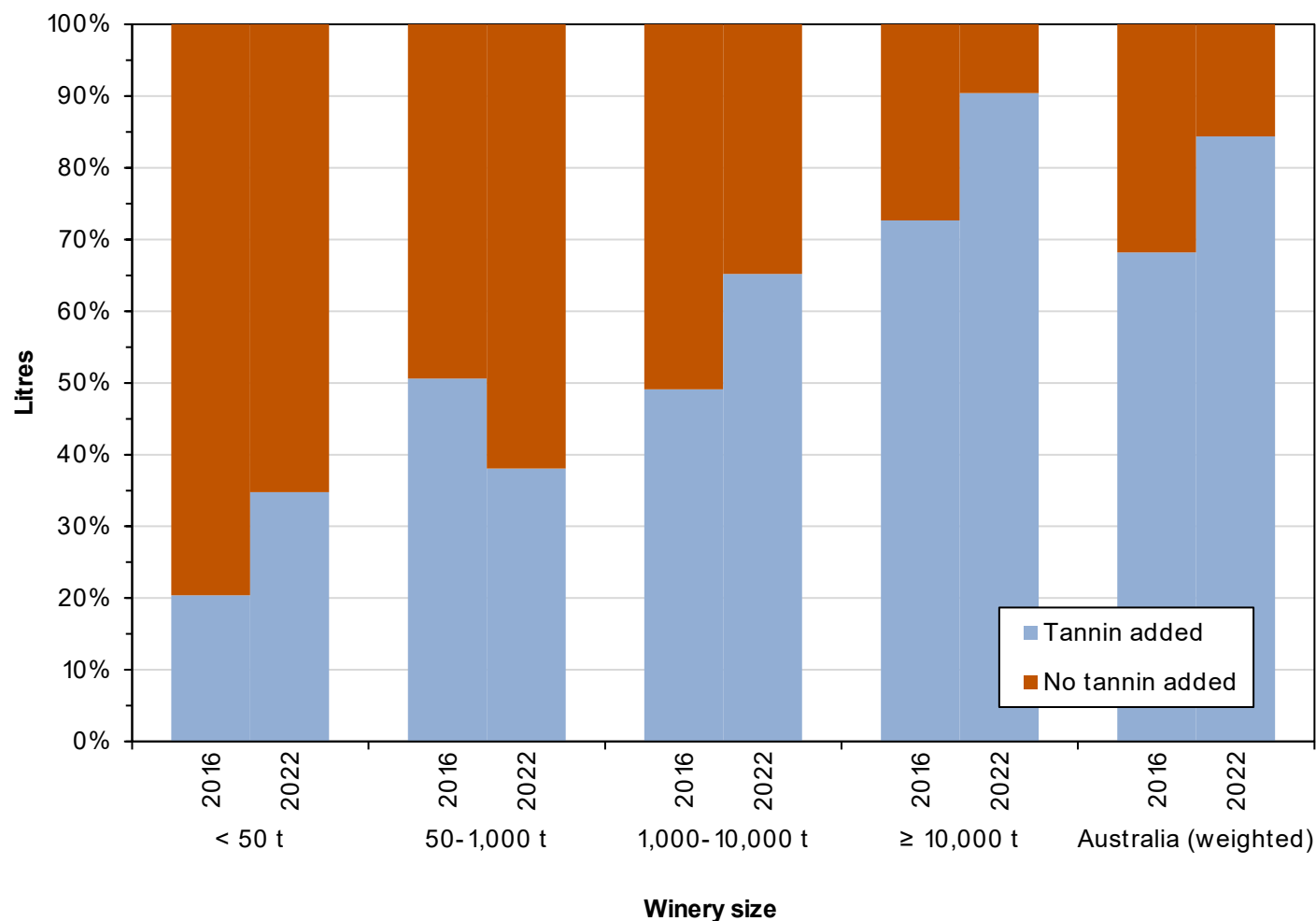
Weighted values for Australia

	2016	2022
Oak ferments All	49%	41%
Oak ferments Red	71%	55%
Oak ferments White	24%	25%

- In larger wineries, oak contact was much more commonly used for red ferments than white ferments in both surveys.
- The proportion of red ferments in contact with oak was slightly lower in 2022 than it was in 2016.

*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. Oak-fermented litres were estimated based on this, the winery intake tonnage and fractions of red and white grapes.

Red ferments with tannin addition



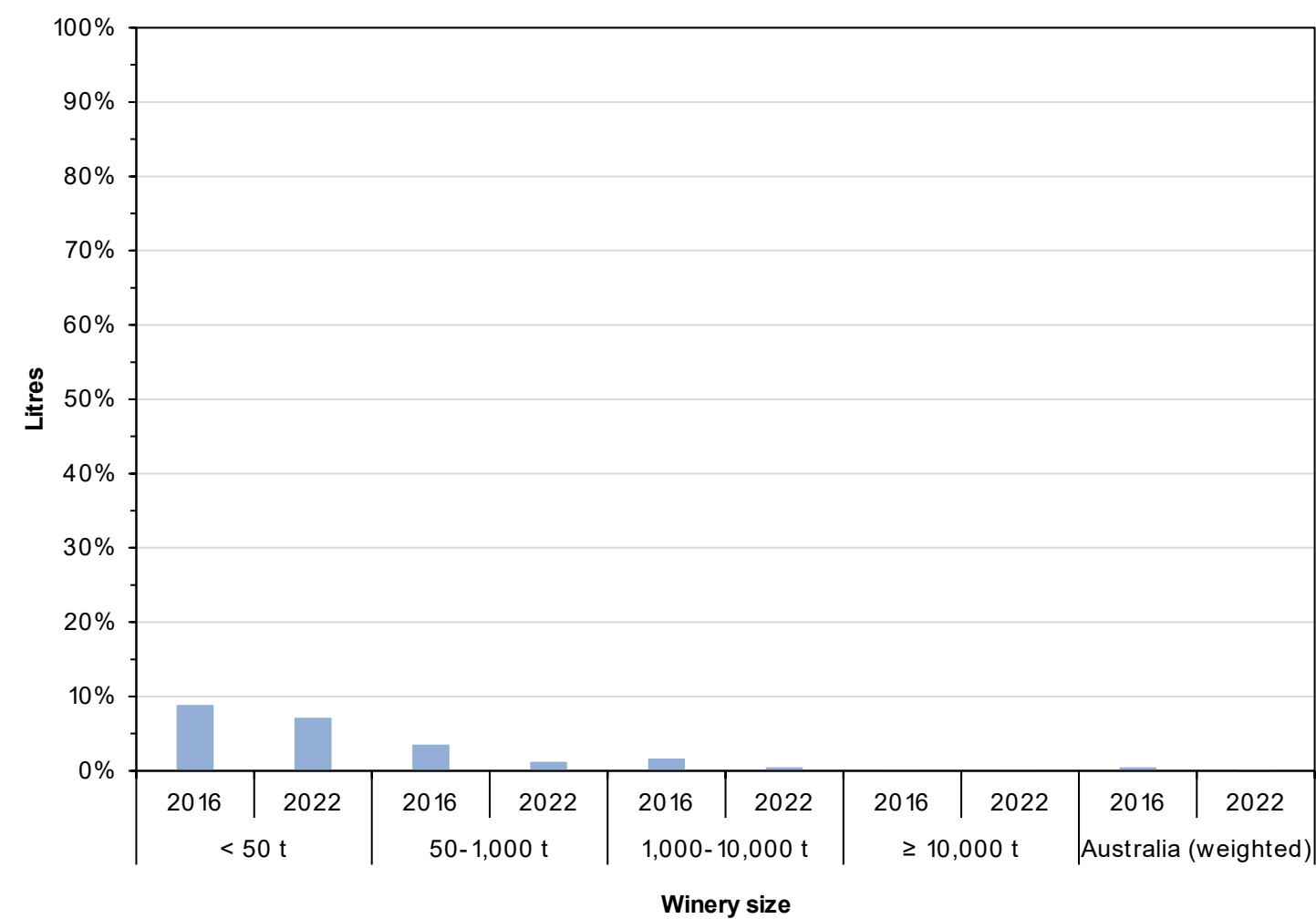
Weighted values for Australia

	2016	2022
Tannin red ferment	68%	84%

- Tannin was more commonly added to red ferments in larger wineries.
- The proportion of red ferments receiving tannins in 2022 was slightly higher than it was in 2016.

*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



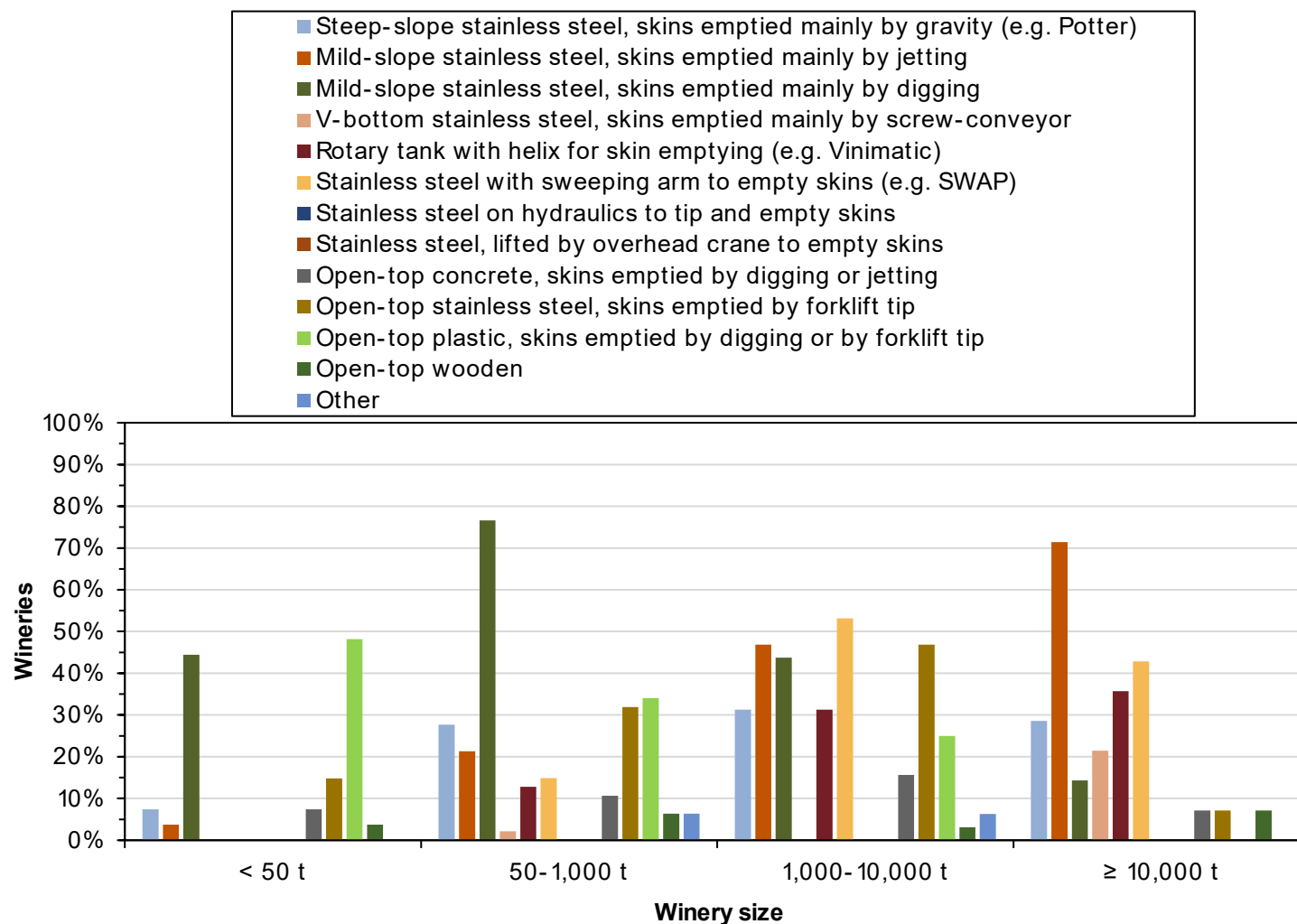
Weighted values for Australia

	2016	2022
Stem addition	0.5%	0.2%

- Back-addition of separated stems to red ferments was very uncommon in 2022 as it was in 2016.

*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 were 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.

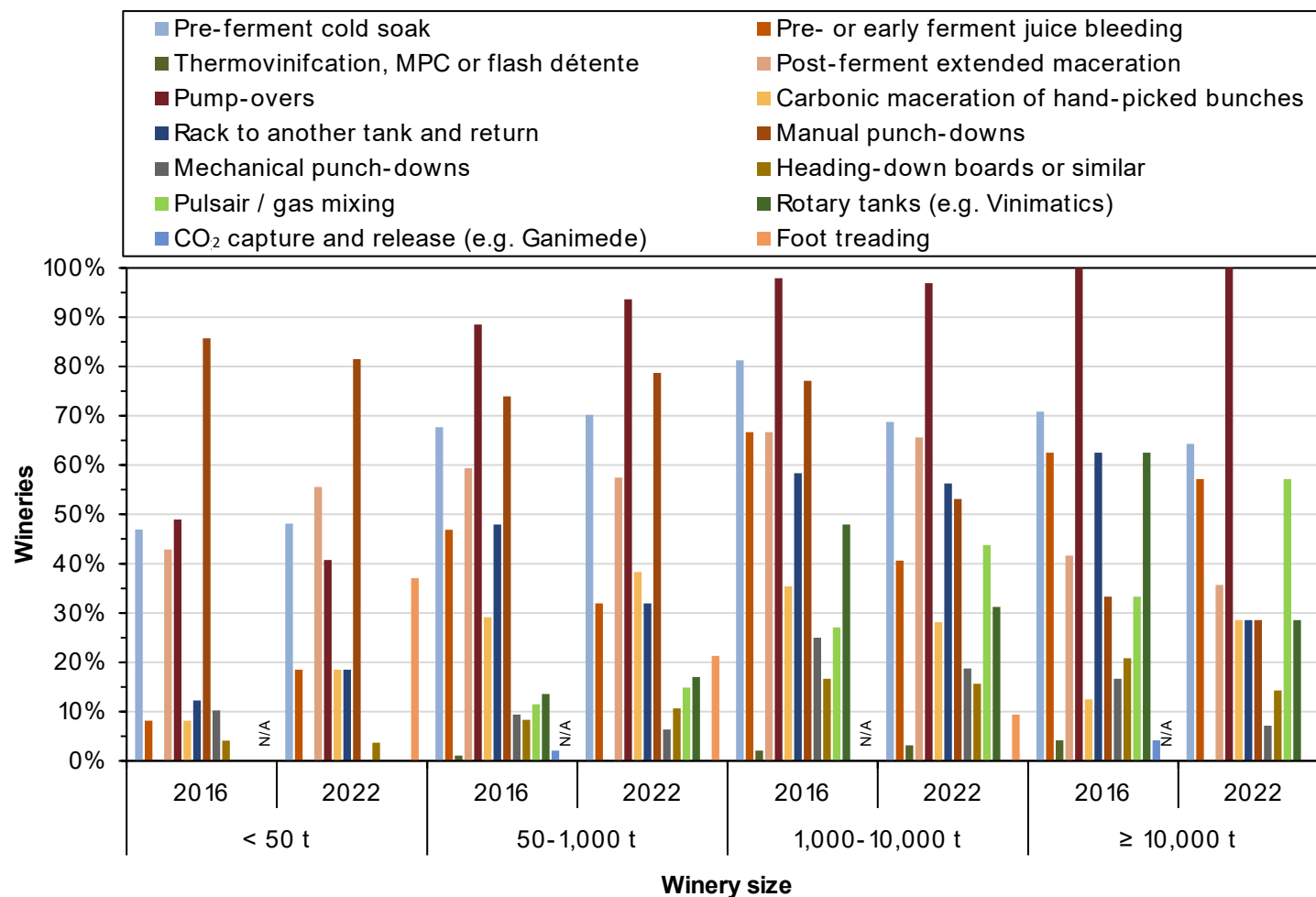
Red fermentation tank designs (used at all)



- Digging or tipping is used in smaller wineries, while larger wineries rely on jetting, sweeping arms, rotary tanks, steep slopes, and screw-conveyors.
- Wooden vats were not listed as an option but were noted by several respondents as an 'Other' and have been broken out into a new 'Open-top wooden' series in the plot.
- Remaining responses in the 'Other' category included slate tanks, non-open top concrete tanks, and on-skin barrel ferments.

*Respondents were asked to select from a list of red fermentation tank designs.

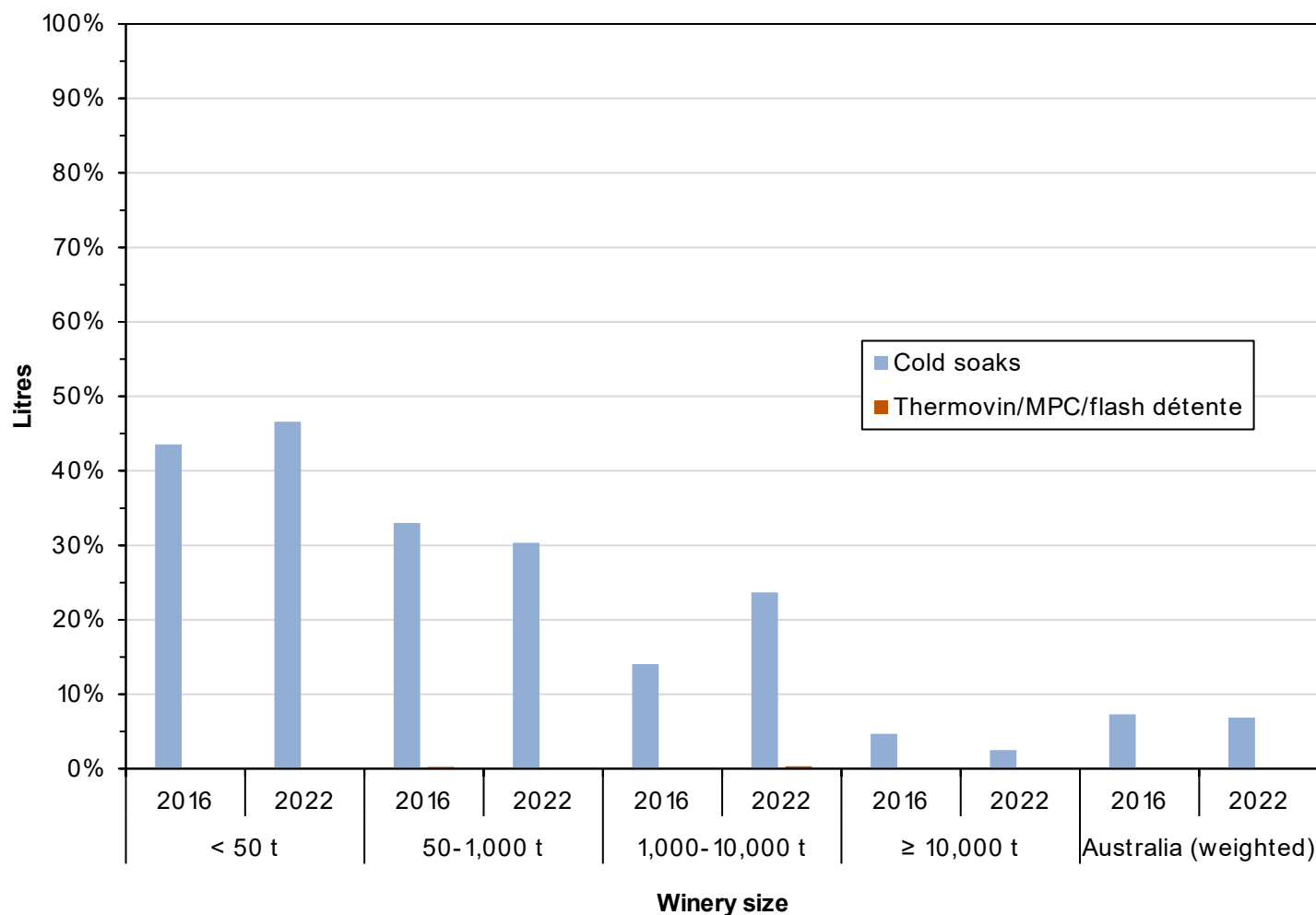
Red ferment extraction techniques (used at all)



- 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 using CO₂ capture and release.
- Pulsair / gas mixing was relatively common and appears to have increased between 2016 and 2022.
- Treading was added as an option for the 2022 survey and was most common in smaller wineries.

*Respondents were asked to select from a list all the extraction management techniques used.

Red wines from grapes/ferments having undergone cold soaks or heat treatment



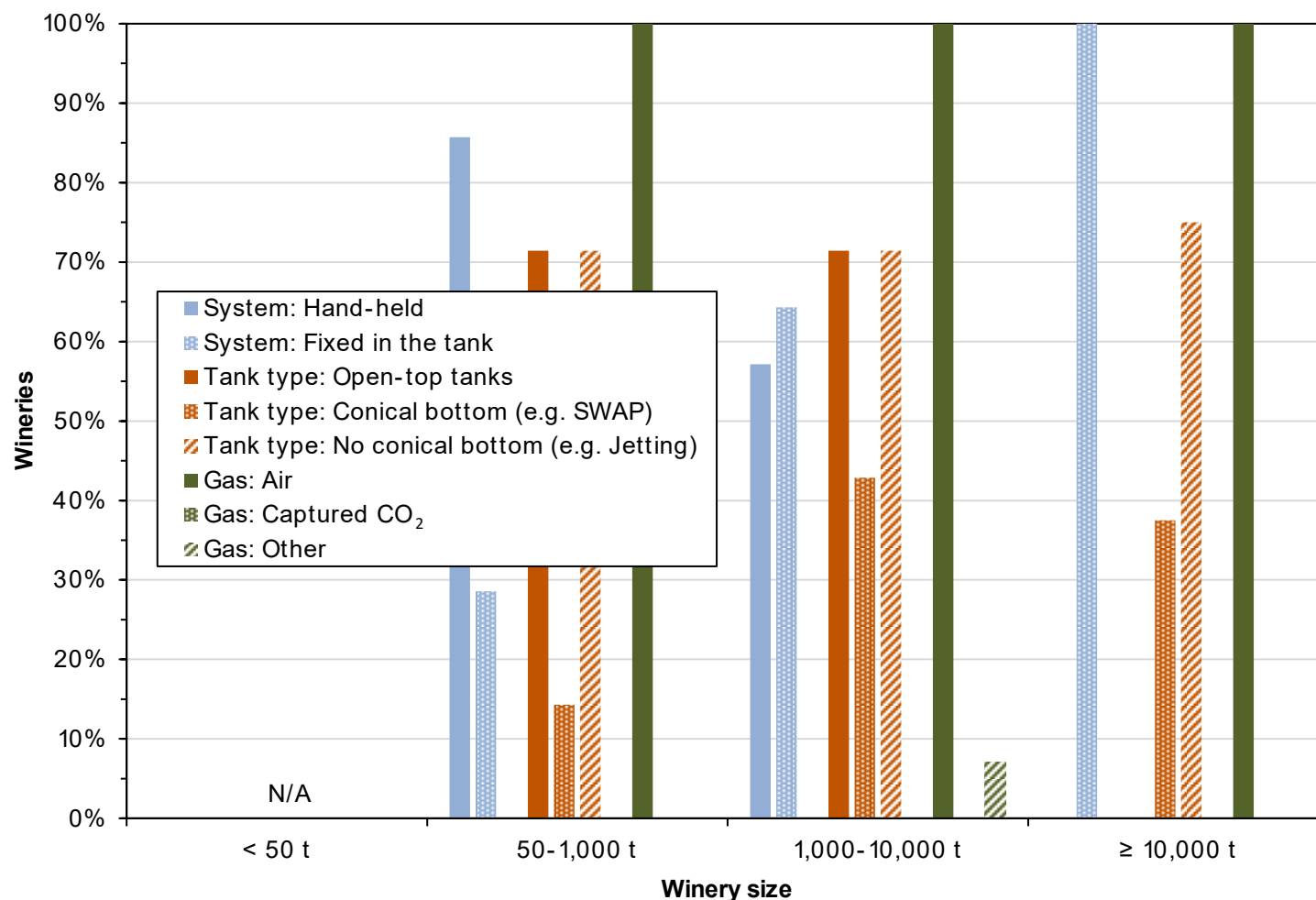
Weighted values for Australia

	2016	2022
Cold soaks	7%	7%
Heat treatment	<0.1%	<0.1%

- Many wineries performed some cold soaks with smaller wineries cold soaking a greater proportion of their production than larger wineries.
- Very little pre-fermentation heat treatment was performed, although the true value is likely slightly higher than shown as one large winery that didn't respond to the survey has a flash détente unit installed.

*Respondents that performed cold soaks or heat treatment of grapes over 50°C were asked to select what % of red ferments by volume underwent these treatments. Overall volumes were then estimated based on this, the winery intake tonnage and fraction of red grapes.

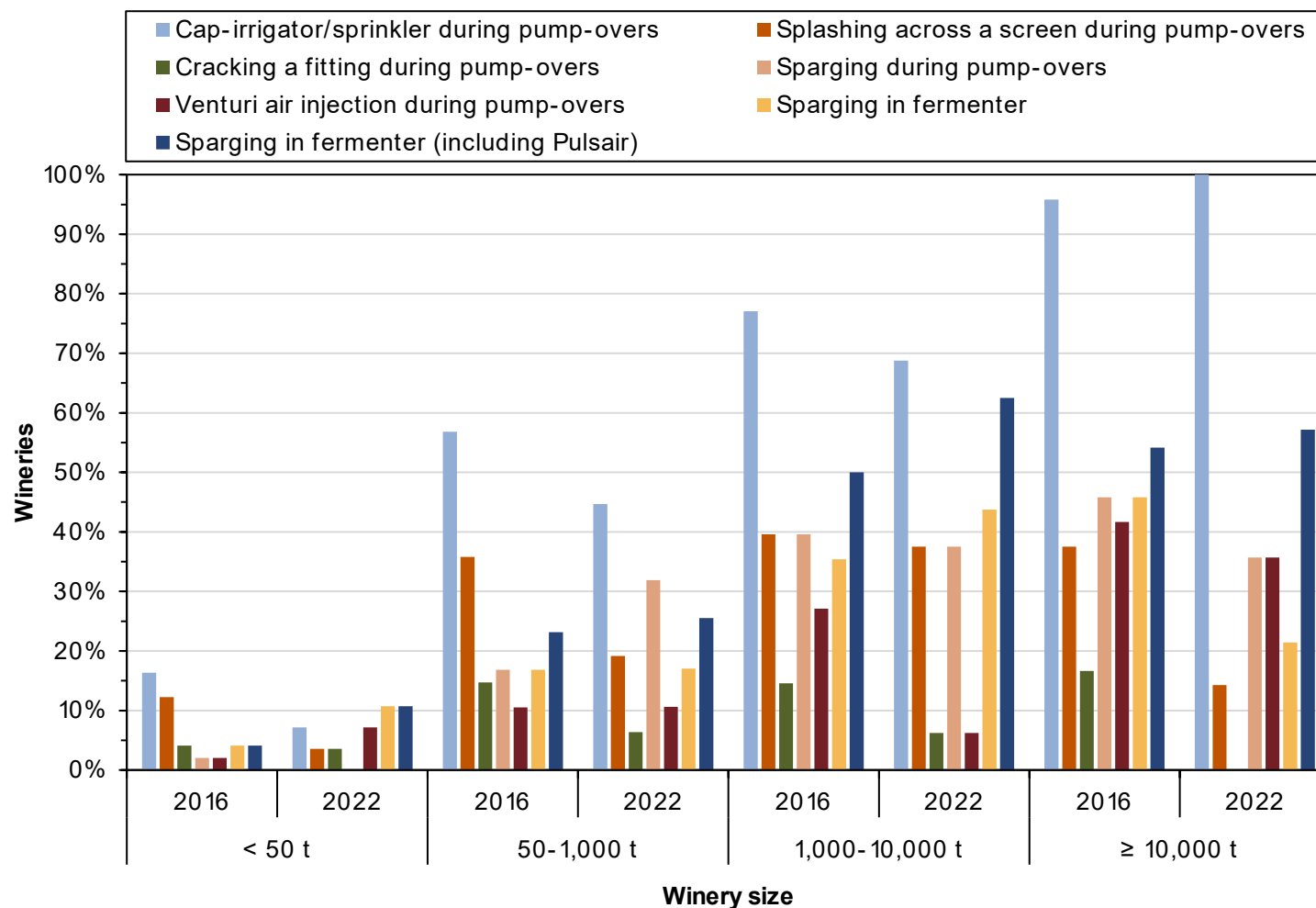
Pulsair / gas mixing choices - fixed or portable, tank style, and gas used



- Larger wineries were more likely to use fixed rather than portable gas mixing systems.
- Systems were used in a range of tank types relevant to wineries of different sizes.
- Air was employed by all users, although one respondent nominated 'Other' and detailed that they used nitrogen at the end of ferments to avoid oxidation. It wasn't covered in the survey, but some wineries use air mixing then revert to pump-overs at the end of ferments for this reason.
- No wineries used CO₂ captured from ferments for gas mixing (this technique is used in some Spanish wineries).

*Respondents that said that they performed pulsair / gas mixing, were asked to select whether the system was hand-held or fixed, the tank styles it was used in, and the gas types used. This question was not asked in 2016. The plot shows data for 2022.

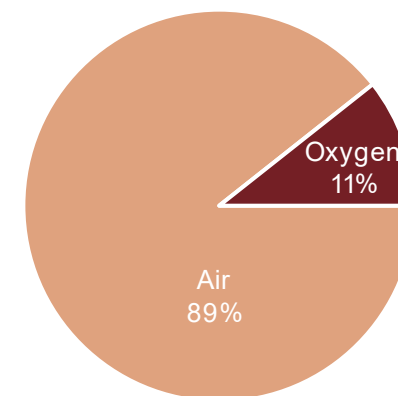
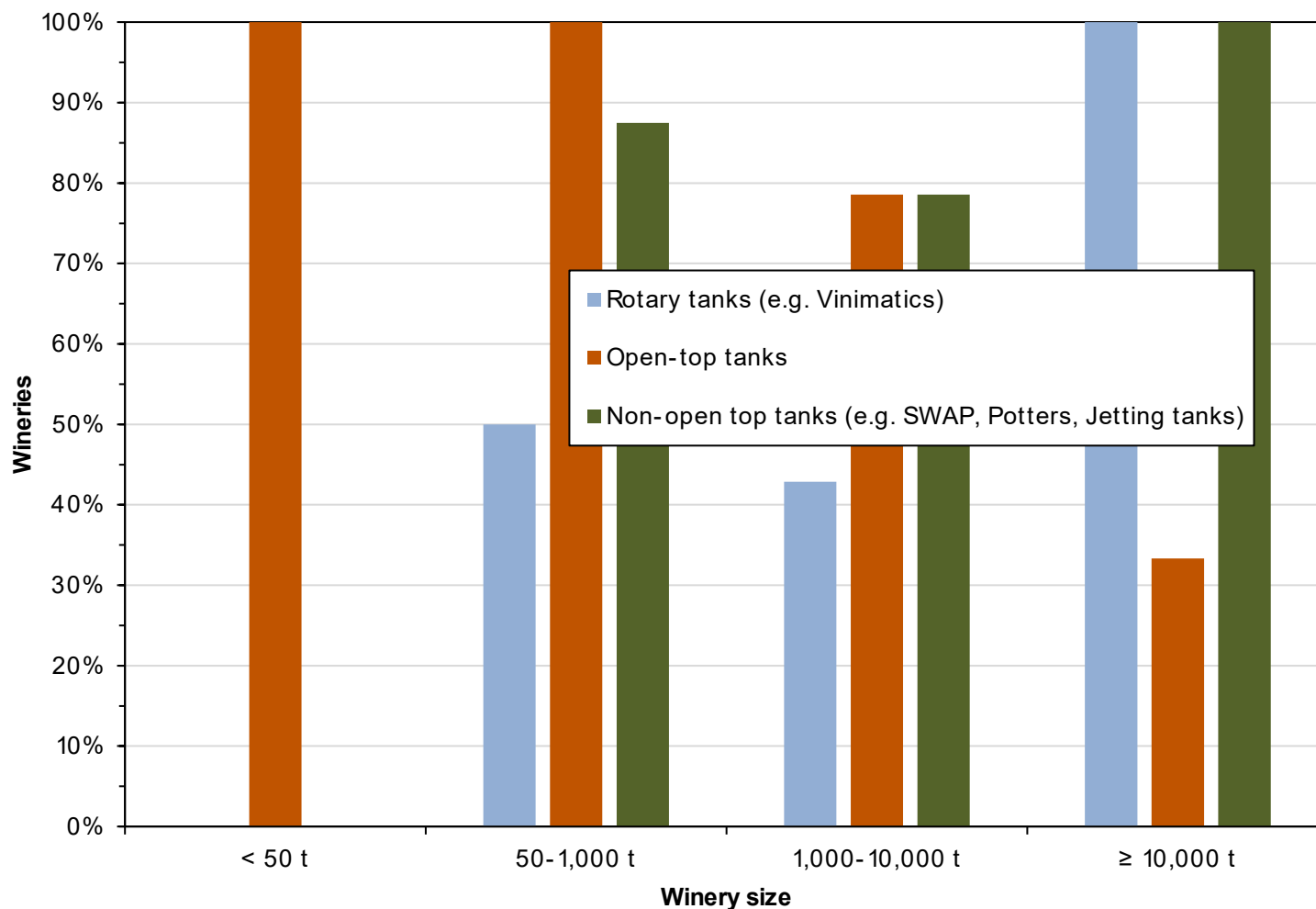
Red ferment oxygen introduction techniques (used at all)



- Cap-irrigators during pump-overs were the most common means of introducing oxygen.
- Please also refer to page 120 for data on extractive methods, some of which may also introduce oxygen.

*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 more limited oxygenation.

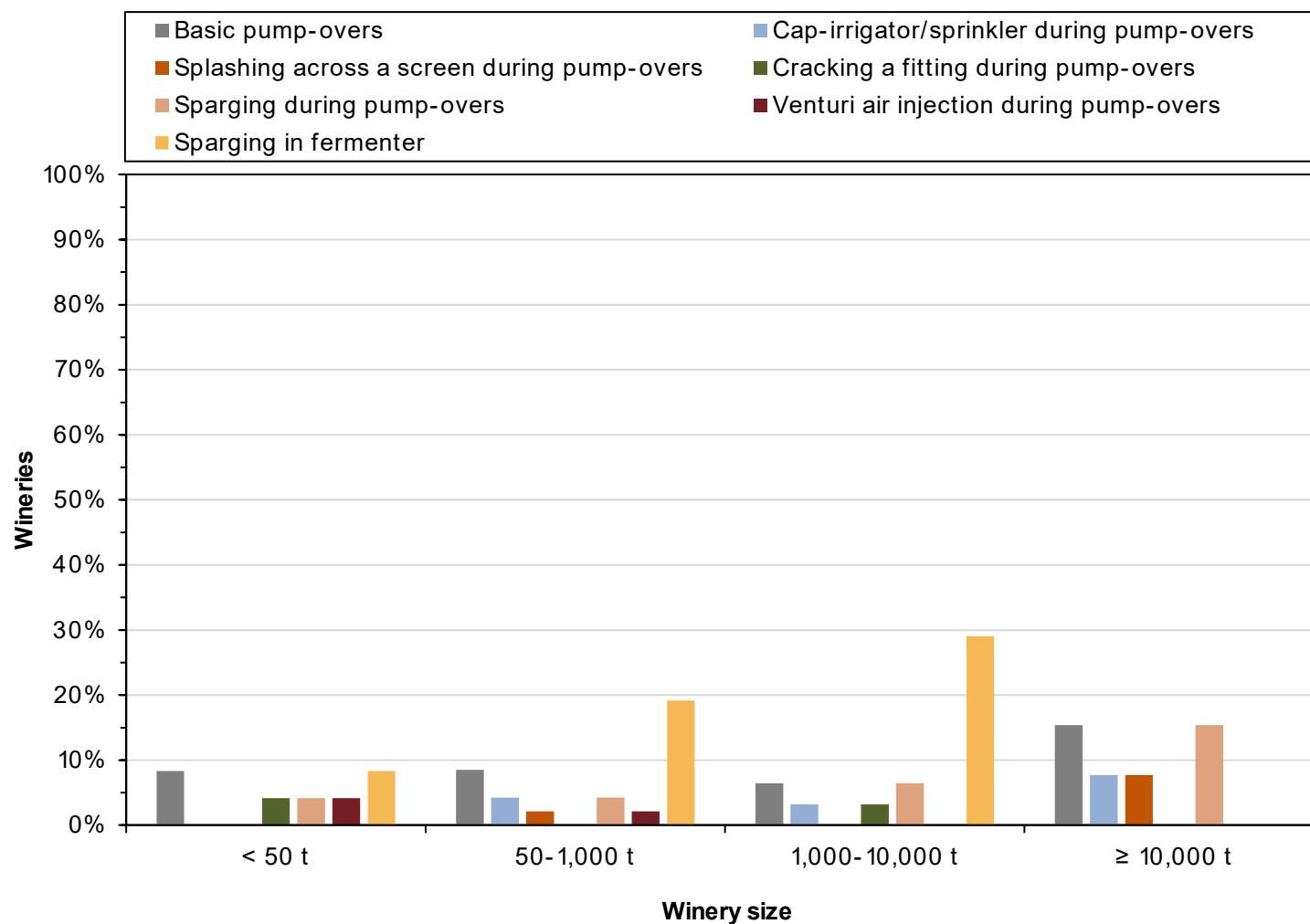
Types of red fermenters for in-fermenter sparging, and gas type (used at all)



- Of those wineries sparging in-fermenters, sparging was performed in a variety of tank styles, characteristic of winery size categories.
- For example, of the 3 wineries ≥ 10,000 t that sparged in-fermenters, all 3 performed it in both rotary and other non-open top fermenters.
- Wineries most commonly used compressed air, not pure oxygen.

*Respondents that sparged in fermenter (excluding pulsair) were asked to select all types of tanks it was performed in. Respondents that sparged in fermenter (excluding pulsair) or sparged during pump-overs, were asked to select all gases that were used. This question was not asked in 2016. The plot shows data for 2022.

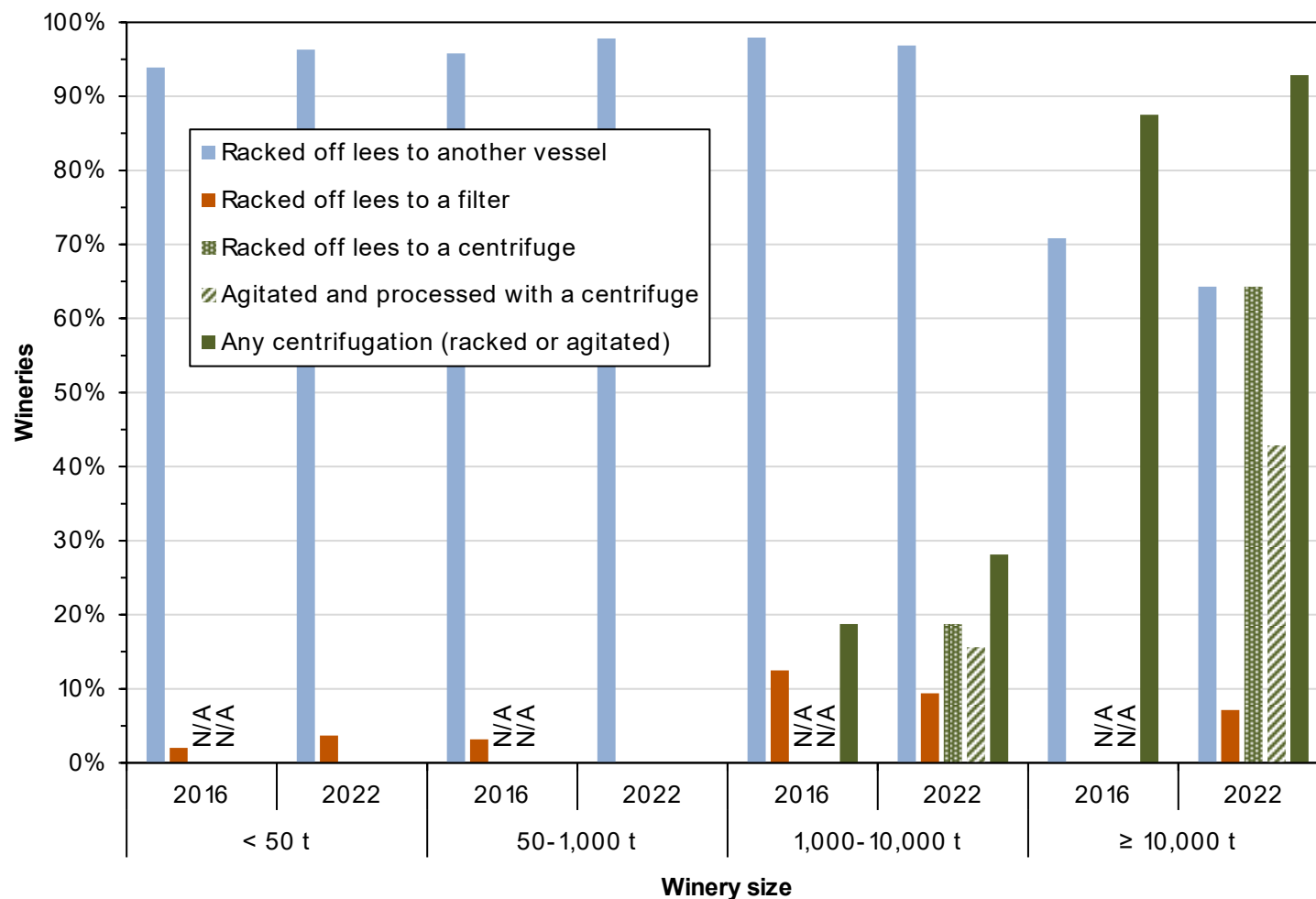
White ferment oxygen introduction techniques (used at all)



- Intentional oxygen introduction was less common for white ferments than red ferments (see page 123).
- This question was added to the 2022 survey, after wineries mentioned aerating some white ferments in addition to red ferments during 2016 survey follow-up site visits.

*Respondents were first asked whether any oxygen introducing techniques were used during white ferments. If they answered yes, they were then asked to select from a list all techniques that were used to introduce oxygen. This question was not asked in 2016.

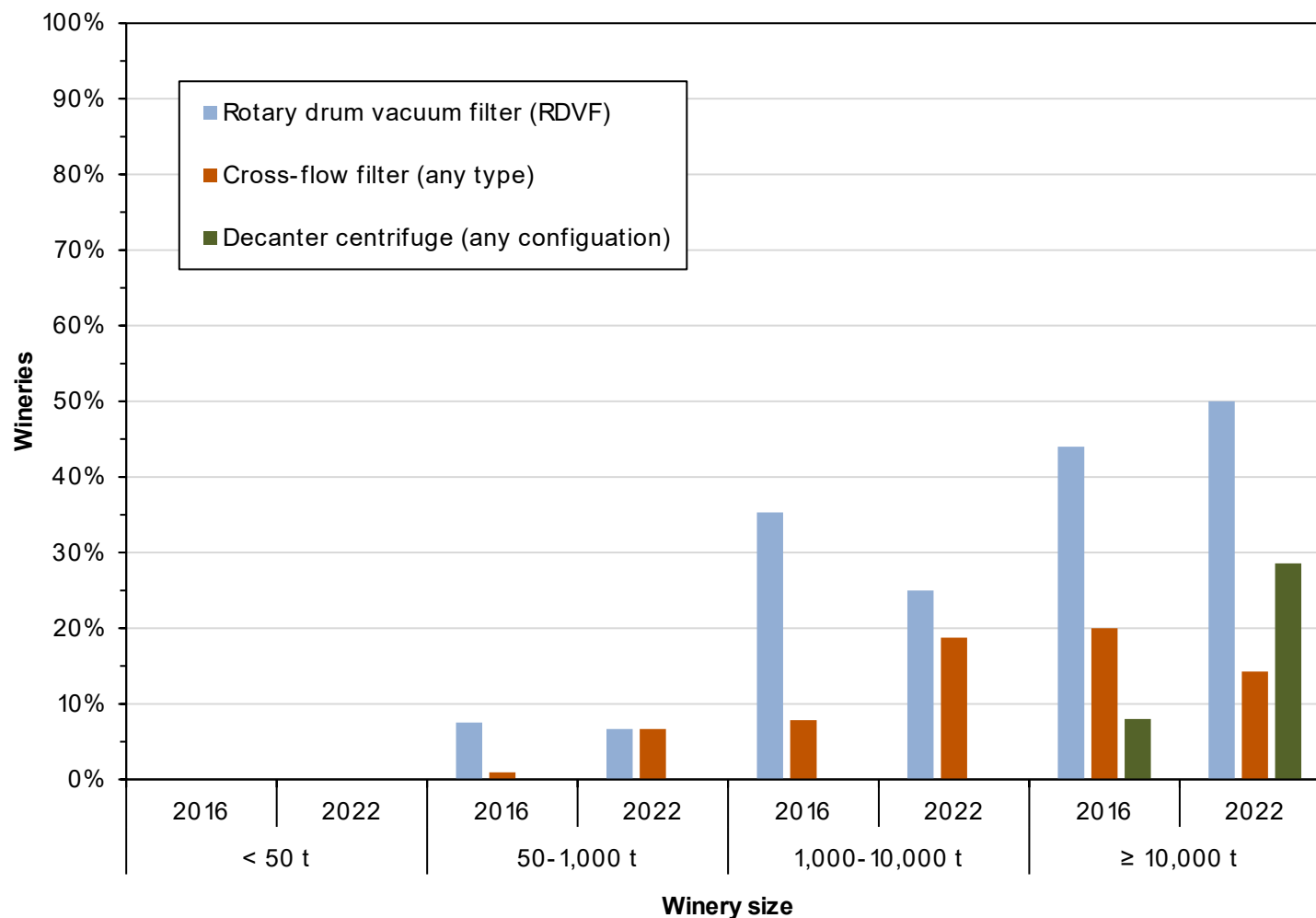
Initial separation from gross red lees (used at all)



- Racking was the principal technique used in small wineries.
- Large wineries often used centrifugation, either racking to the centrifuge or agitating the tank and processing the mixture through the centrifuge.

*Respondents were asked to select which techniques were used to first separate wine from gross red ferment lees. In the 2022 survey, racking to the centrifuge or agitating the tank to the centrifuge were explicitly broken out as separate responses - some wineries do both and some only one of these. An aggregate category of wineries using centrifugation is provided for comparison between 2022 and 2016, where it wasn't broken out so clearly in the original survey and where in the report division of centrifuge data was based on the most common approach to centrifuge use.

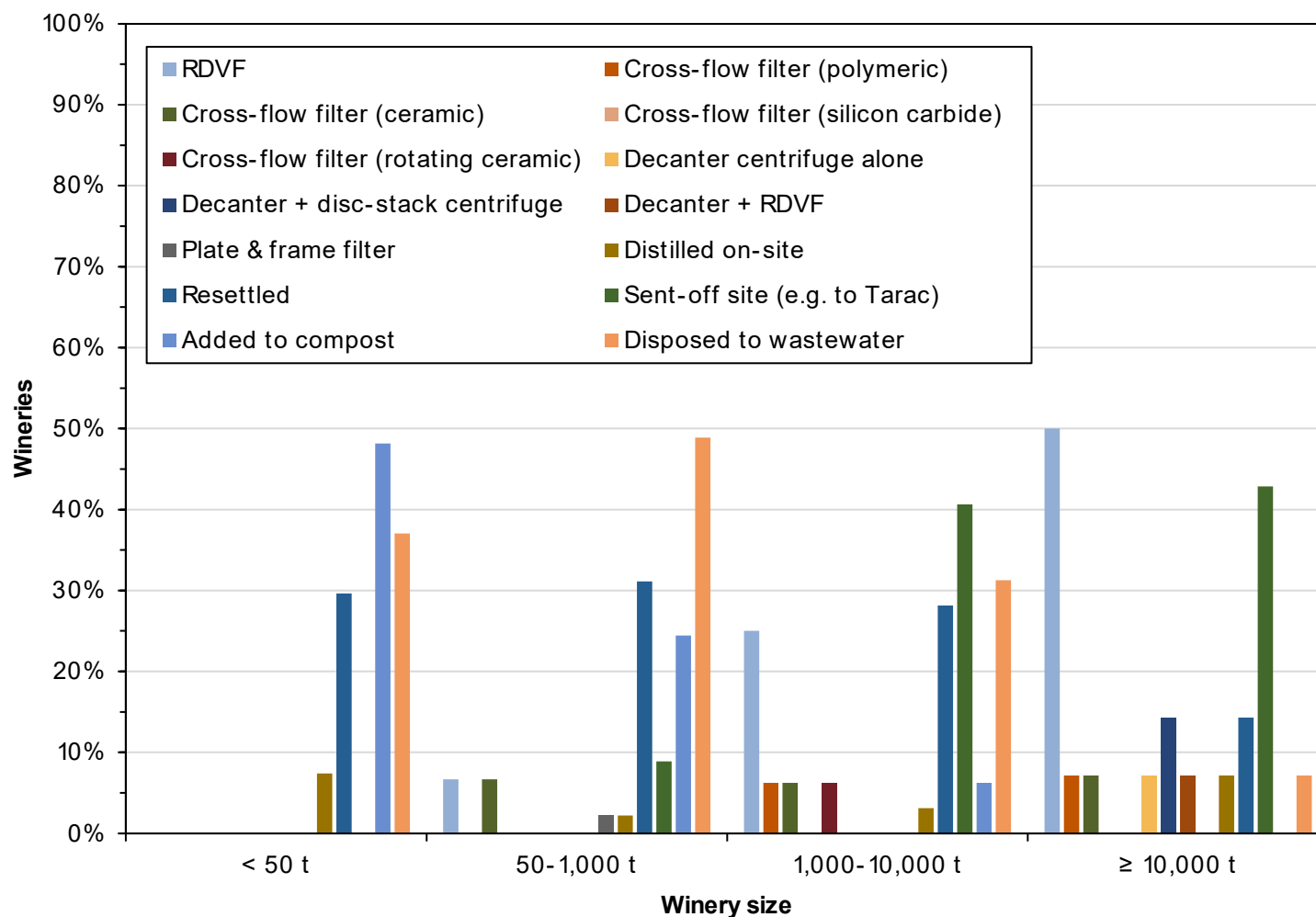
Red gross lees recovery by RDV, cross-flow filters, or decanters (used at all)



- Cross-flow filtration did not clearly increase in use for red lees recovery like it did for white juice lees between 2016 and 2022 (see page 98), likely due to the higher thickness of red lees.
- The adoption of decanter centrifuges for processing red lees/desludge did increase in large wineries between 2016 and 2022, likely reflecting the ability of decanters to handle higher feed solids, even if the product retains some residual solids.
- A detailed breakdown of all technologies used for processing red lees/desludge in 2022 is provided on the next page, including the use of cross-flow filters with different types of membranes and different secondary stages after decanter centrifuges.

*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. In the 2022 survey, the details on some options were expanded to collect information on topics like different cross-flow membrane filter materials, but all cross-flow filters have been aggregated into a single category in this plot to allow comparison between 2016 and 2022 as has decanter centrifuge use where it might be used alone or soon followed by disc-stack centrifugation or RDVF.

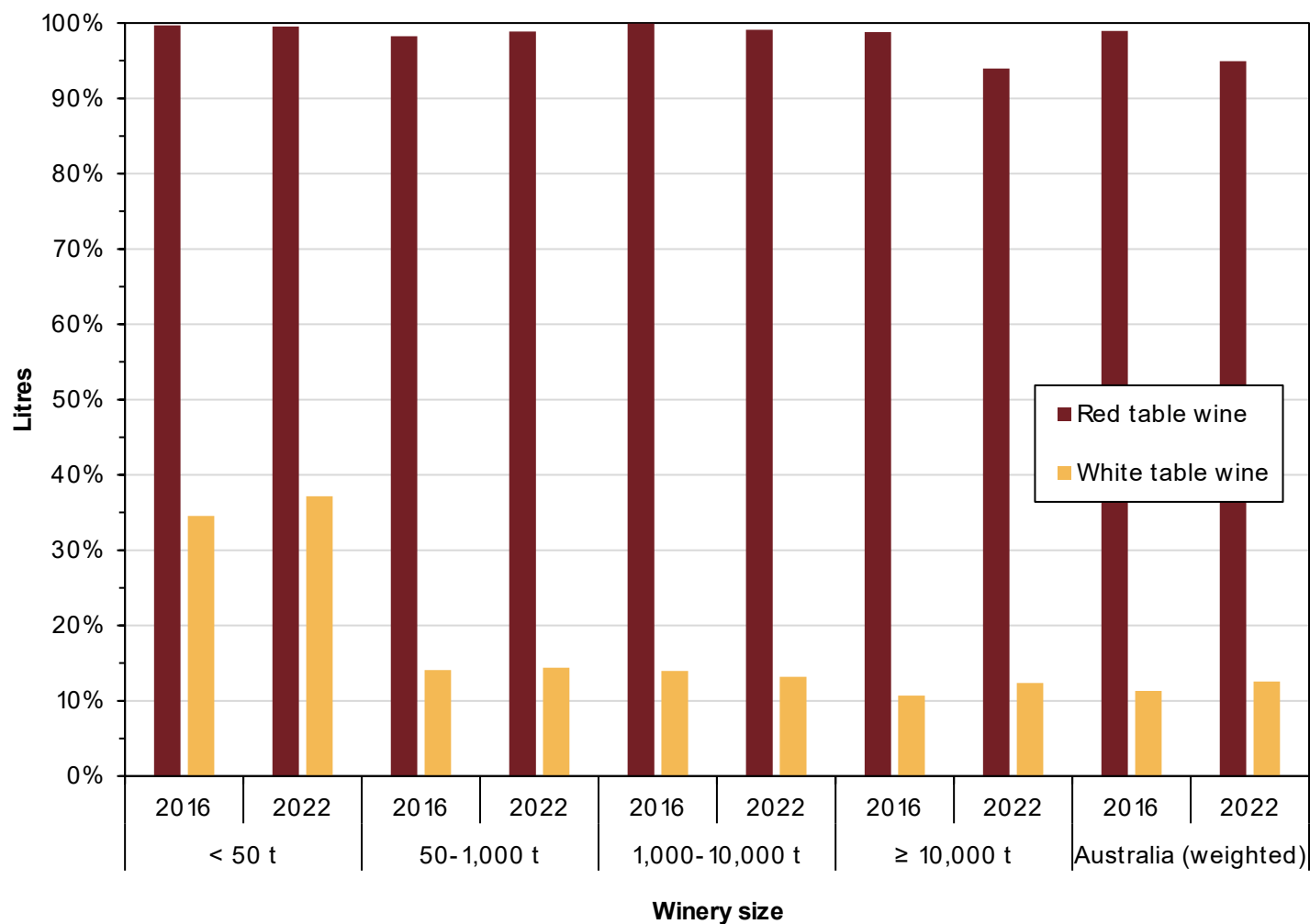
Red gross lees/desludge management techniques (used at all)



- Many large wineries sent some lees off-site for reprocessing, likely often centrifuge desludge.

*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. Plot shows data from the 2022 survey, which included more detailed questions on cross-flow filter membrane materials and disposal methods than the 2016 survey.

Wine undergoing malolactic fermentation (MLF)



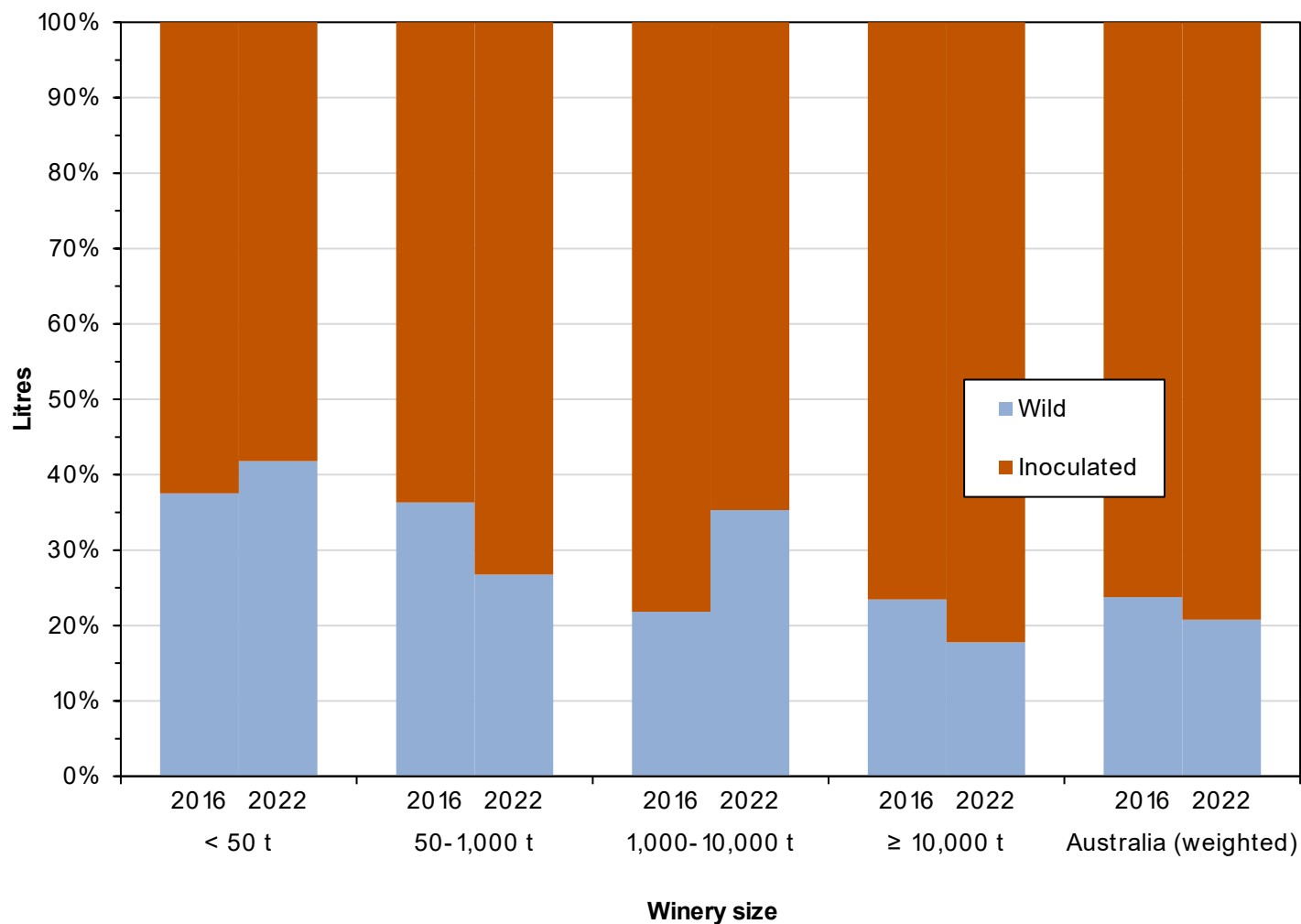
Weighted values for Australia

	2016	2022
Red wine MLF	99%	95%
White wine MLF	11%	13%

- Most red wines go through MLF, while only a small fraction of white wines do.

*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



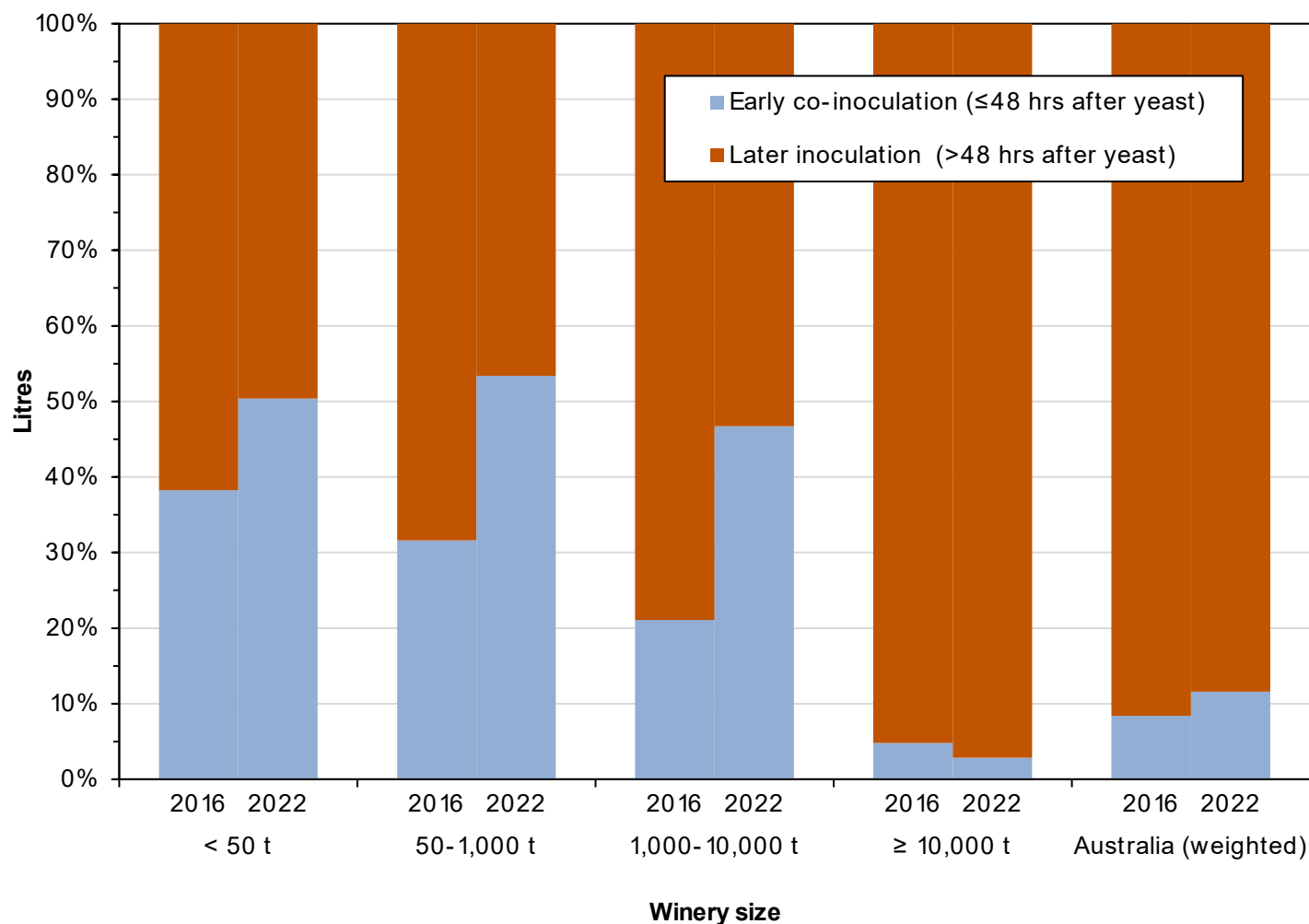
Weighted values for Australia

	2016	2022
Wild red MLF	24%	21%

- More wine underwent inoculated MLF (including by cross-seeding) than wild MLF.

*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.

Timing of MLF inoculations for red table wine



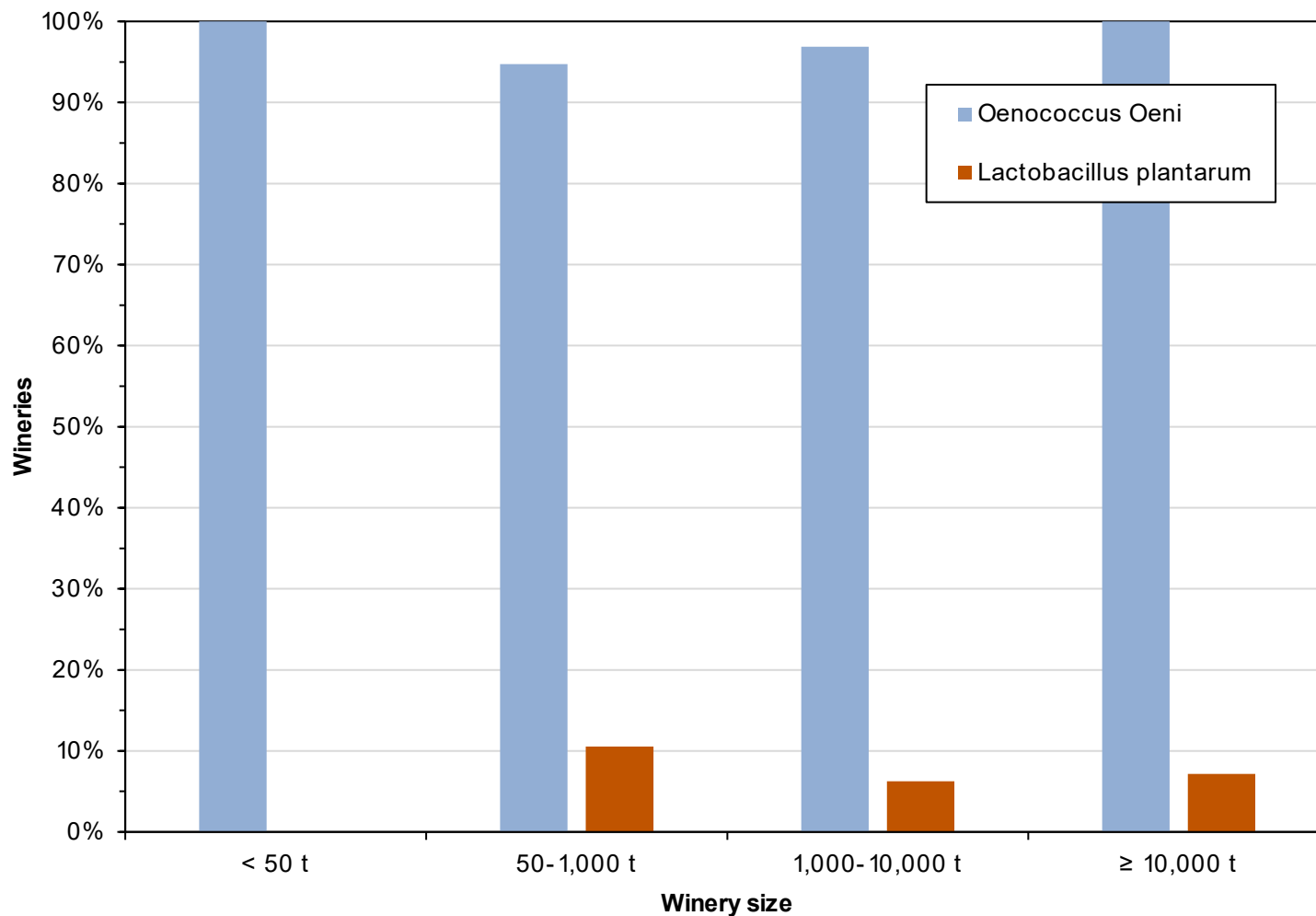
Weighted values for Australia

	2016	2022
Early MLF co-inoculation	8%	12%

- The prevalence of early co-inoculation for MLF increased between 2016 and 2022, except in very large wineries.

*Respondents that inoculated MLFs in 2022 were asked what % by volume was inoculated ≤48 hrs after yeast addition (early co-inoculation) versus any time after that to the nearest 10%. The early co-inoculation 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. In 2016, the initial web-based survey question had focused on co-inoculation anytime during alcoholic fermentation not specifically on early co-inoculation, so follow-up emails were sent to establish the proportion that was specifically early co-inoculation (with a ≤48 hrs after yeast addition cut-off).

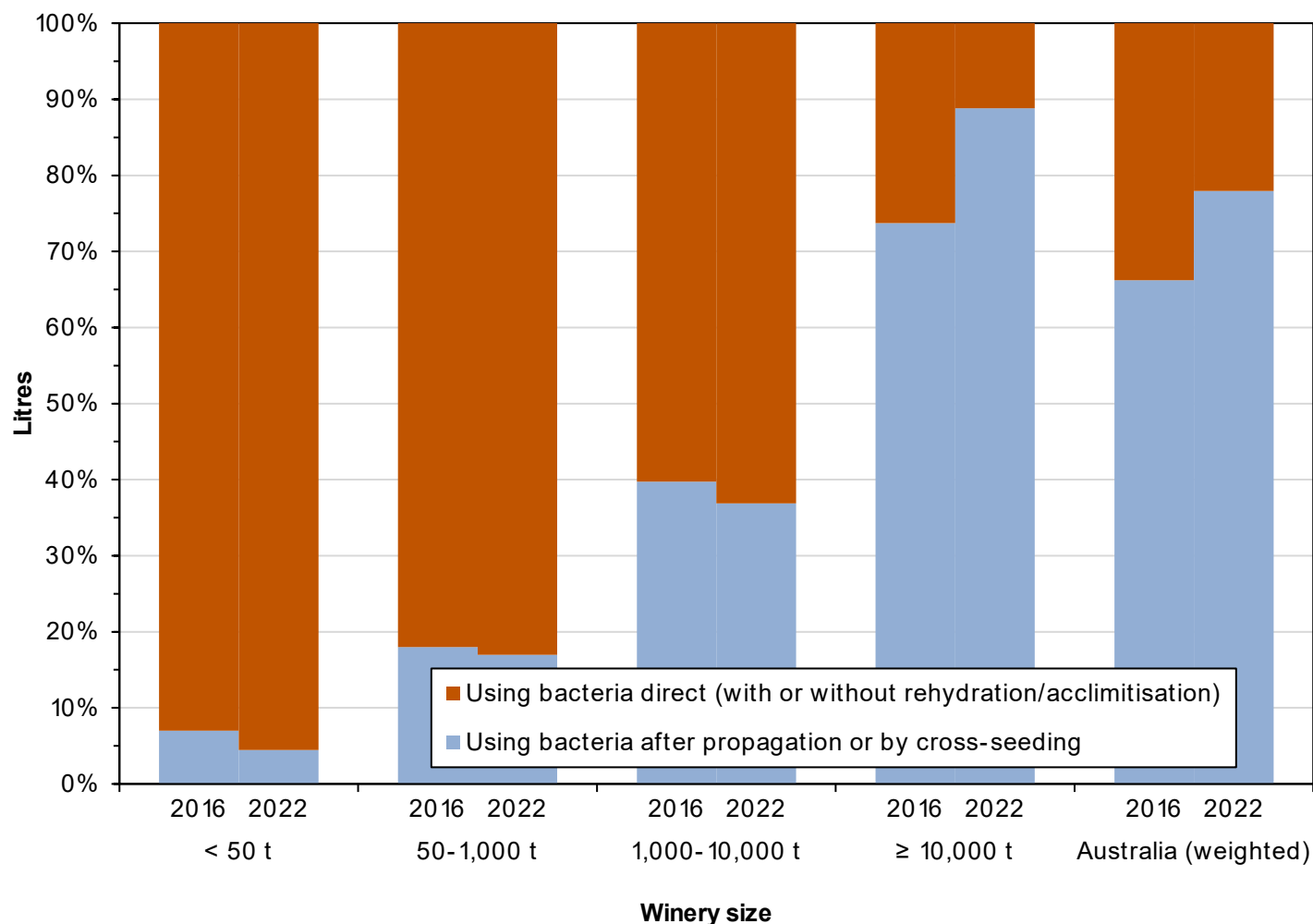
Species of MLF bacteria used for inoculation



- *Oenococcus oeni* was by far the most common bacterium used for inoculation.
- Only 7 respondents used *Lactobacillus plantarum*.
- Those using *Lactobacillus plantarum* were most commonly inoculating 24-48 hours after yeast addition and none were inoculating with bacteria before yeast addition as has been proposed by one supplier.

*Respondents that inoculated MLFs were asked to select what species of bacteria were used. Respondents using *Lactobacillus plantarum*, were then asked to select what time it was added in relation to the yeast. This question was not asked in 2016. The plot shows data for 2022.

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



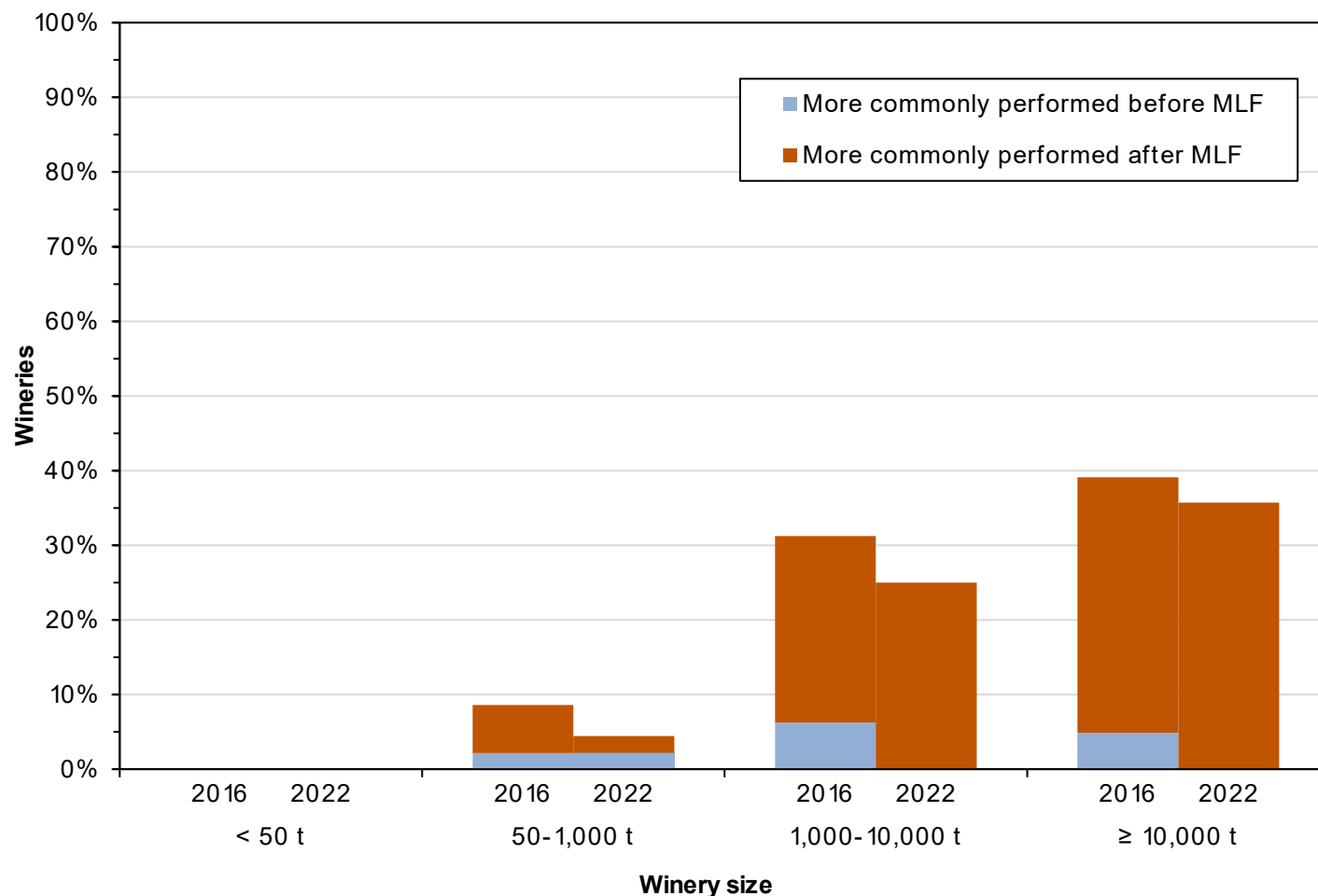
Weighted values for Australia

	2016	2022
Prop/cross-seeded MLF	66%	78%

- Larger wineries used more propagation and cross-seeding for MLF inoculation than smaller wineries.
- The increase in propagation/cross-seeding between 2016 and 2022 is likely an artefact of different wineries responding in the ≥ 10,000 t category, rather than a real practice shift.

*Respondents that inoculated MLFs were asked whether inoculations were performed directly with bacteria from the supplier or after first propagating to a large quantity at the winery or cross-seeded from another tank, or 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.

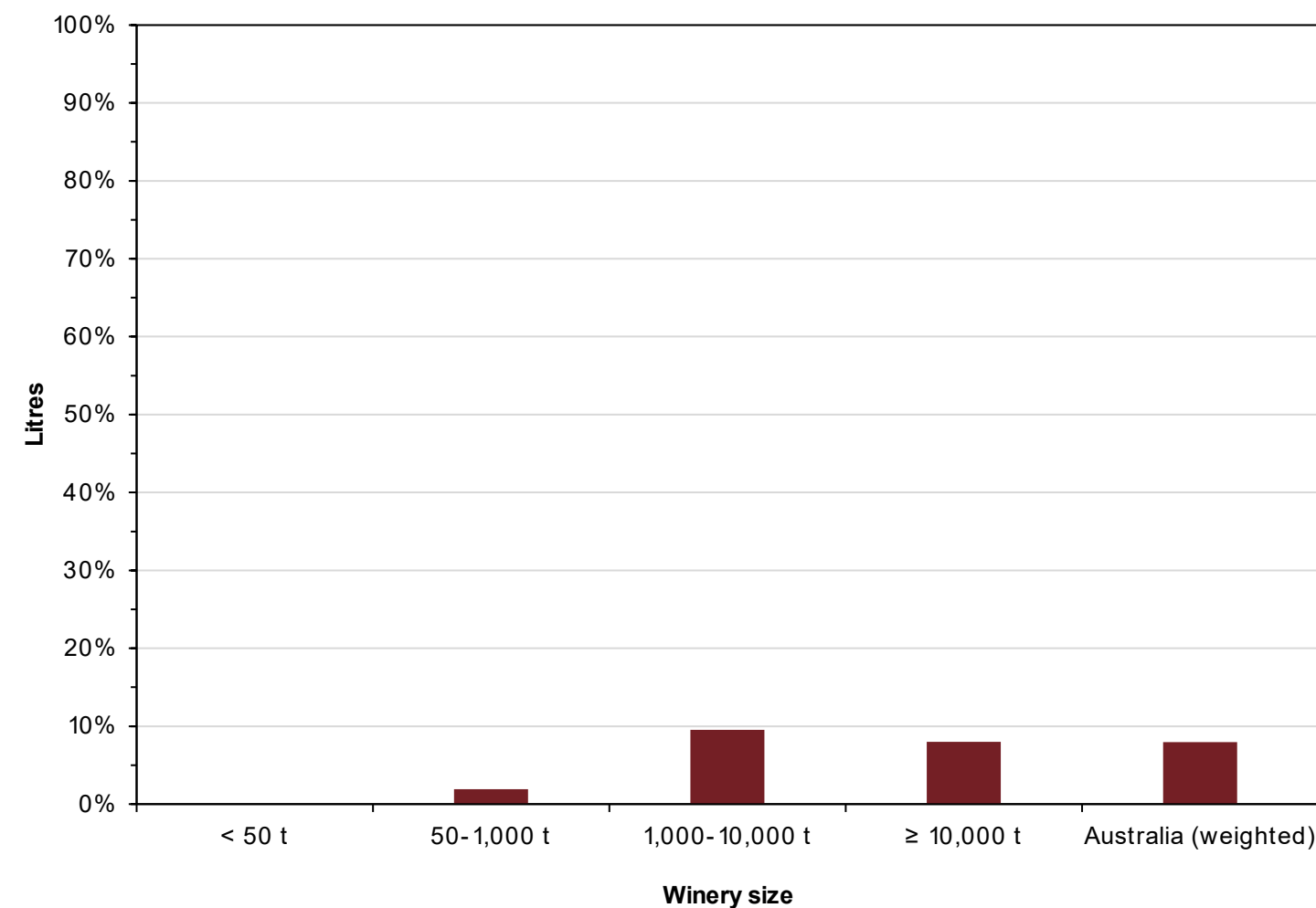
Micro-oxygenation (MOX) of red table wine (used at all)



- The number of wineries performing MOX was similar in 2016 and 2022.
- In 2016, in follow-up site visits most wineries using MOX were not using it commonly. An additional question was added to the 2022 survey to capture how much wine undergoes MOX (see next page).
- The actual quantity of red wine undergoing MOX was only 8%.

*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.

Micro-oxygenation (MOX) on red table wine



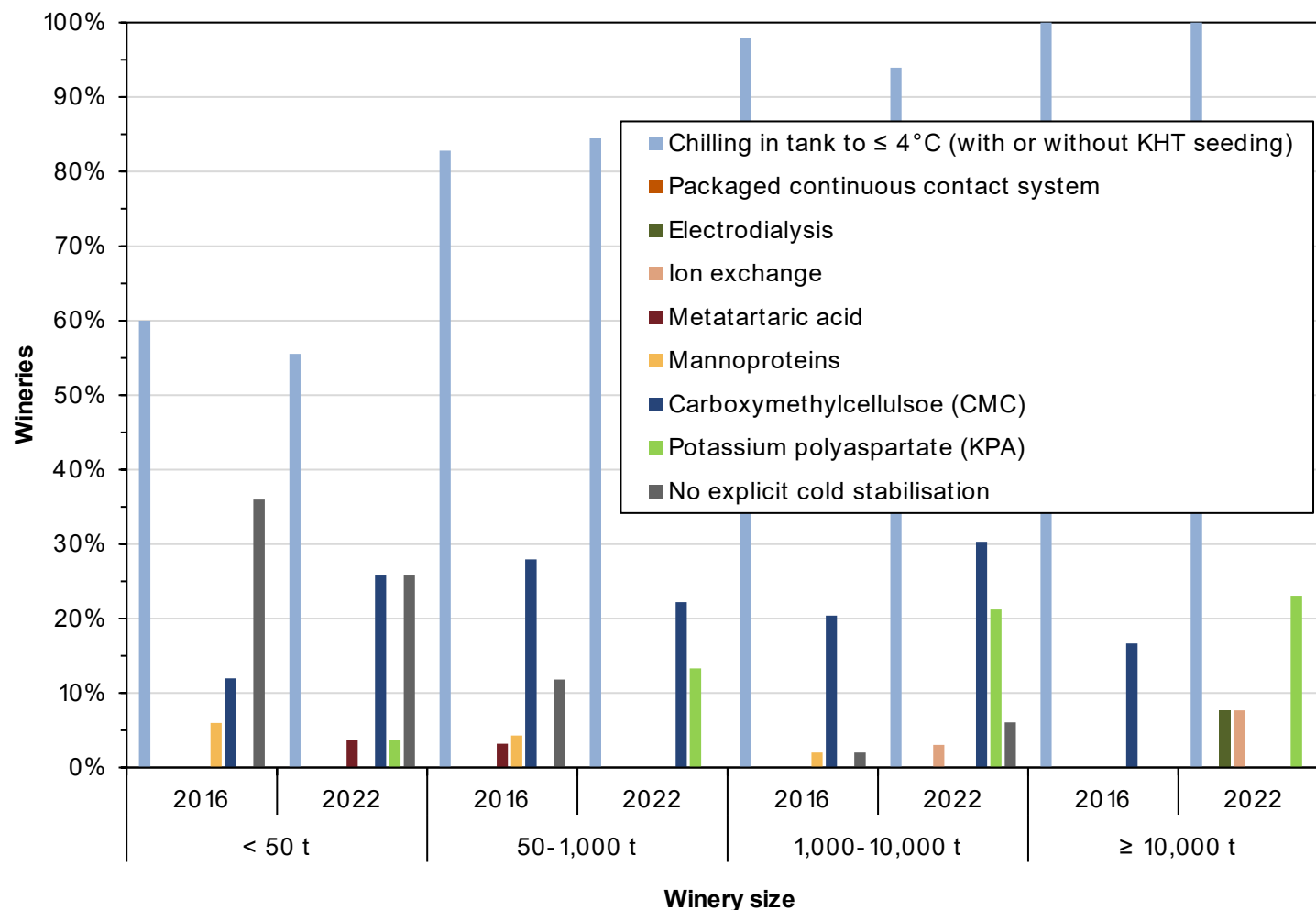
Weighted values for Australia

	2016	2022
MOX	N/A	8%

- While many large wineries performed some MOX, the overall volume of red table wine on which it was performed was only 8% across the industry in 2022.

*Respondents were asked whether any micro-oxygenation was performed on red table wine. In 2022, if they answered yes, there was a follow-up question on what % by volume undergoes MOX to the nearest 10%. Litres undergoing MOX or not were estimated based on this, the winery intake tonnage and the fraction of red grapes.

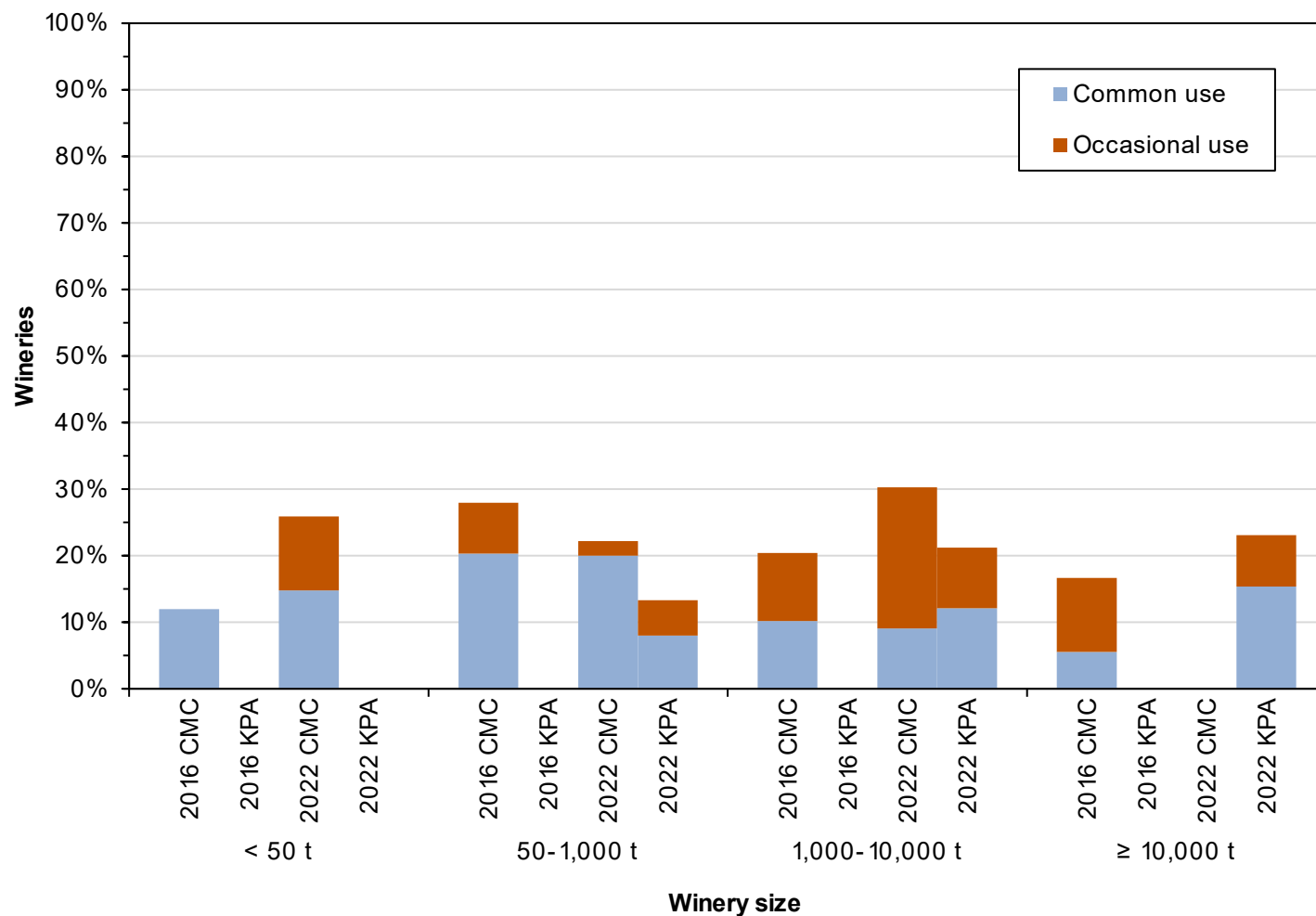
Cold/tartrate stabilisation methods (used at all)



- Chilling in tank with or without seeding with potassium bitartrate (KHT) crystals remains the most common method of cold stabilisation.
- Of the crystallisation inhibitors available, CMC and KPA are the most commonly used products.
- KPA was introduced to the market between the 2016 and 2022 surveys.
- In the 2022 survey, CMC was not used at all by ≥ 10,000 tonne wineries, in contrast to smaller wineries and 2016 data. However, follow-up site visits in 2016 showed most were only using it occasionally or on some products.
- For the key crystallisation inhibitors, the proportion of wineries using them commonly or only occasionally is shown on the next page.

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

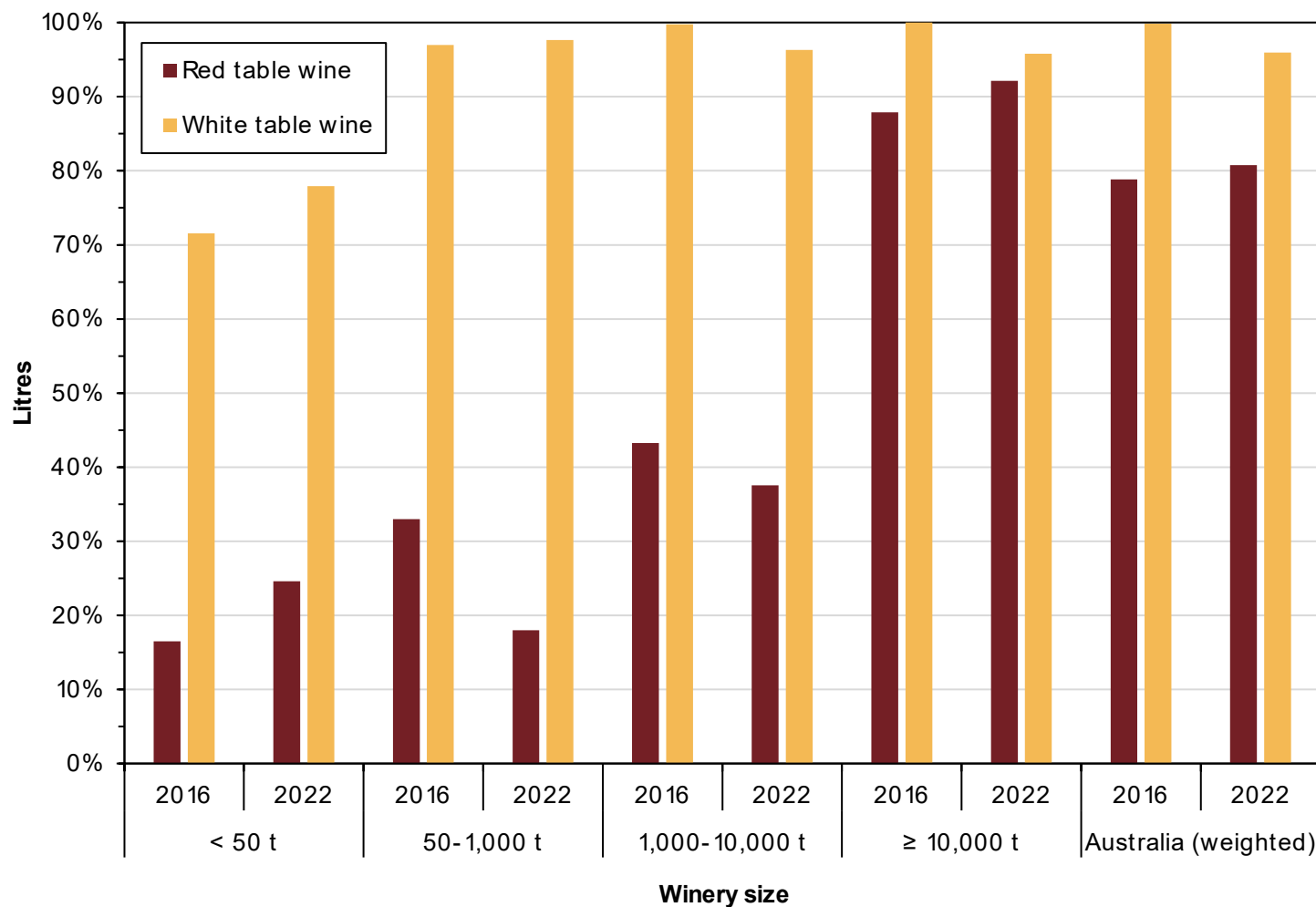
CMC and KPA for cold/tartrate stabilisation



- Whether wineries were using crystallisation inhibitors commonly or occasionally varied between sites.

*Respondents that selected that they used any crystallisation inhibitors for cold stabilisation, were asked whether they were used commonly or only occasionally for each of the crystallisation inhibitors that they used.

Cold stabilised (using one of the methods listed)



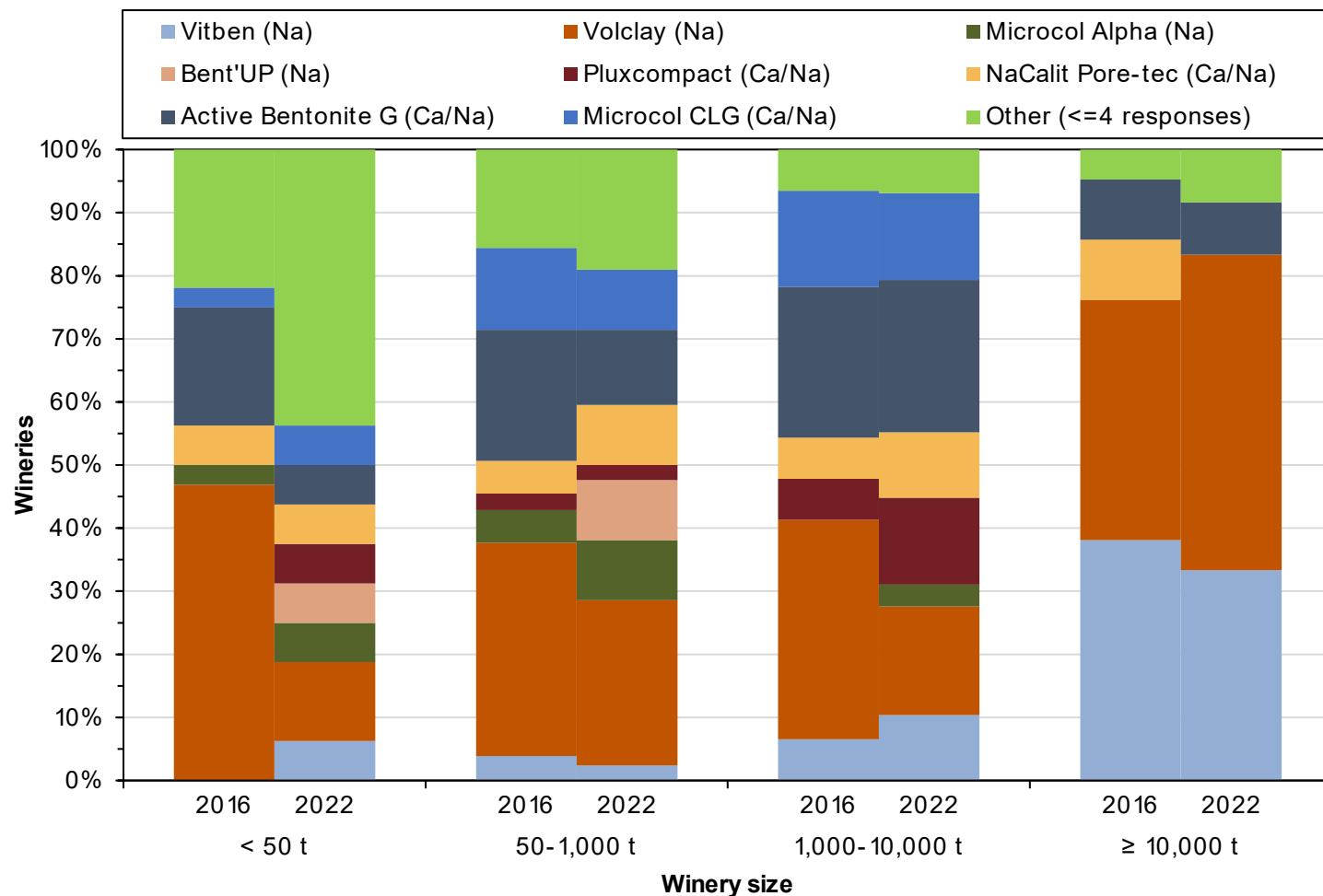
Weighted values for Australia

	2016	2022
Red wine cold stab	79%	81%
White wine cold stab	100%	96%

- Smaller wineries were less likely to explicitly cold stabilise wines, particularly red wines.
- 2016 and 2022 data were similar.

*Respondents were asked what % of the volume of red and white table wines were explicitly cold stabilised. If they selected that they did not cold stabilise any wines by the methods listed (in 2016) or selected none of the above (in 2022) the fraction stabilised was set to 0%. Litres cold stabilised were estimated based on this, the winery intake tonnage and fraction of red and white grapes.

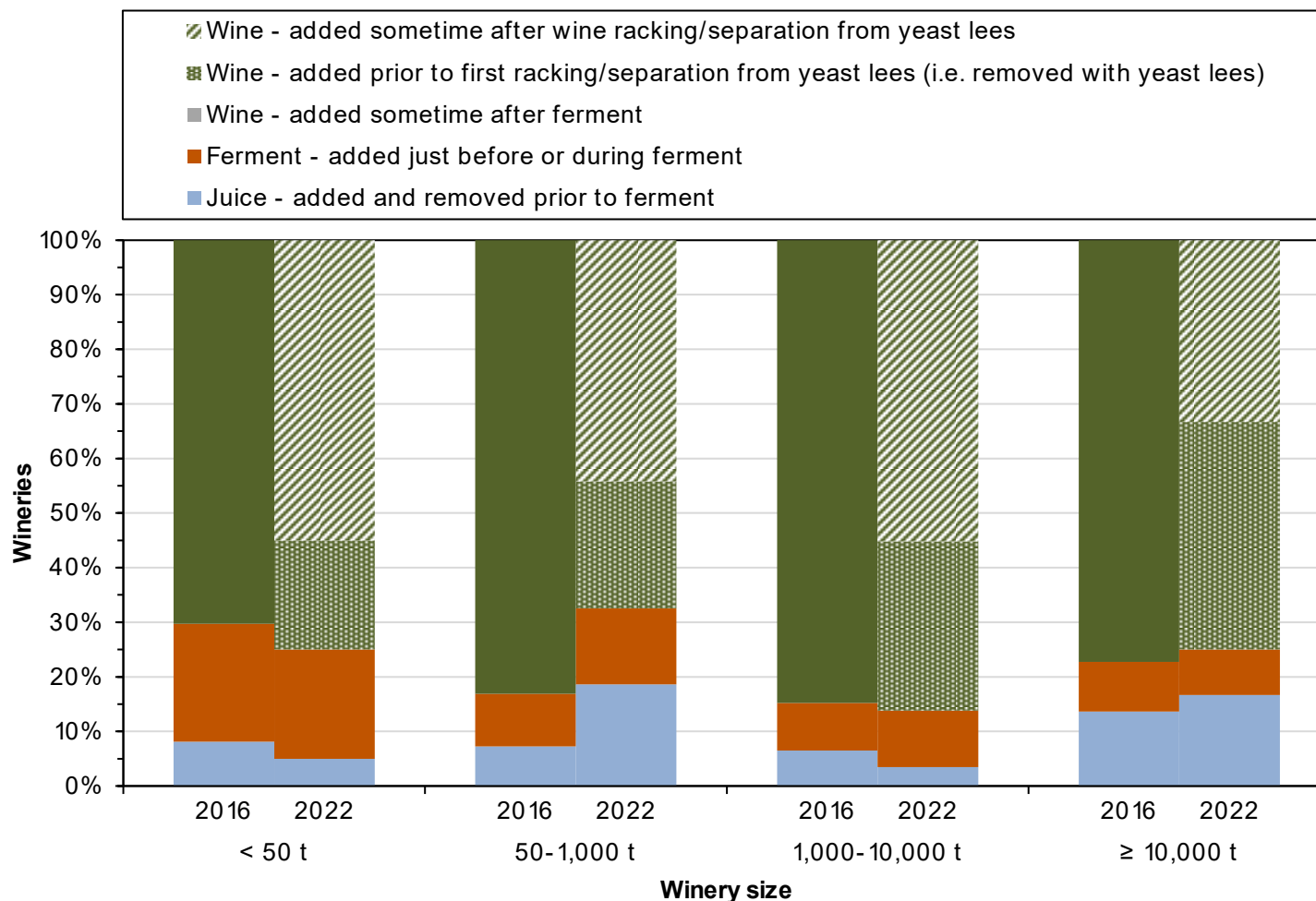
Most common bentonite type used



- The bentonites most commonly used in wineries were similar in the 2016 and 2022 surveys.
- In the surveys there was only the opportunity to select the one most common bentonite in use at a winery, so bentonites marketed specifically for flotation (e.g. Bent'UP, Flottobent) that may be a secondary bentonite at a site may seem under-represented in this plot.

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

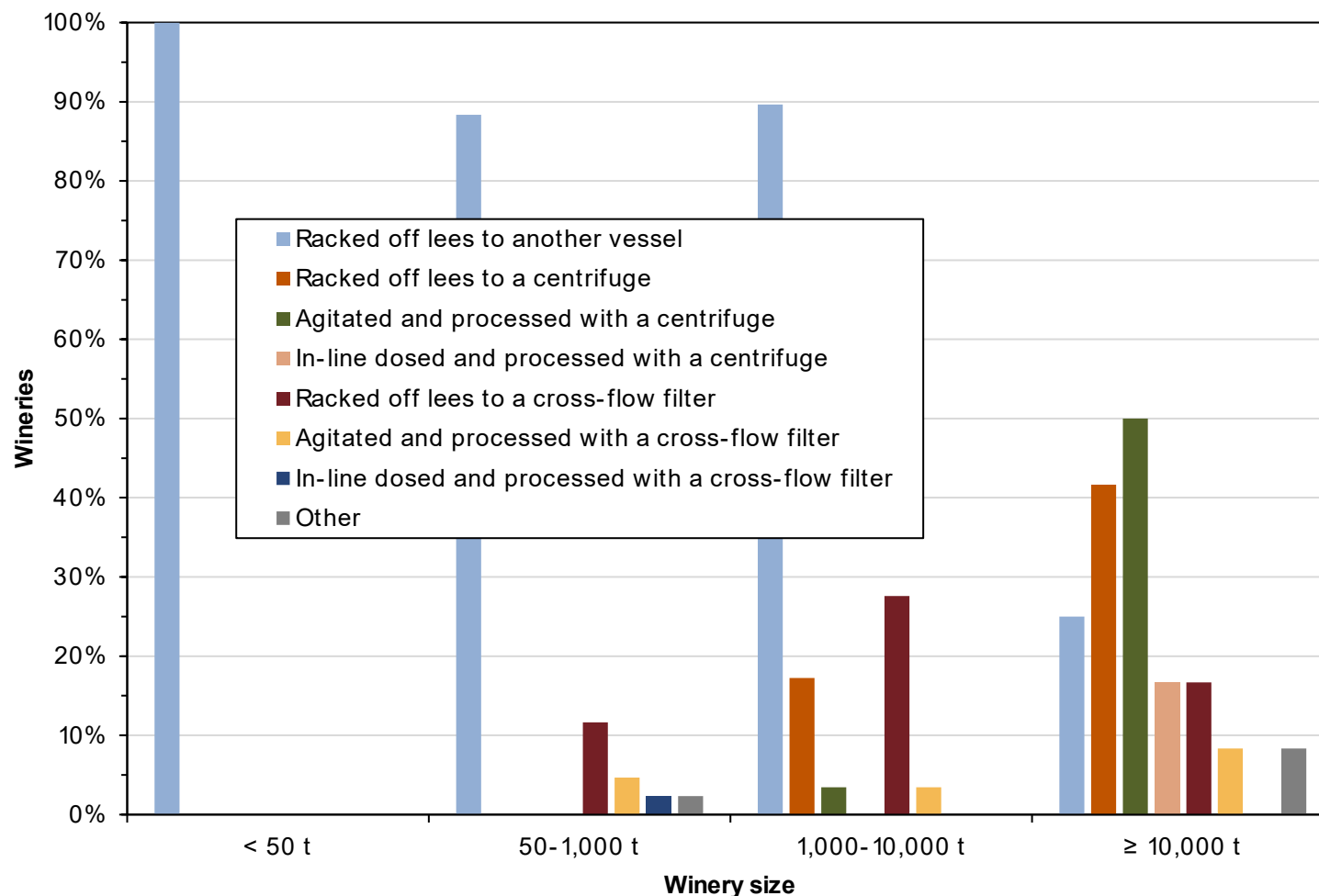
Timing of largest bentonite addition



- Bentonite was most commonly added at the wine stage in 2022 as it was in 2016.
- The question was changed for the 2022 survey to more explicitly capture whether bentonite additions at wine stage were being added before the first yeast removal or at some time later in the winemaking process.
- The prevalence of a small bentonite dose to aid juice flotation was not explicitly captured in the survey, but bentonite is very commonly added to some juice (page 100), including for flotation (page 95).

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

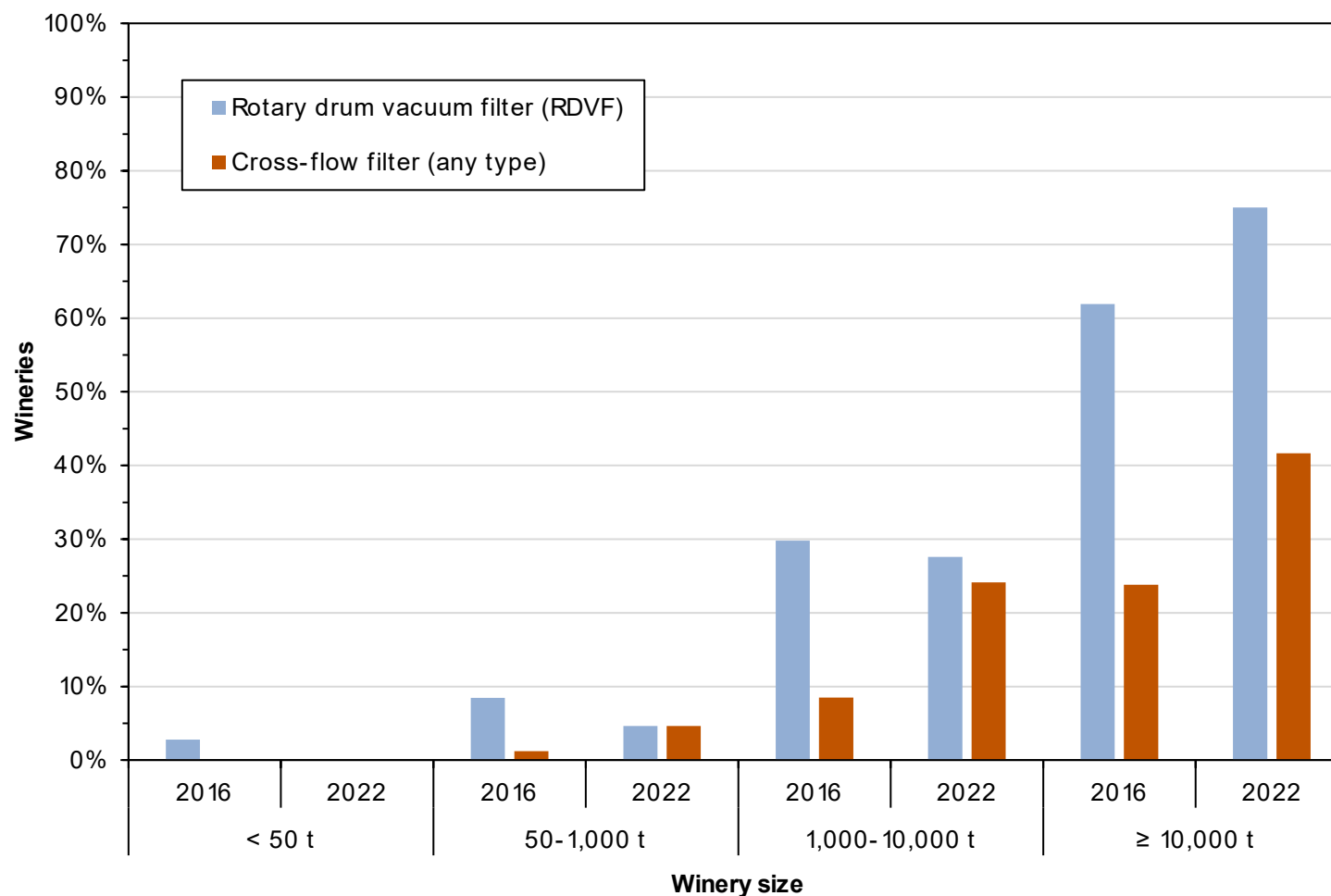
Initial separation of bentonite (used at all)



- Most respondents relied on bentonite additions to a tank followed by gravity settling and racking.
- Larger wineries also used disc-stack centrifuges and cross-flow filters for bentonite removal, with some racking and others agitating the tank and processing it.
- Only 1 respondent in-line dosed bentonite upstream of a cross-flow filter, and 2 others in-line dosed upstream of a centrifuge.
- 2 respondents mentioned flotation and many others would have also been removing some bentonite by flotation since bentonite is commonly used to enhance juice solids removal during flotation (page 95).

*Respondents were asked to select which methods were used to initially remove juice/wine from bentonite solids. Plot shows data from the 2022 survey, which included more explicit questions on whether tanks were racked or agitated before clarification than in the 2016 survey.

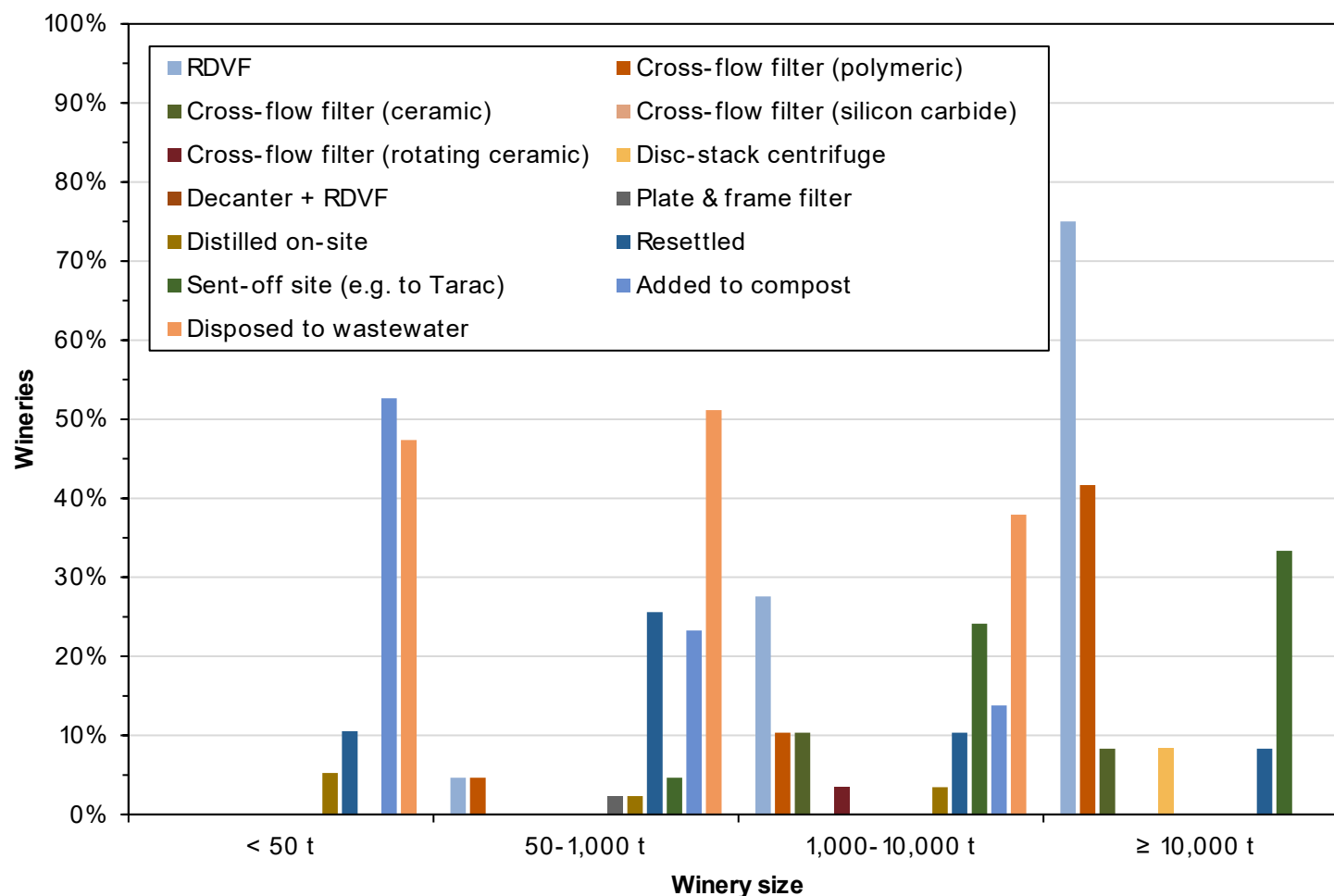
Bentonite lees/desludge management techniques (used at all)



- The use of cross-flow filtration for bentonite lees increased between 2016 and 2022, but not to the same extent that it did for juice lees (see page 98).

*Wineries were asked to select from a list all the techniques that were used to manage the lees/bottoms/floats/desludge/retentate from the clarification processes selected in the previous question. In the 2022 survey, the details on some options were expanded to collect information on topics like different cross-flow membrane filter materials, but all cross-flow filter types have been aggregated into a single category in this plot to allow comparison between 2016 and 2022.

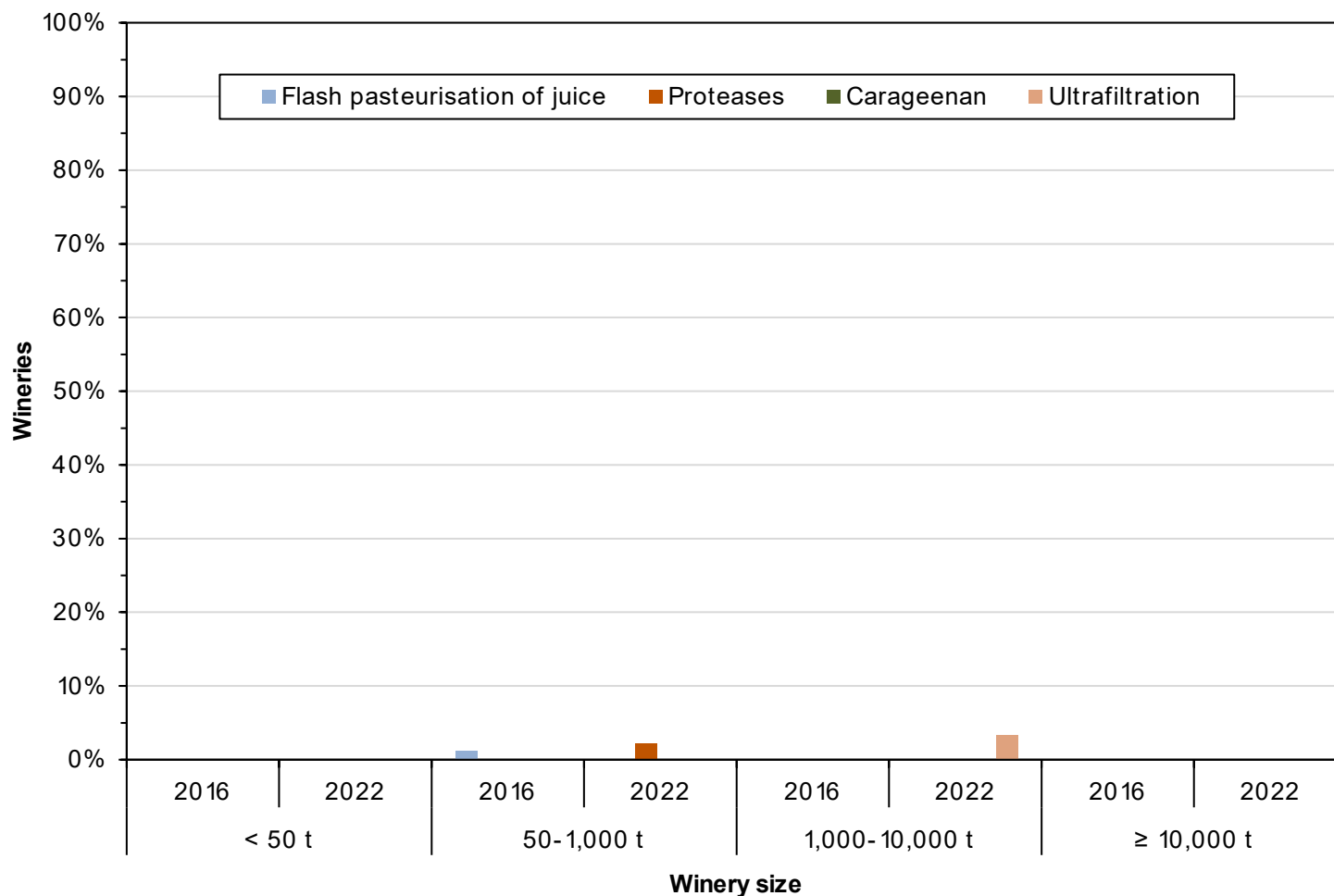
Bentonite lees/desludge management techniques (used at all)



- As with other lees management steps, larger wineries were more likely to try to use equipment to recover more wine, while smaller wineries were more likely to dispose of them to wastewater or compost.

*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. Plot shows data from the 2022 survey, which included more detailed questions on cross-flow filter membrane materials and disposal methods than the 2016 survey.

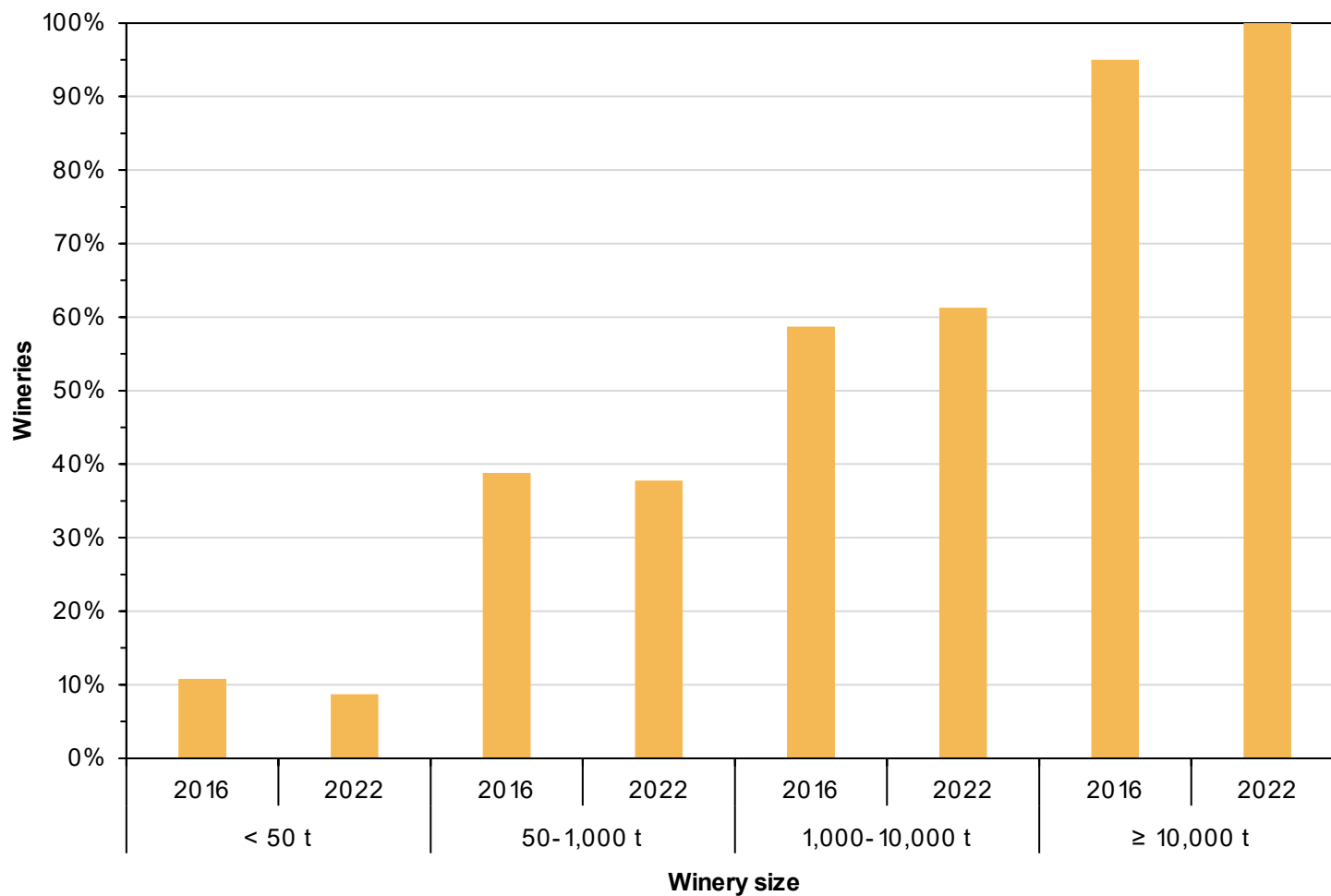
Alternatives to bentonite for heat/protein stabilisation (used at all)



- Bentonite is the predominant method of managing heat/protein stability.
- One novel alternative technique that is seeing some limited commercial adoption is ultrafiltration.
- It is primarily being used as a vegan alternative to manage phenolics in high value press juices but has a beneficial side-effect of removing proteins in these juices.

*Respondents making white wine were asked if any other techniques were used to heat stabilise or partially heat stabilise white wine and were provided with a list to select from.

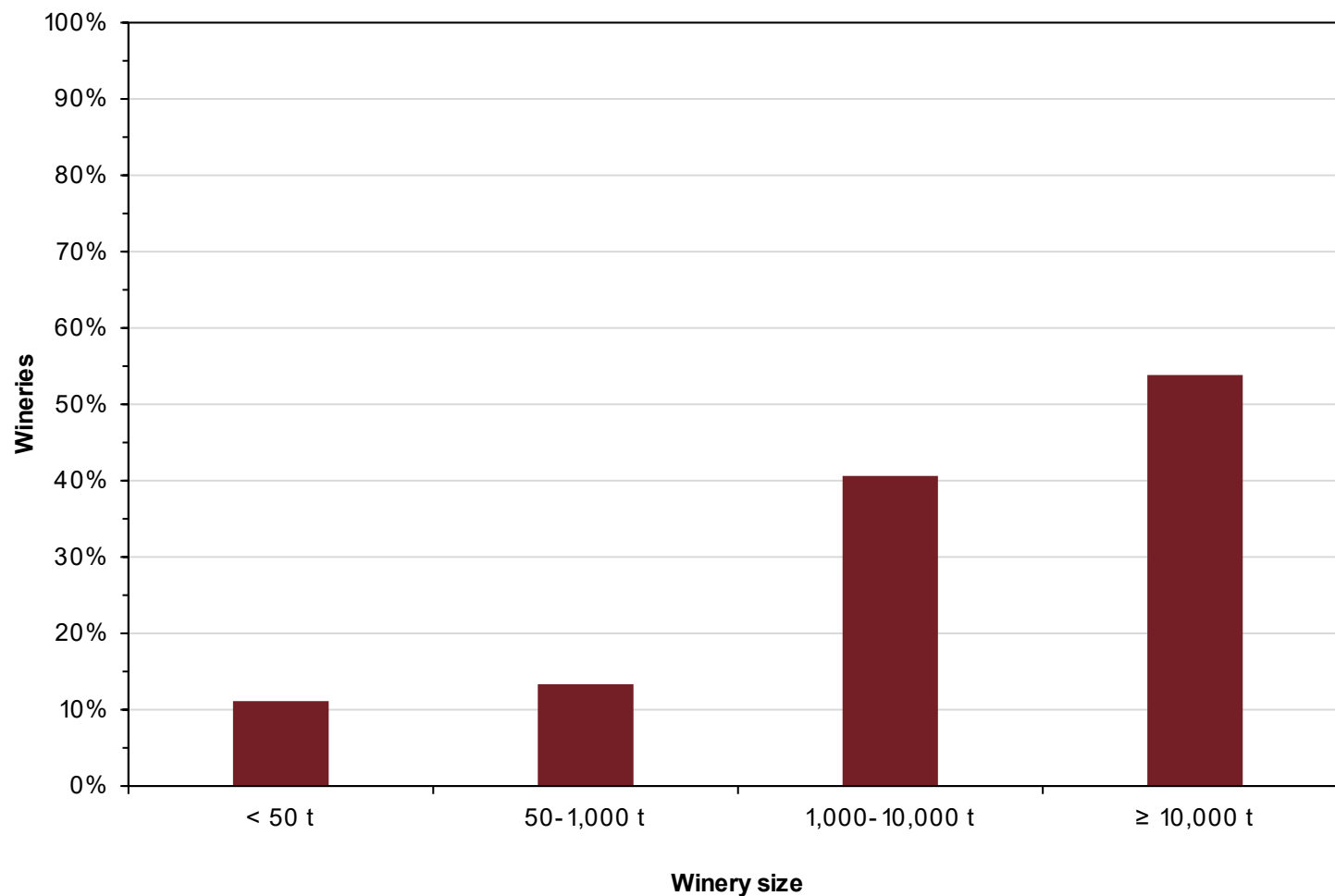
Ascorbic acid addition to white table wines (used at all)



- 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, including that added in the form of salts (e.g. sodium erythorbate).

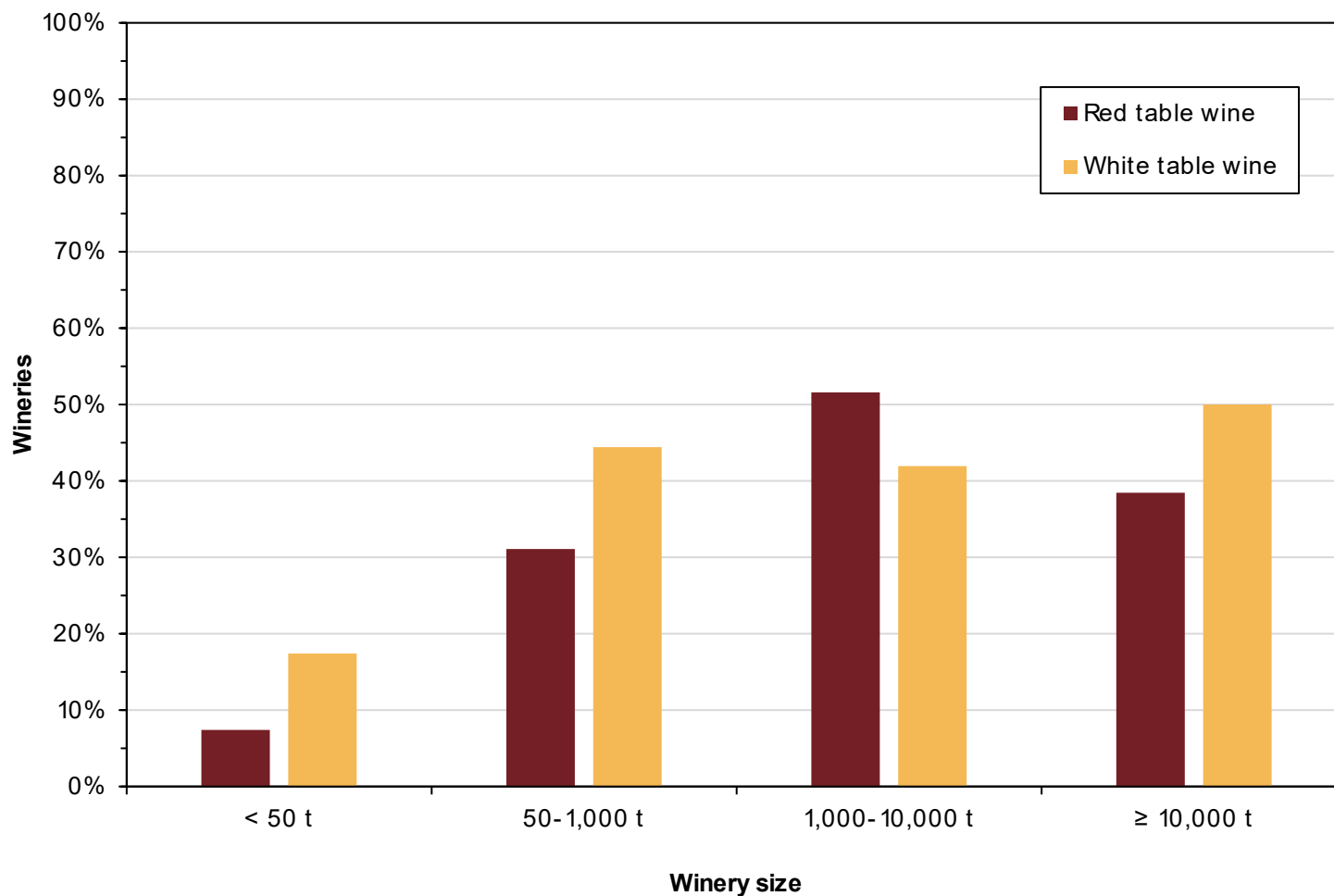
Gum arabic addition to red table wines (used at all)



- Larger wineries were more likely to use gum arabic than smaller wineries.

*Respondents were asked whether they added gum arabic to any red wines, either by itself or combined with other additives (e.g. KPA for cold stabilisation of red wines is often sold mixed with gum arabic). This question was not asked in 2016. This question was not asked in 2016. The plot shows data for 2022.

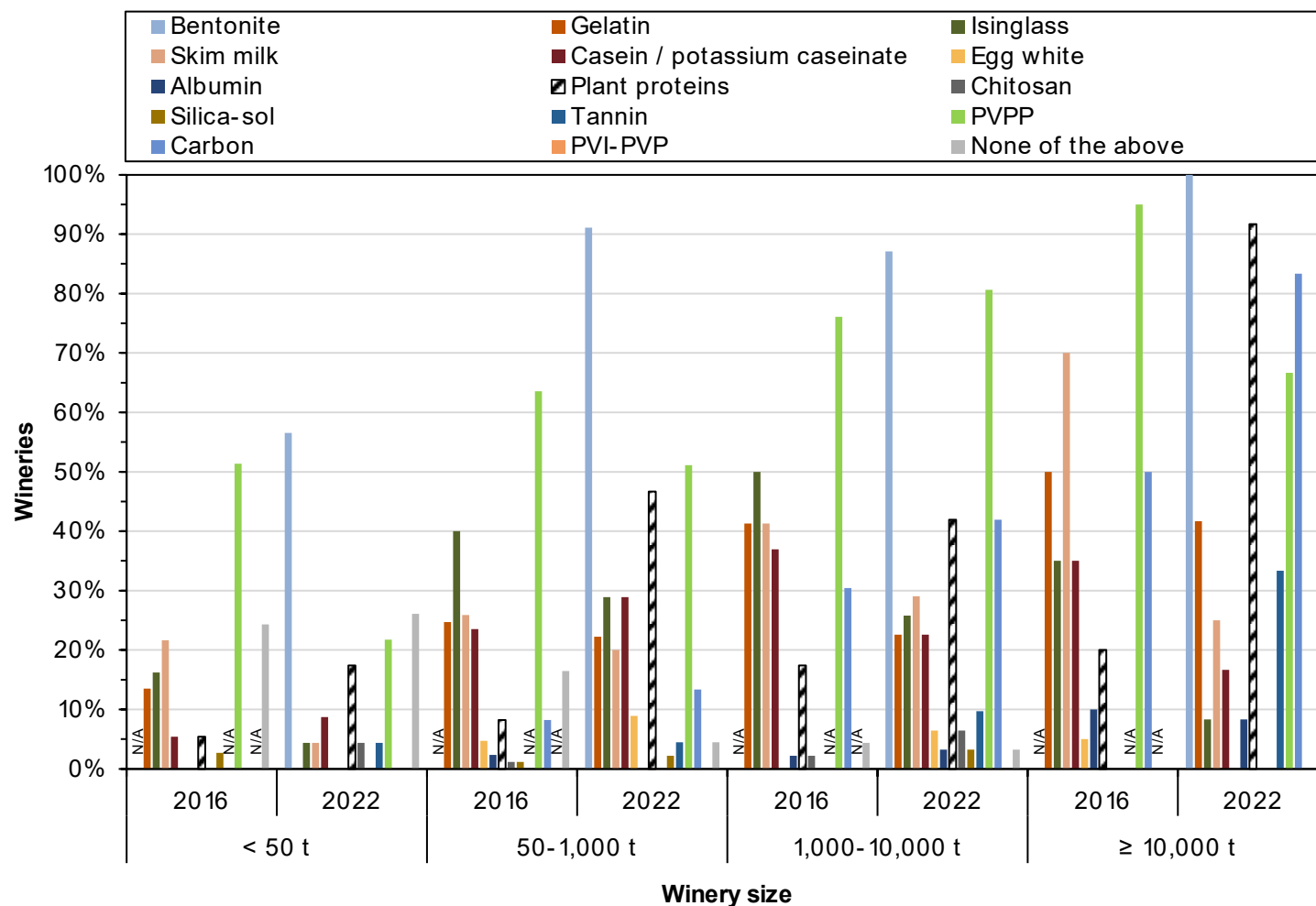
Inactivated yeasts, extracts, mannoprotein products (used at all)



- Products derived from yeast are marketed for purposes including improving mouthfeel, limiting oxidation, and aroma protection.
- From discussions with suppliers, it appears that improving mouthfeel is the main use case.

*Respondents were asked whether they used any inactivated yeast, yeast cell wall extracts or mannoprotein products (e.g. for influencing mouthfeel, oxidation or for aroma protection). This question was not asked in 2016. The plot shows data for 2022.

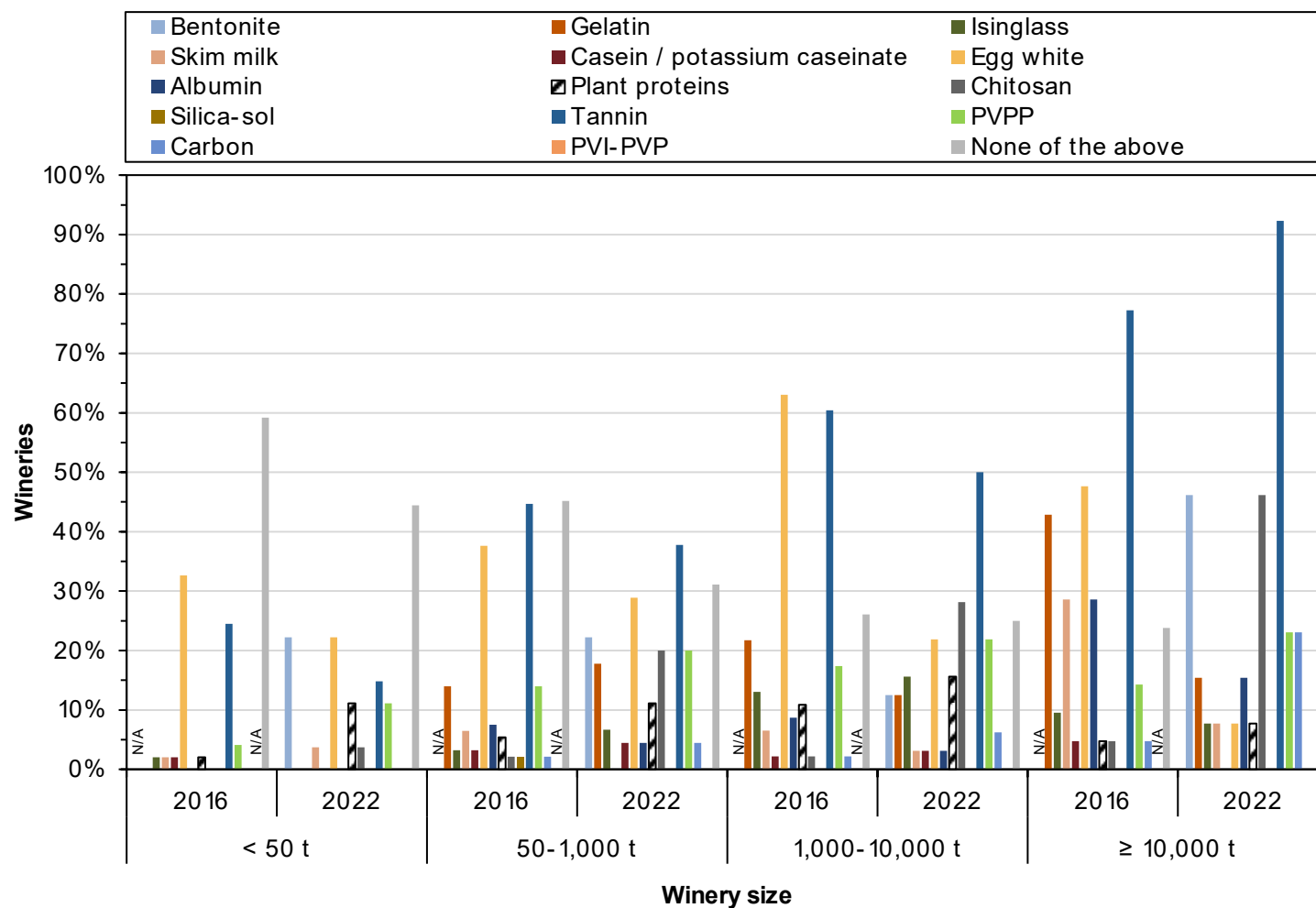
Processing aids used on white table wine (used at all)



- As with white juice treatment, the use of plant fining proteins when needed increased hugely between 2016 and 2022.
- See also pages 100 and 149 for data on processing aids used at all for white juice and red table wine, respectively.

*Respondents were asked to select from a list which processing aids were used on white table wines at some point after alcoholic fermentation. In 2022, Bentonite, tannin and PVI-PVP were added to the list. In 2016, the timeline was a typical year, while in 2022, the timeline was changed to being just the 2021/2022 financial year.

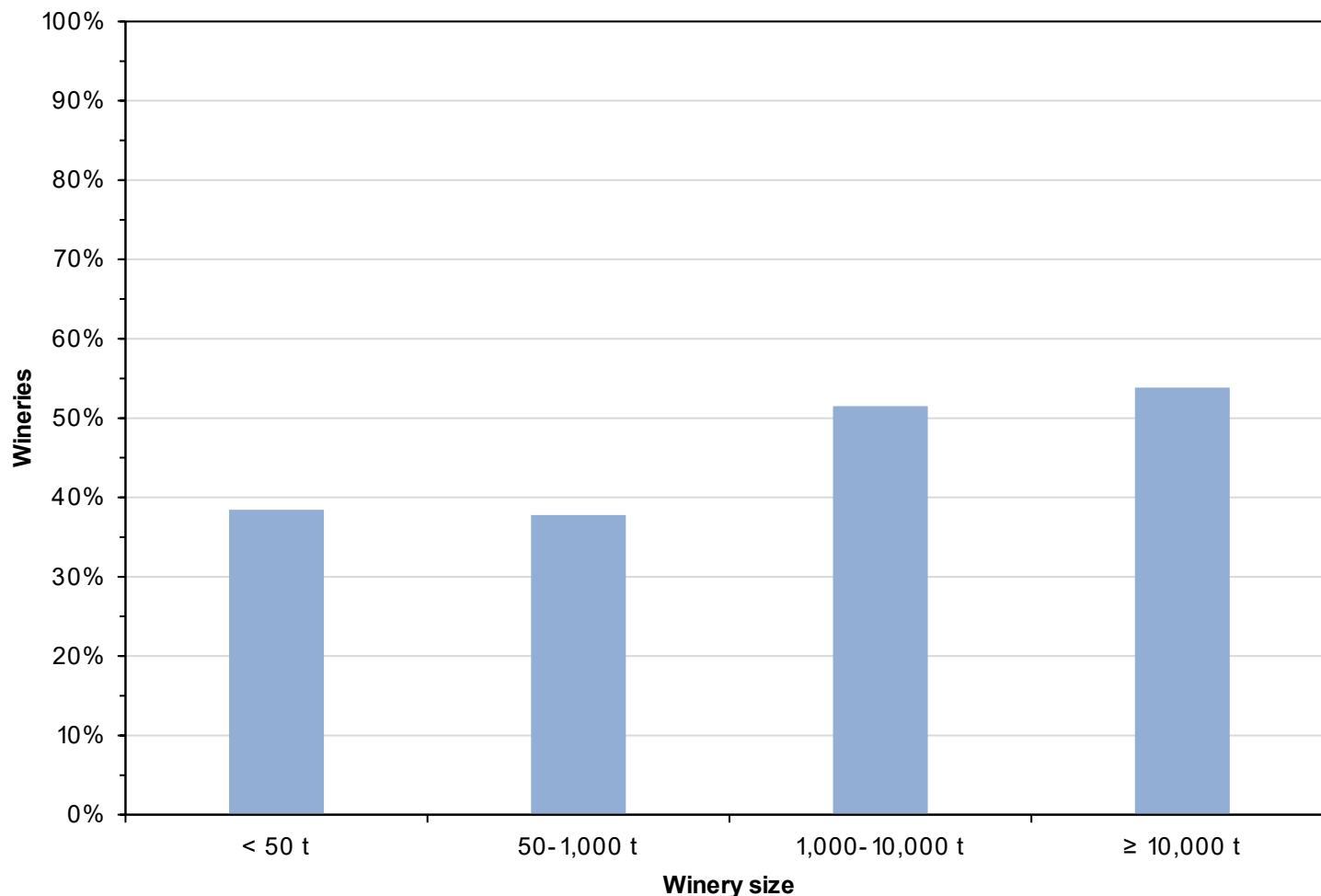
Processing aids used on red table wine (used at all)



- Egg whites and tannins were common fining agents for red wines.
- Red wines are generally fined less than white wines and use of plant proteins did not increase to the same extent between 2016 and 2022 as it did for white juices and wines.
- Bentonite was selected more often than had originally been expected for red wines.
- See pages 100 and 148 for data on processing aids used at all for white juice and white table wine, respectively.

*Respondents were asked to select from a list which processing aids were used on red table wines at some point after alcoholic fermentation. In 2022, Bentonite and PVI-PVP were added to the list. In 2016, the timeline was a typical year, while in 2022, the timeline was changed to being just the 2021/2022 financial year.

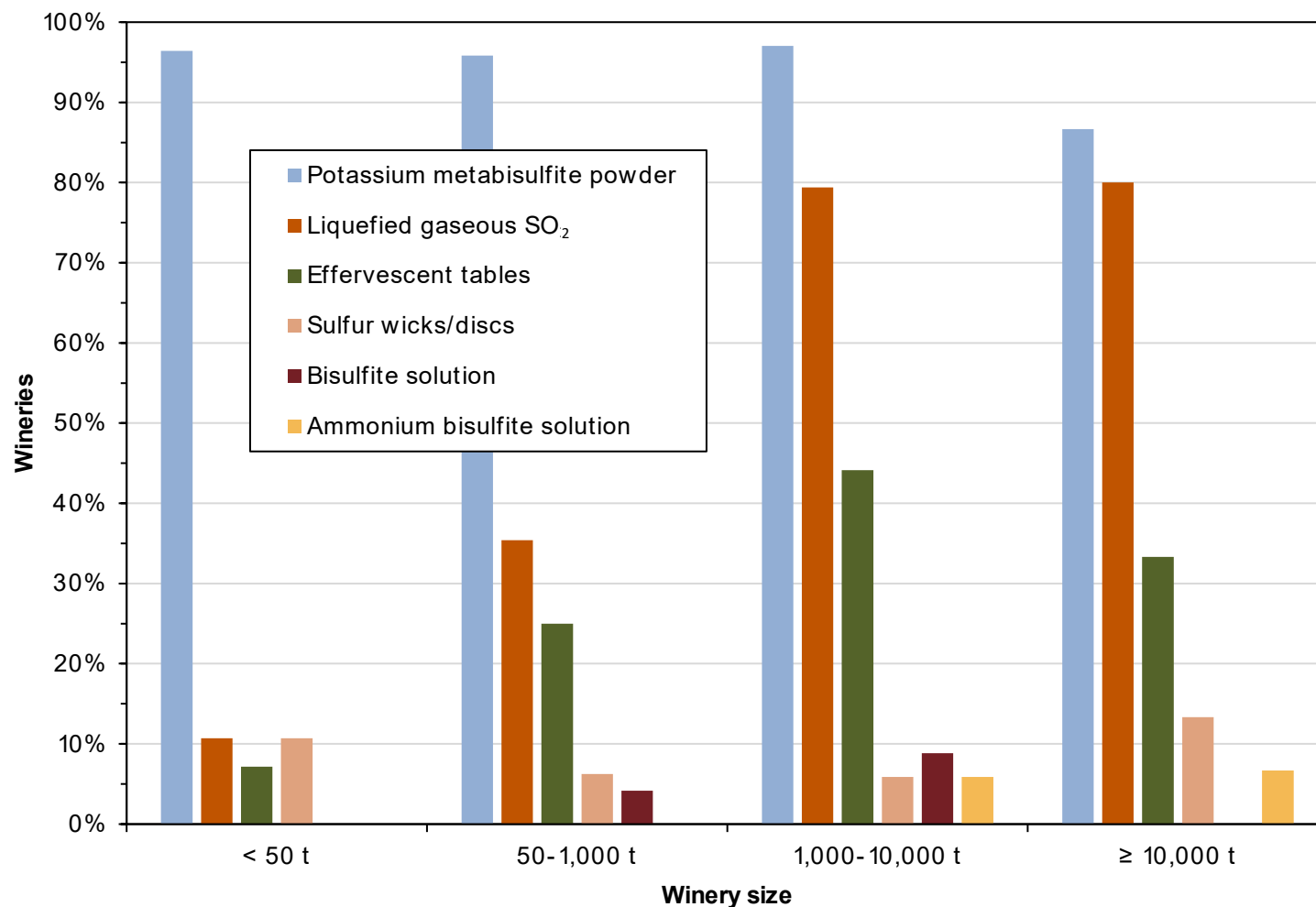
Site winemaking exclusively vegan



- The winemaking at many wineries is now exclusively vegan.
- This has occurred relatively recently for large wineries and matches the increasing use of plant proteins and decreasing use of animal-derived products like gelatin and skim milk between 2016 and 2022 (see pages 100, 148 and 149).
- Some large wineries communicated that it was easiest to go completely vegan, even when not all products would be labelled as vegan-friendly, so as not to create extra blending constraints.

*Respondents were asked in the 2022 survey, whether their site winemaking is exclusively vegan (i.e. no animal proteins are used on site). This question was not asked in 2016. The plot shows data for 2022.

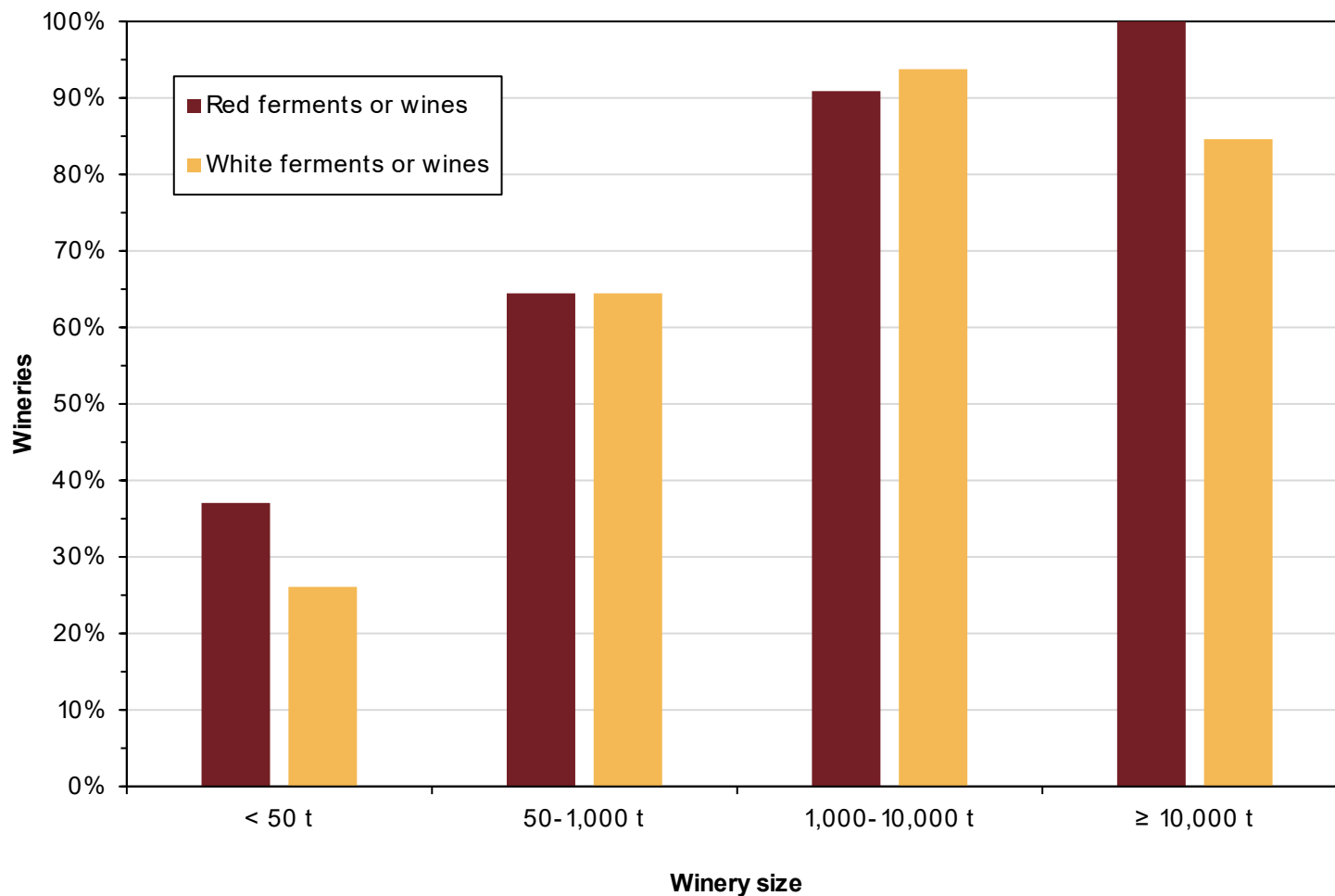
Forms that SO₂ was purchased in for grape, juice or wine treatment (used at all)



- Potassium metabisulfite was commonly used in wineries of all sizes.
- The use of liquefied gaseous SO₂ increases with winery size.
- A few large wineries have adopted ammonium bisulfite solution, because of safety concerns with using liquefied gaseous SO₂.

*Respondents were asked in the 2022 survey to select which forms SO₂ is purchased in for treating grapes, must, juice or wine. This question was not asked in 2016. The plot shows data for 2022.

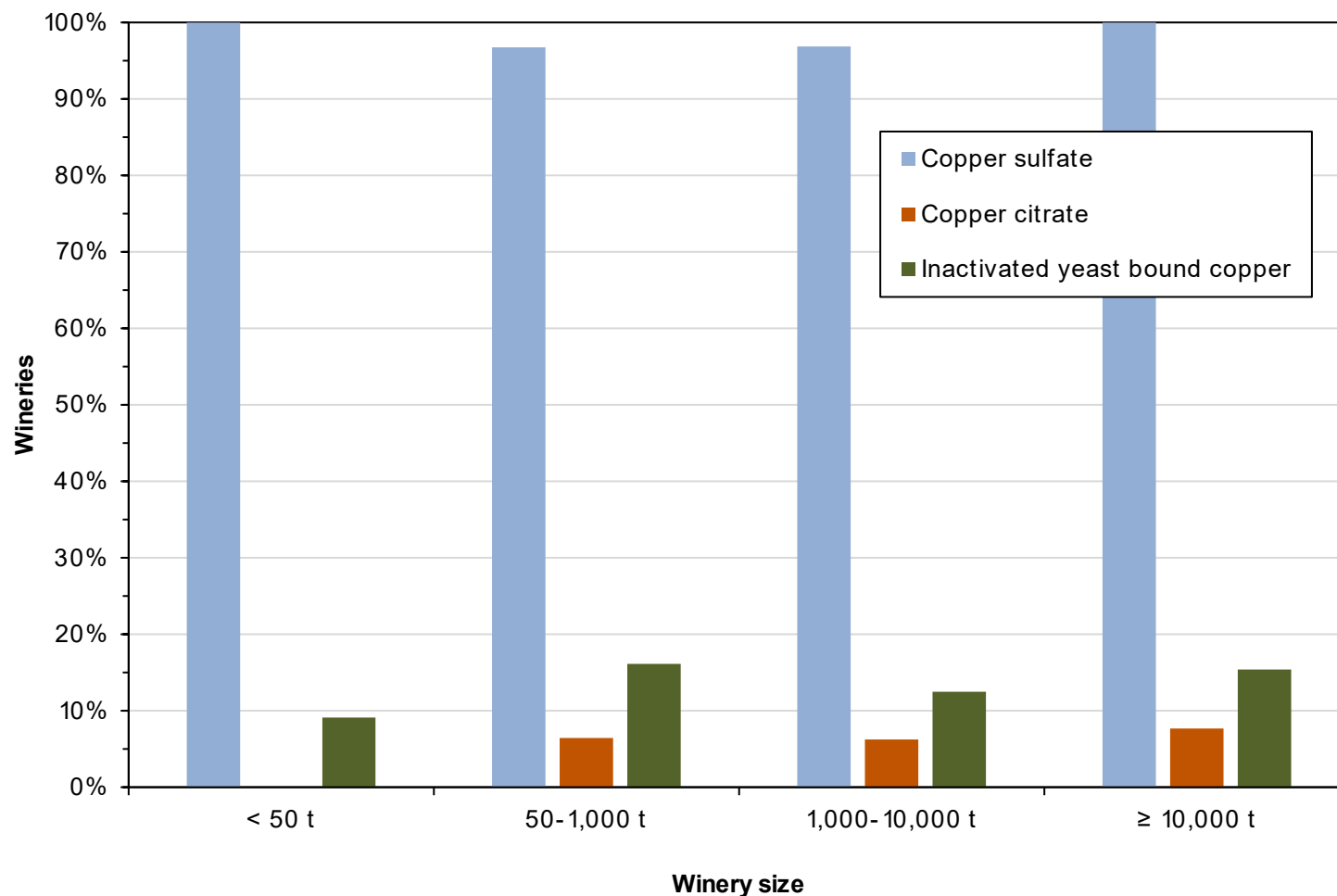
Copper additions to ferments and wines (used at all)



- Larger wineries were more likely to ever make some copper additions and they used copper with both red and white wines.

*Respondents were asked whether copper additions were made to any red ferments or wines. Plot shows data from the 2022 survey, which broke down usage at all by red and white wine.

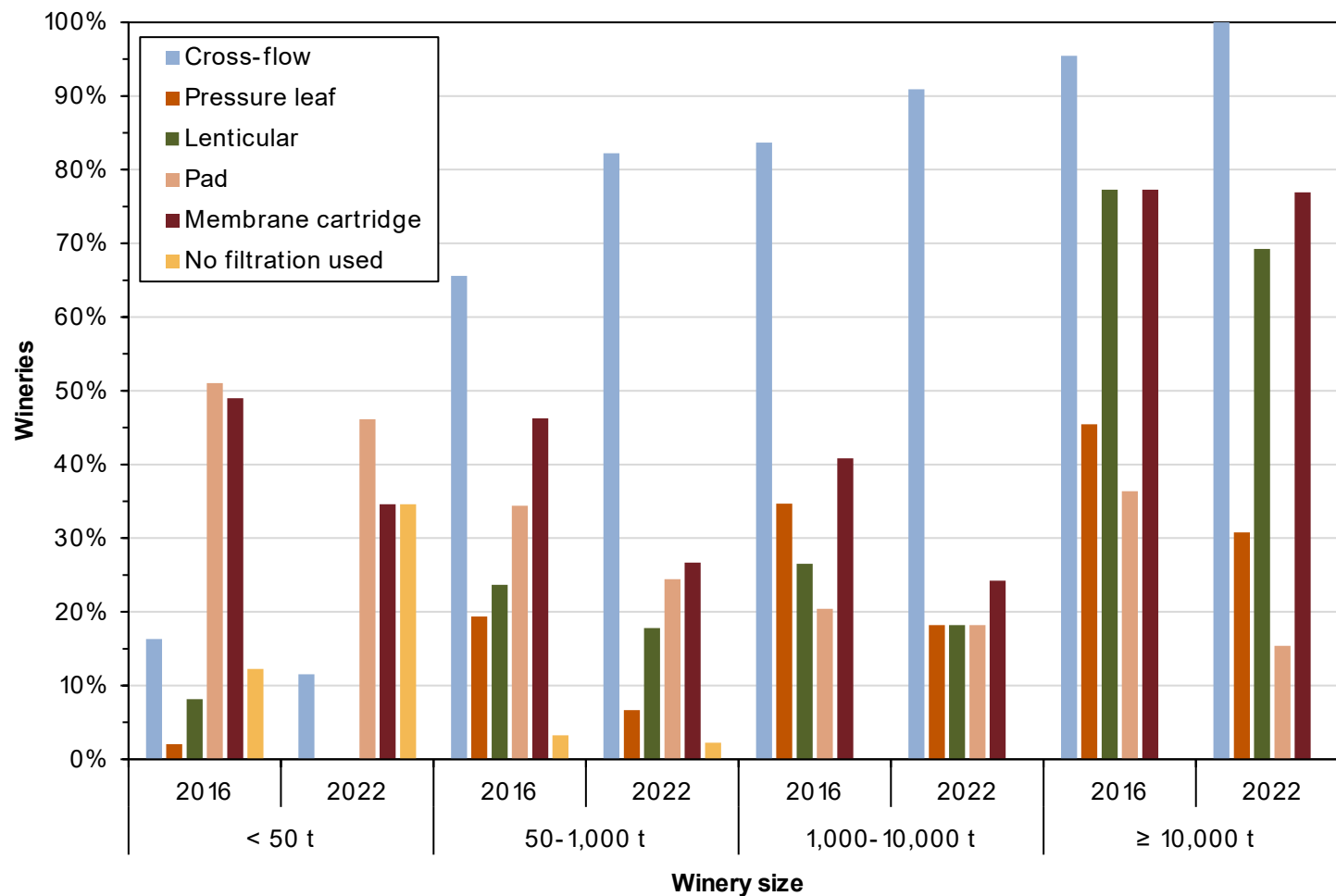
Copper forms for additions (used at all)



- Copper sulfate was the most common form that copper was added in.

*Respondents adding copper, were asked to select all forms that it was added in. This question was not asked in 2016. The plot shows data for 2022.

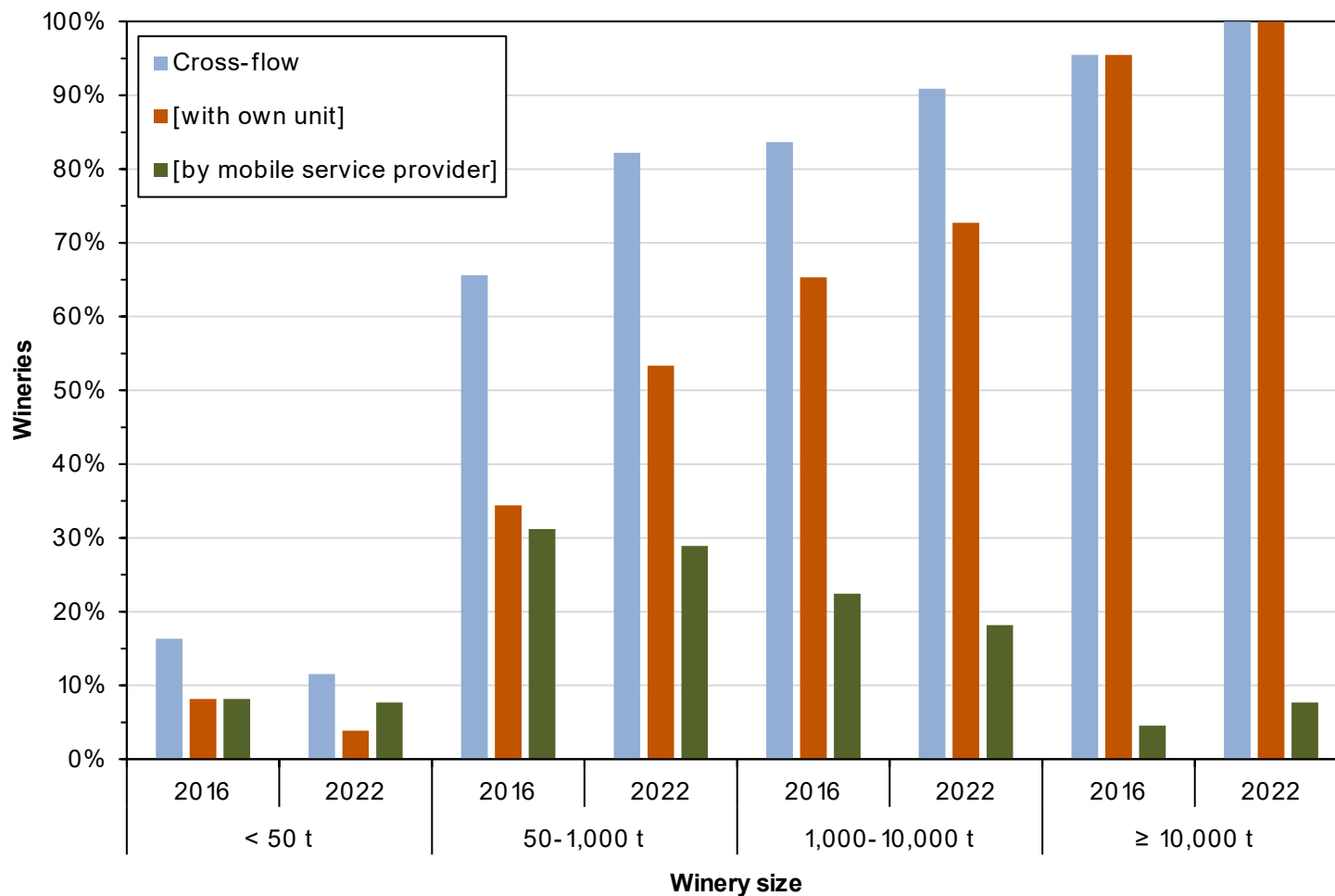
Wine filtration techniques (used at all)



- Cross-flow filtration use was high in 2016 and increased again slightly in 2022 in all but very small wineries.

*Wineries were asked to select from a list which filtration methods were used to filter wine (not lees).

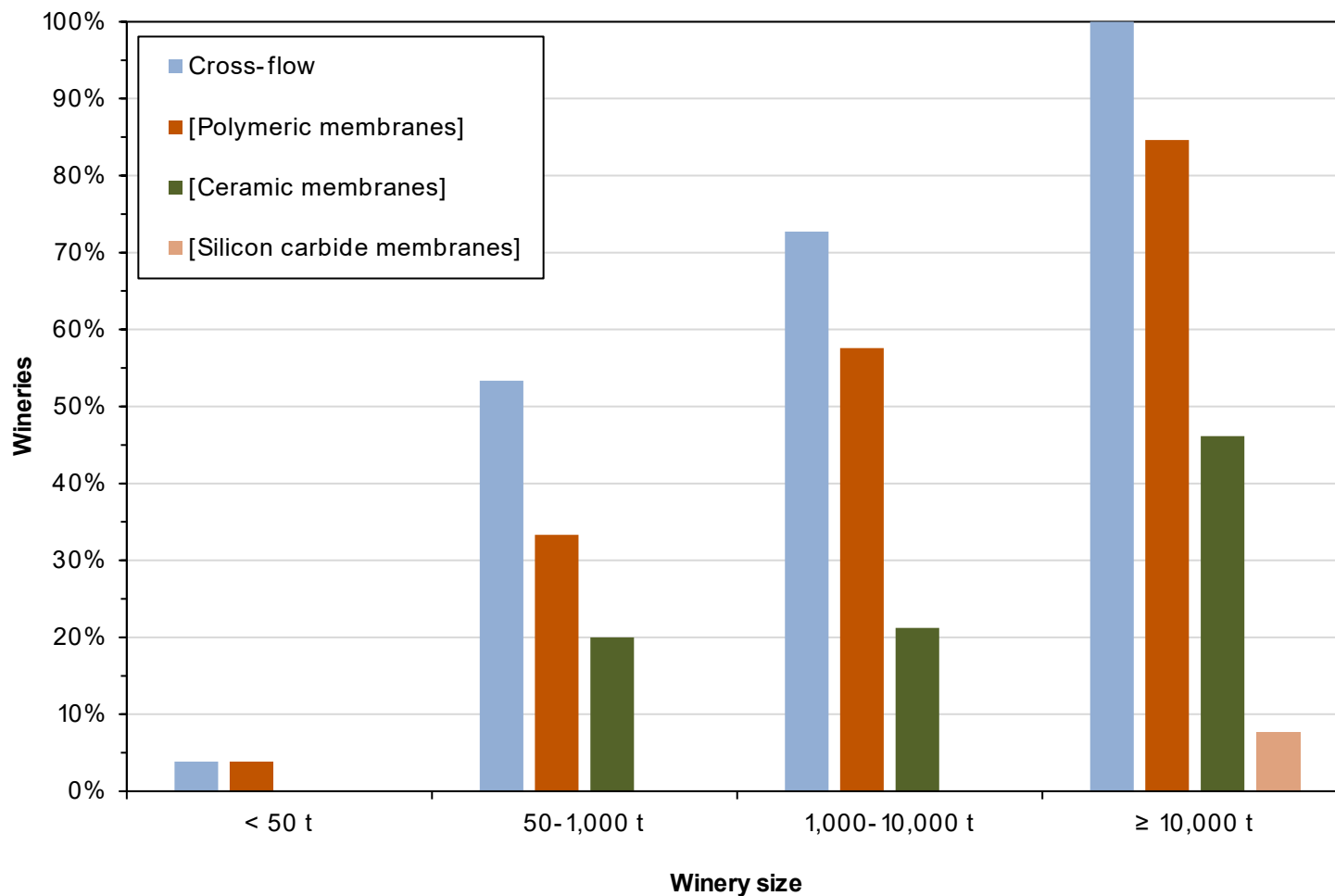
Cross-flow wine filtration - own or mobile unit (used at all)



- Cross-flow filtration was by far the most commonly nominated new practice to have a positive impact mentioned in 2022, as it had been in 2016 (see page 187).
- Medium-sized wineries still use mobile service providers, but the proportion with their own units increased between 2016 and 2022.

*Wineries were asked to select from a list which filtration methods were used to filter wine (not lees). Cross-flow filtration had options for with own unit and by a mobile service provider.

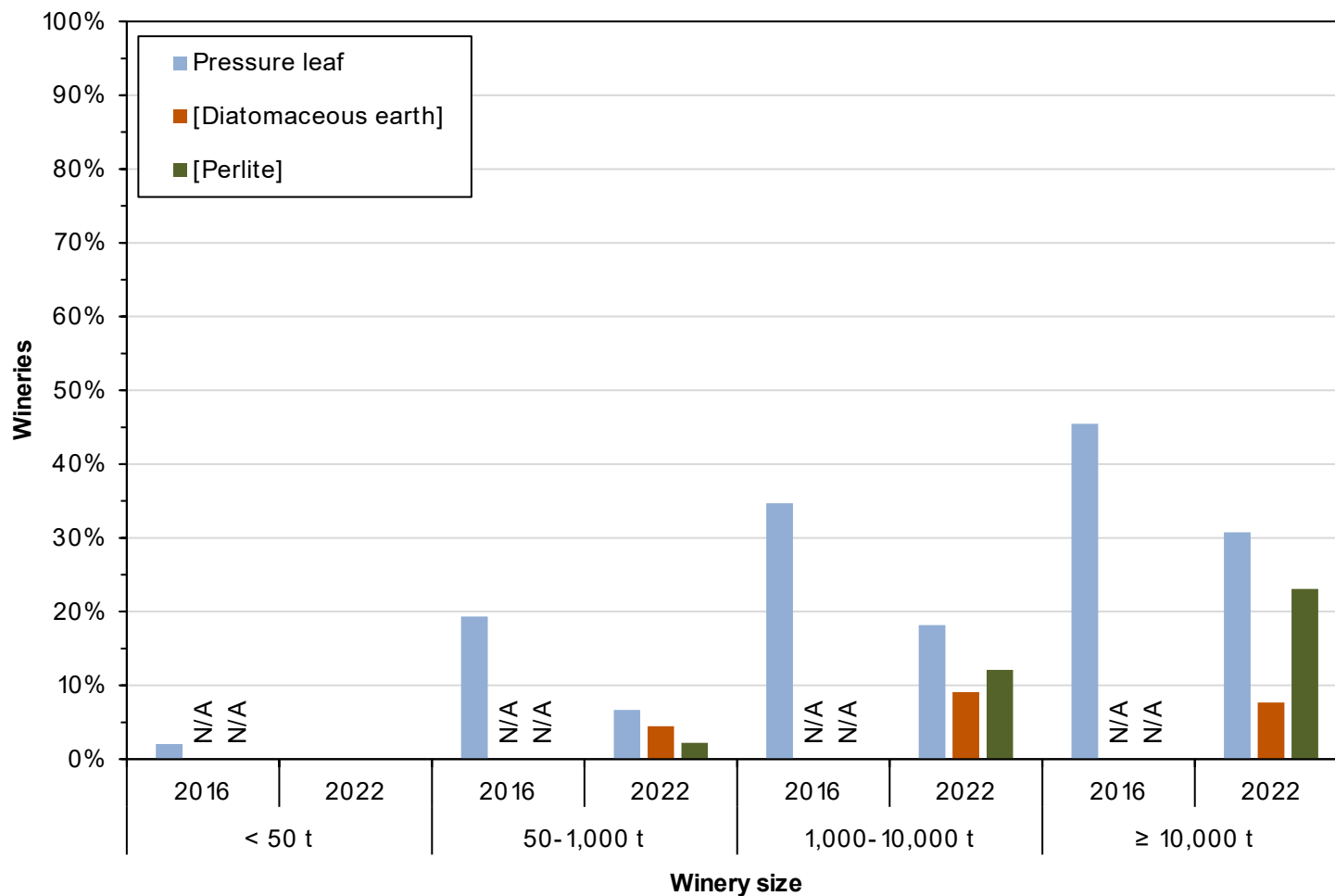
Cross-flow wine filtration - membrane type (used at all)



- Polymeric and ceramic membranes were both used for wine filtration, with polymeric membranes being more common.
- Only one winery was using silicon carbide membranes and since the survey they have reverted to using more traditional ceramic membranes.

*Wineries that used their own cross-flow filter to filter wines (not lees) in 2022 were asked to select the types of membrane used. This question was not asked in 2016. The plot shows data for 2022.

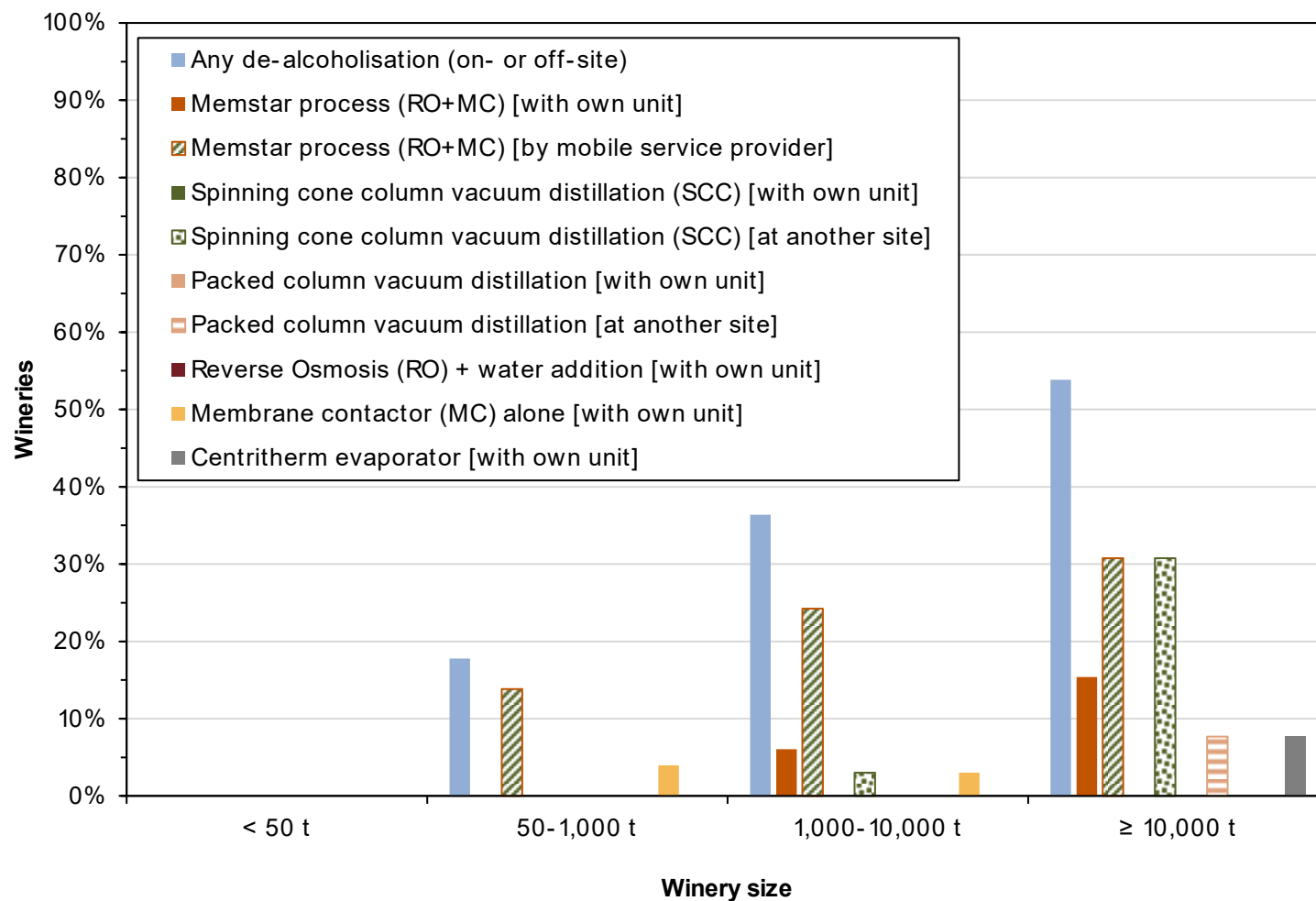
Pressure leaf wine filtration - filter media type (used at all)



- Pressure-leaf filtration decreased in use between 2016 and 2022 as more wineries shift to cross-flow filtration.
- For the 2022 survey, a new question was added to understand the specific filter media being used.
- For those wineries still using pressure leaf wine filtration, perlite was now being used by more wineries than diatomaceous earth.

*Wineries that used pressure-leaf filtration to filter wine (not lees) were asked in 2022 to select the filter media used. This question was not asked in 2016.

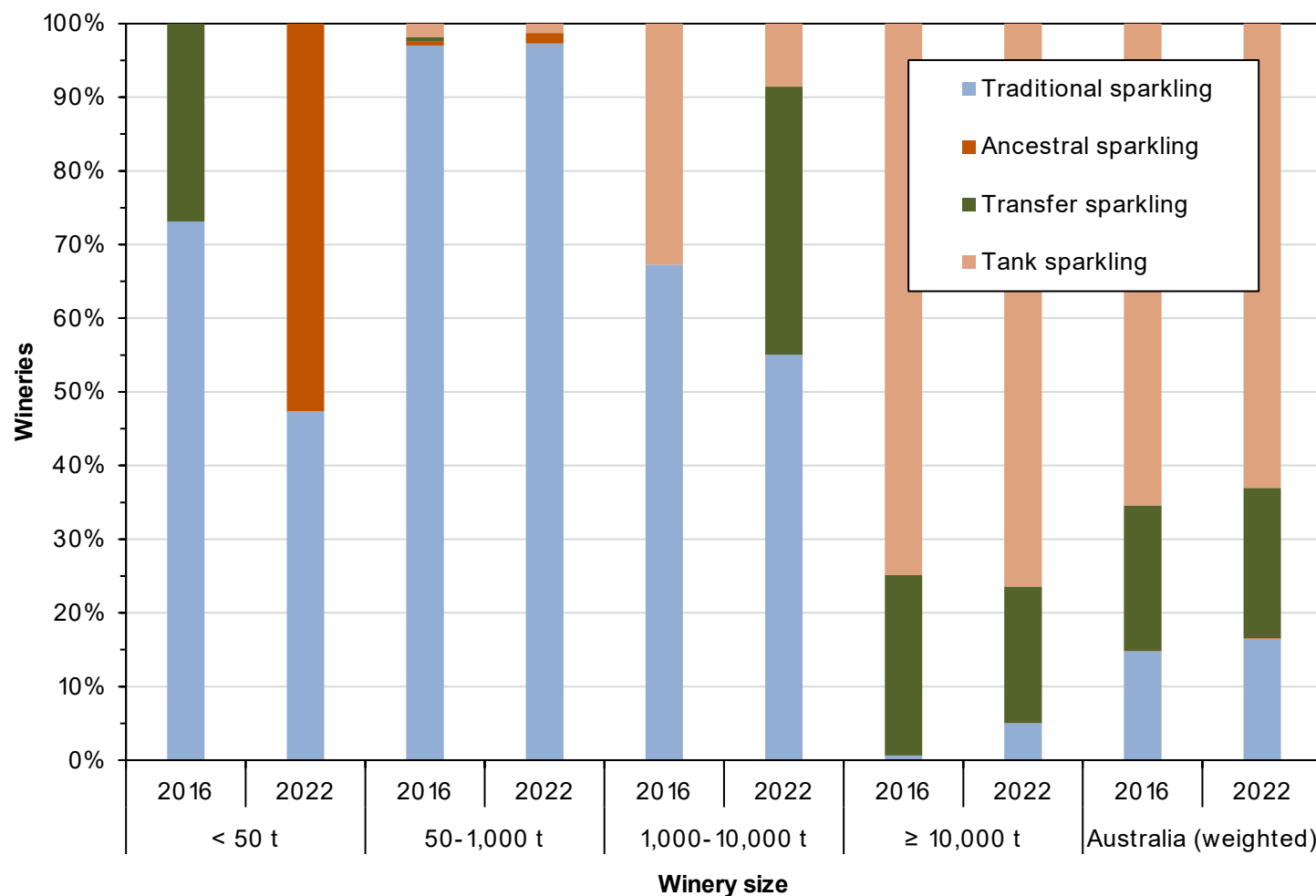
Partial or total de-alcoholisation, including by off-site processing (used at all)



- Larger wineries were more likely to make wines that had undergone de-alcoholisation.
- The most common approaches were the Memstar process (reverse osmosis + membrane contactor) by a mobile service provider and sending wine off-site for processing by spinning cone column vacuum distillation.
- Some mid-sized wineries also used membrane contactors alone to achieve some de-alcoholisation.

*Respondents were first asked in 2022 whether any wine was partially or totally de-alcoholised at the site or sent to another site for de-alcoholisation, and if so the type of equipment used. This question was not asked in 2016. The plot shows data for 2022.

Finished sparkling wine made by technique on site



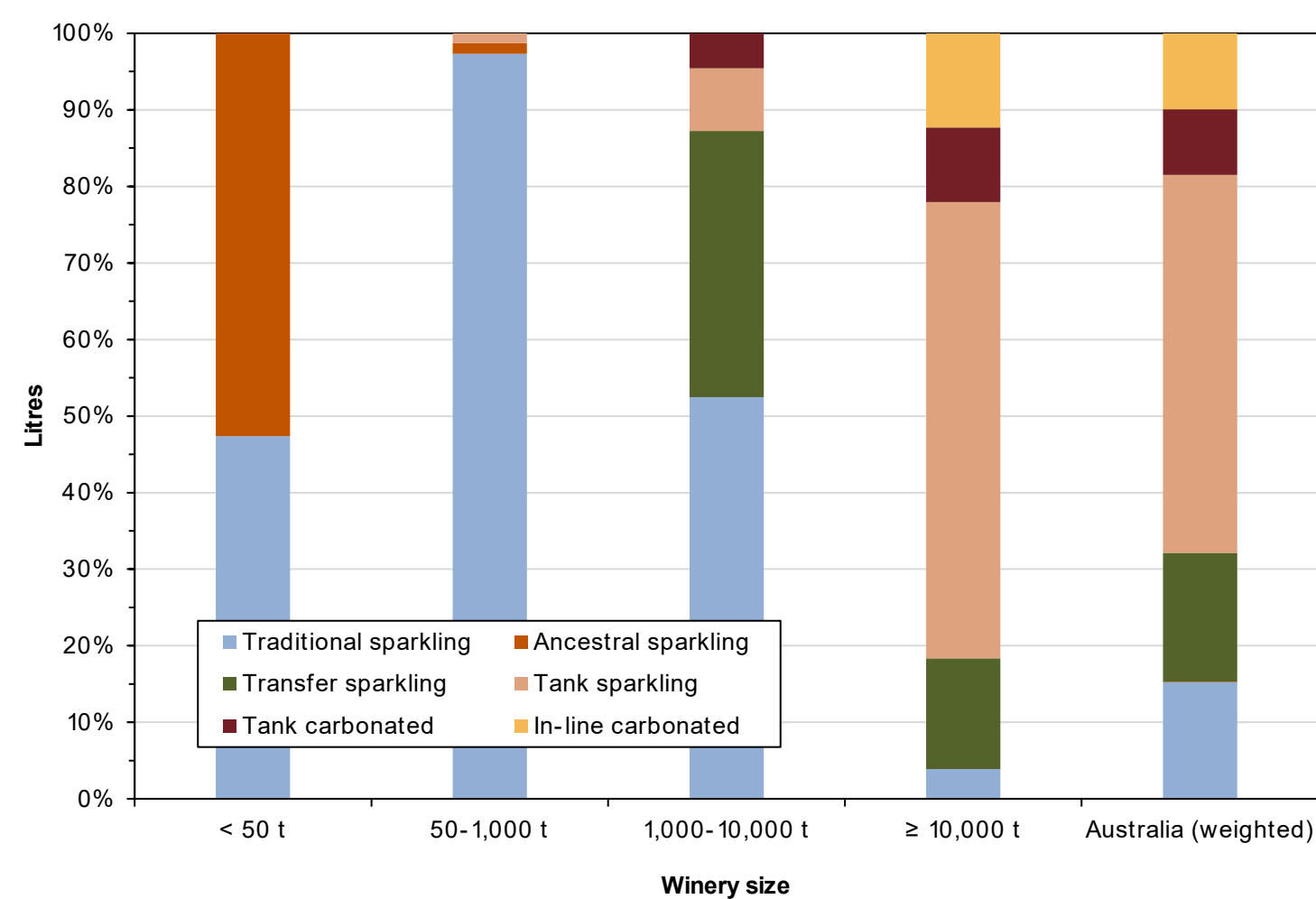
Weighted values for Australia

	2016	2022
Traditional	15%	17%
Ancestral	0%	0%
Transfer	20%	20%
Tank sparkling	65%	63%

- Sparkling wine was as defined by FSANZ standard 4.5.1 (i.e. ≥ 5 g/L of CO₂ from fermentation, not carbonation).
- Volumetrically, tank sparkling wine production (Charmat) was the dominant technique in both 2016 and 2022.
- Some differences within size categories relate to wineries changing size category between the 2016 and 2022 surveys.
- For < 50 t wineries, there were only a small number of respondents, so the results may not be representative.

*Respondents were asked what volume of sparkling wine (2016) or sparkling wine and carbonated wine (2022) was produced. Respondents were then asked to enter the % made with each method and based on this, aggregate industry data was calculated.

Finished sparkling and carbonated wine made by technique on site



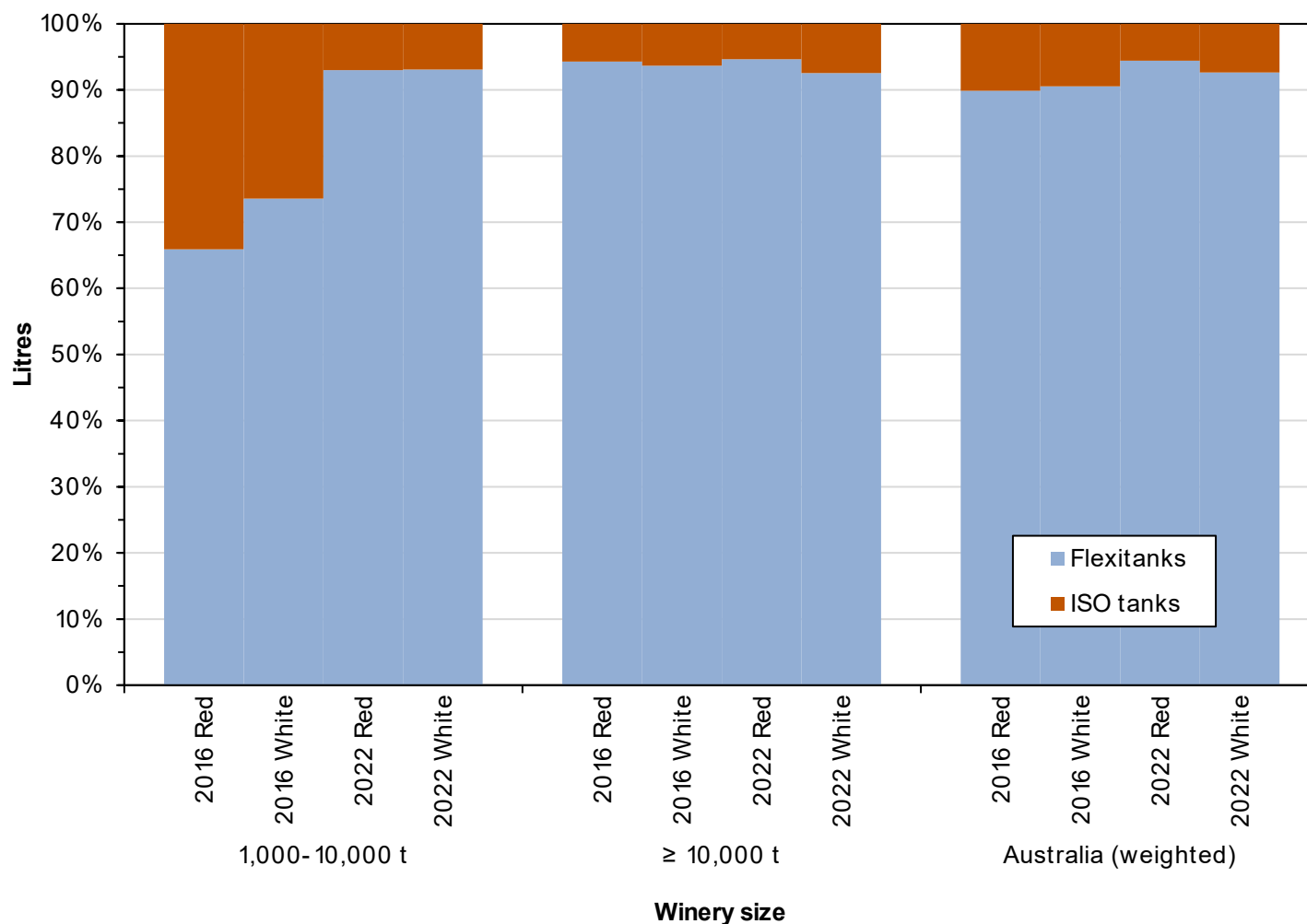
Weighted values for Australia

	2016	2022
Traditional	N/A	15%
Ancestral	N/A	0%
Transfer	N/A	17%
Tank sparkling	N/A	49%
Tank carbonated	N/A	9%
In-line carbonated	N/A	10%

- In the 2022 survey carbonated wine with at least 5 g/L CO₂ was added to the volumes for reporting.
- The quantity of carbonated wines vs. sparkling wines across the sector may be slightly higher than shown as contract bottling facilities may be more likely to use carbonators (few contract bottling facilities responded to the 2022 survey, but one that did produced 60% of their sparkling and carbonated wine using an in-line carbonator).

*Respondents were asked in 2022 what volume of sparkling wine and carbonated wine were produced. Respondents were then asked to enter the % made with each method and based on this, aggregate industry data was calculated.

Bulk export container types for table wines



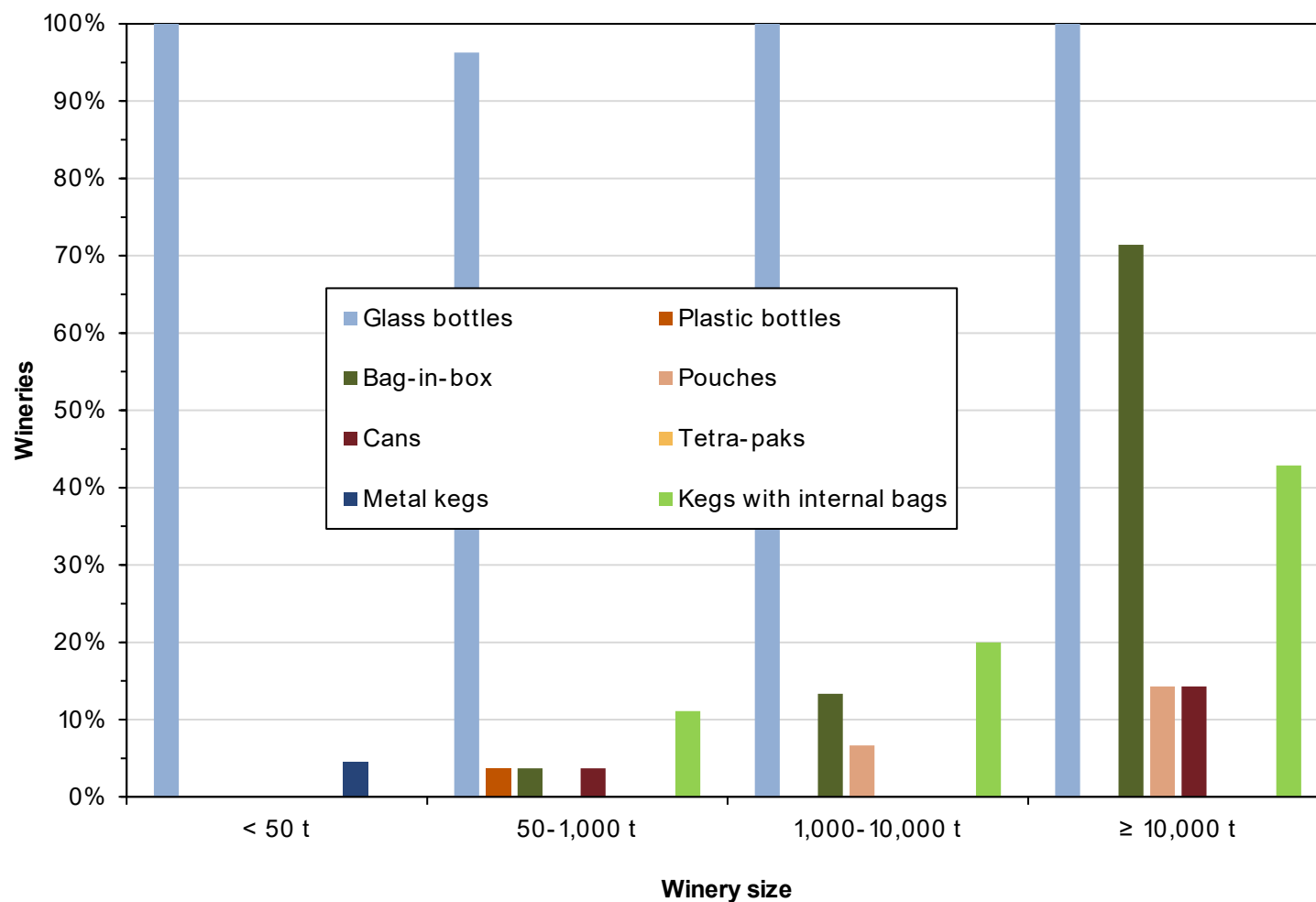
Weighted values for Australia

	2016	2022
Flexitanks All	90%	94%
Flexitanks Red	90%	94%
Flexitanks White	91%	93%

- By volume, most wine is exported in bulk (see page 6).
- Flexitanks are much more commonly used than ISO tanks for these exports.
- In an associated question on the use of Velcorin (DMDC) dosing during bulk container filling, only 1 site responded that yes they had used this technique (but at least one other site that didn't respond to the survey has the capacity to dose Velcorin during bulk container filling).

*Respondents were first asked whether any wine was exported in bulk (flexitanks or ISO tanks). 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.

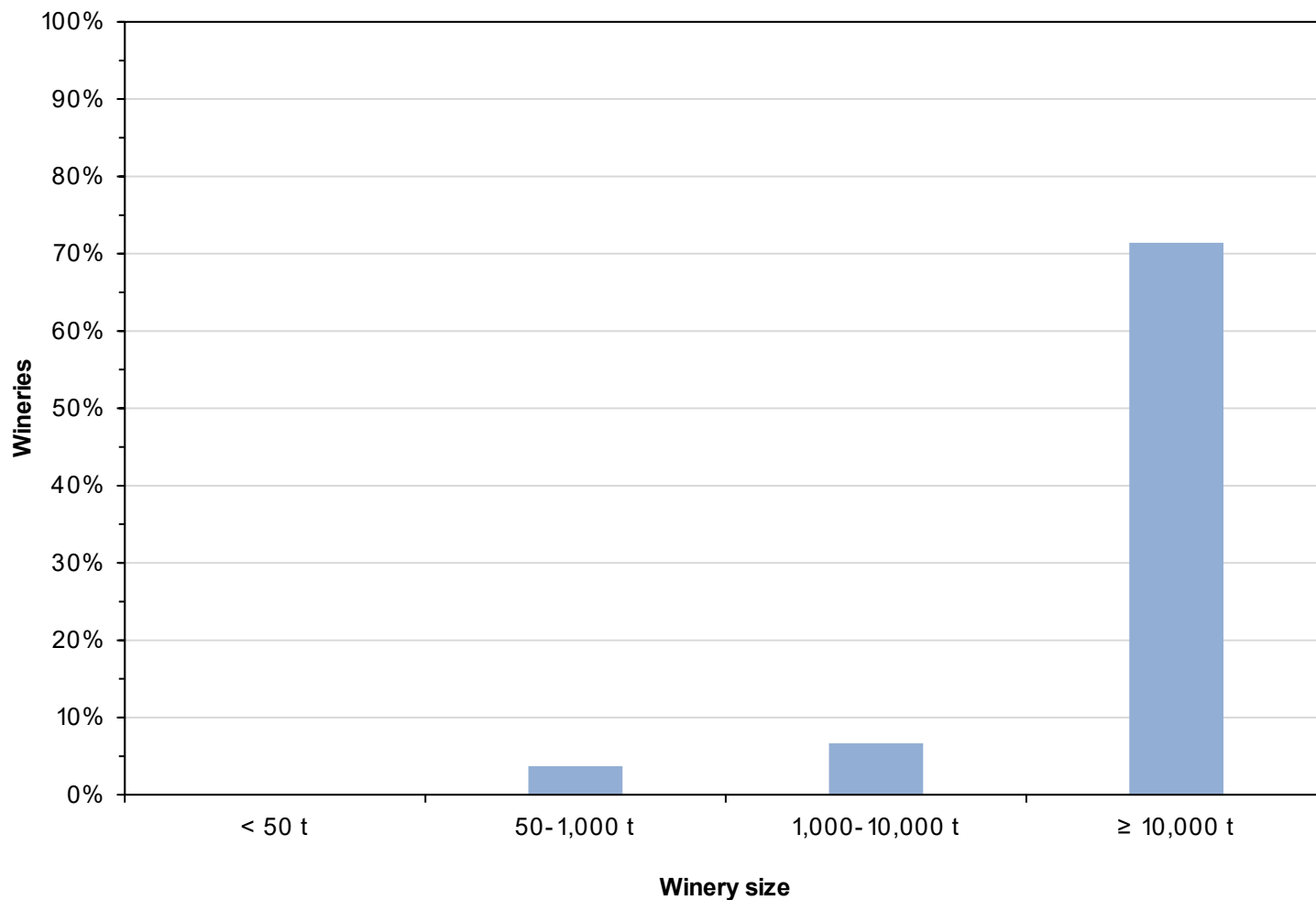
Wine packaging formats for wineries packaging on-site (used at all)



- Glass bottles were the predominant packaging format.
- Bag-in-box was also commonly filled in large wineries.

*Respondents that packaged wine on site were asked in the 2022 survey to select the container types that wine is packaged in at the site, including if it was for other companies' products. This question was not asked in 2016. The plot shows data for 2022.

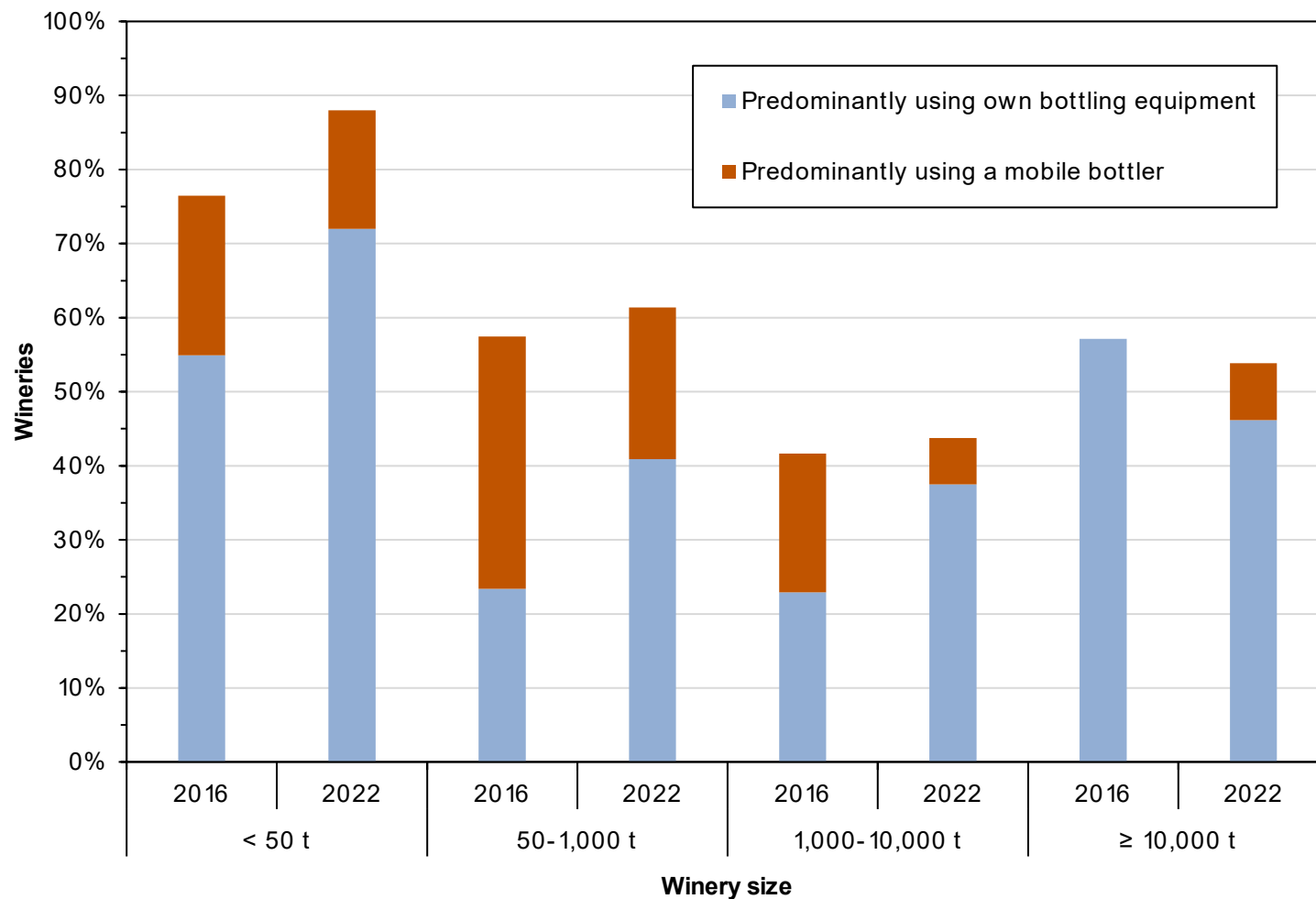
Velcorin (DMDC) for microbial control for wineries packaging on-site (used at all)



- Large wineries were more likely to use Velcorin on some products.

*Respondents that packaged wine on site were asked in the 2022 survey whether Velcorin (DMDC) dosing was used for microbial control for any products packaged at the site. This question was not asked in 2016. The plot shows data for 2022.

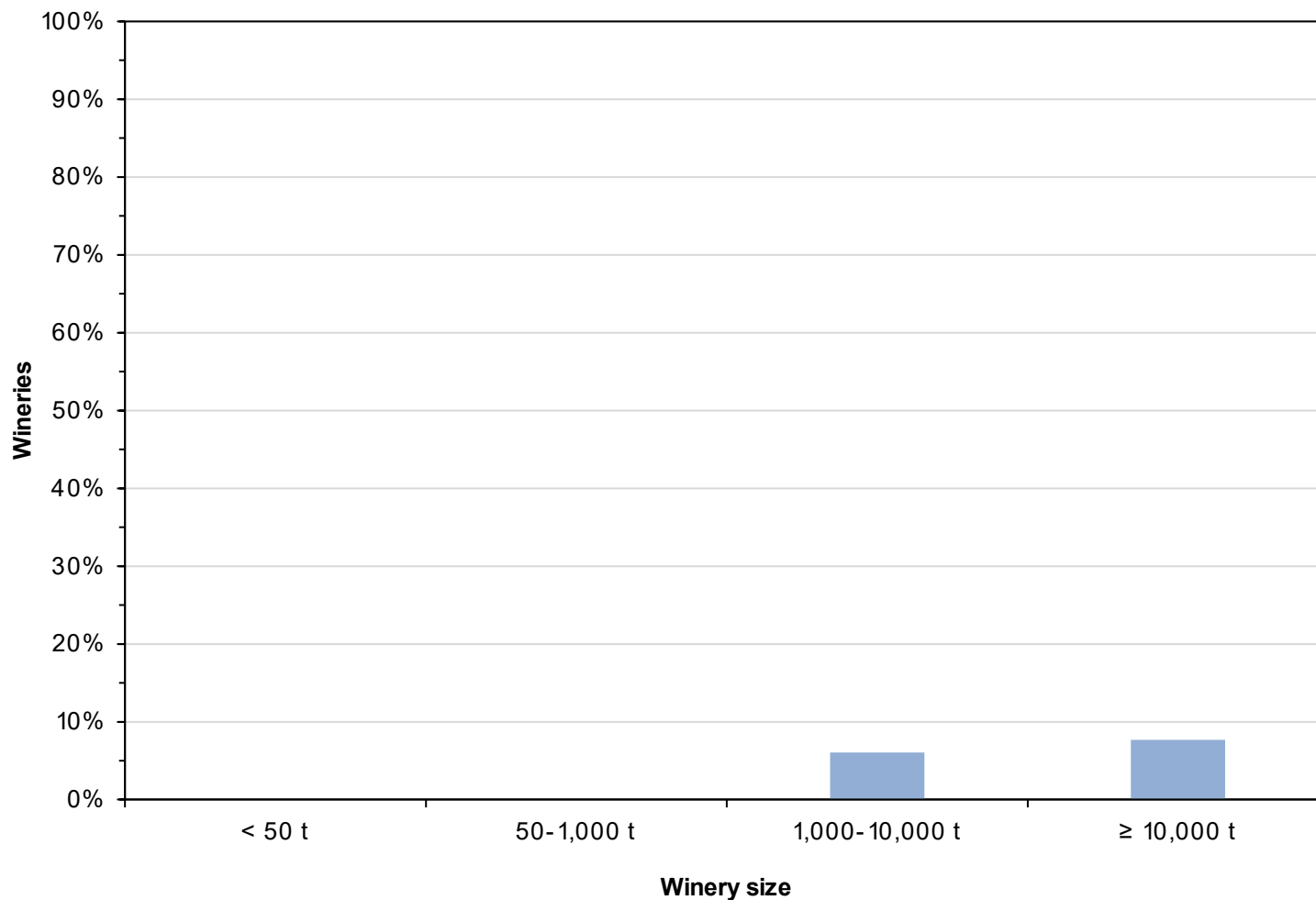
Bottle table wines on site



- 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, likely because they often use off-site contract bottlers, and when mid-sized wineries did bottle on-site it was often using a mobile bottler.
- Large wineries that bottled on-site did so mainly using their own equipment.

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

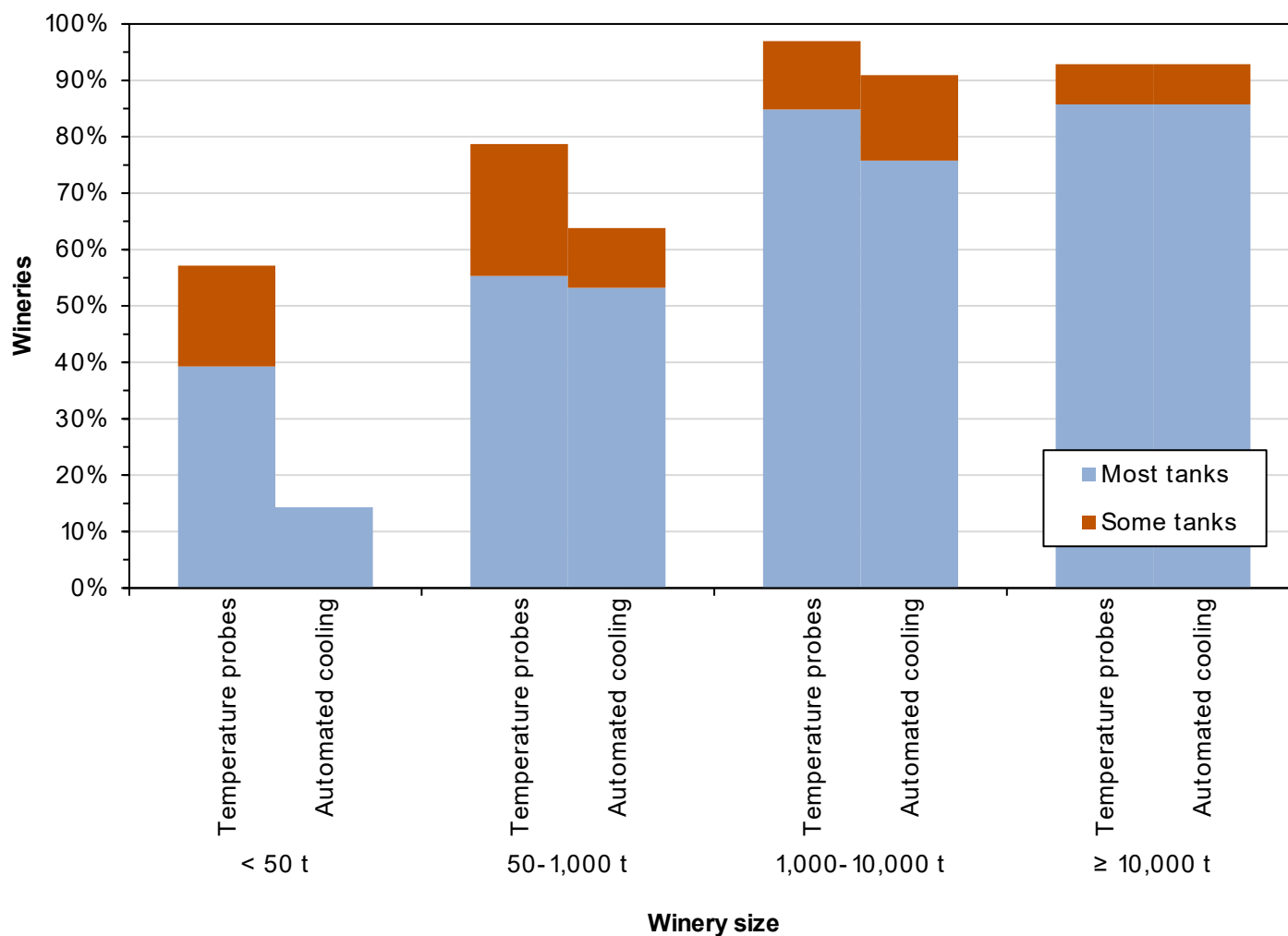
Dissolved gas system/carbonator employing a membrane contactor (used at all)



- Membrane contactors have not yet been widely adopted for dissolved gas adjustment or carbonation.
- In addition to the responses shown from wineries that crush grapes, at least one contract bottling facility has a system.

*Respondents were asked in the 2022 survey whether a dissolved gas adjustment system/carbonator that employs a membrane contactor was used at the site. This question was not asked in 2016. The plot shows data for 2022.

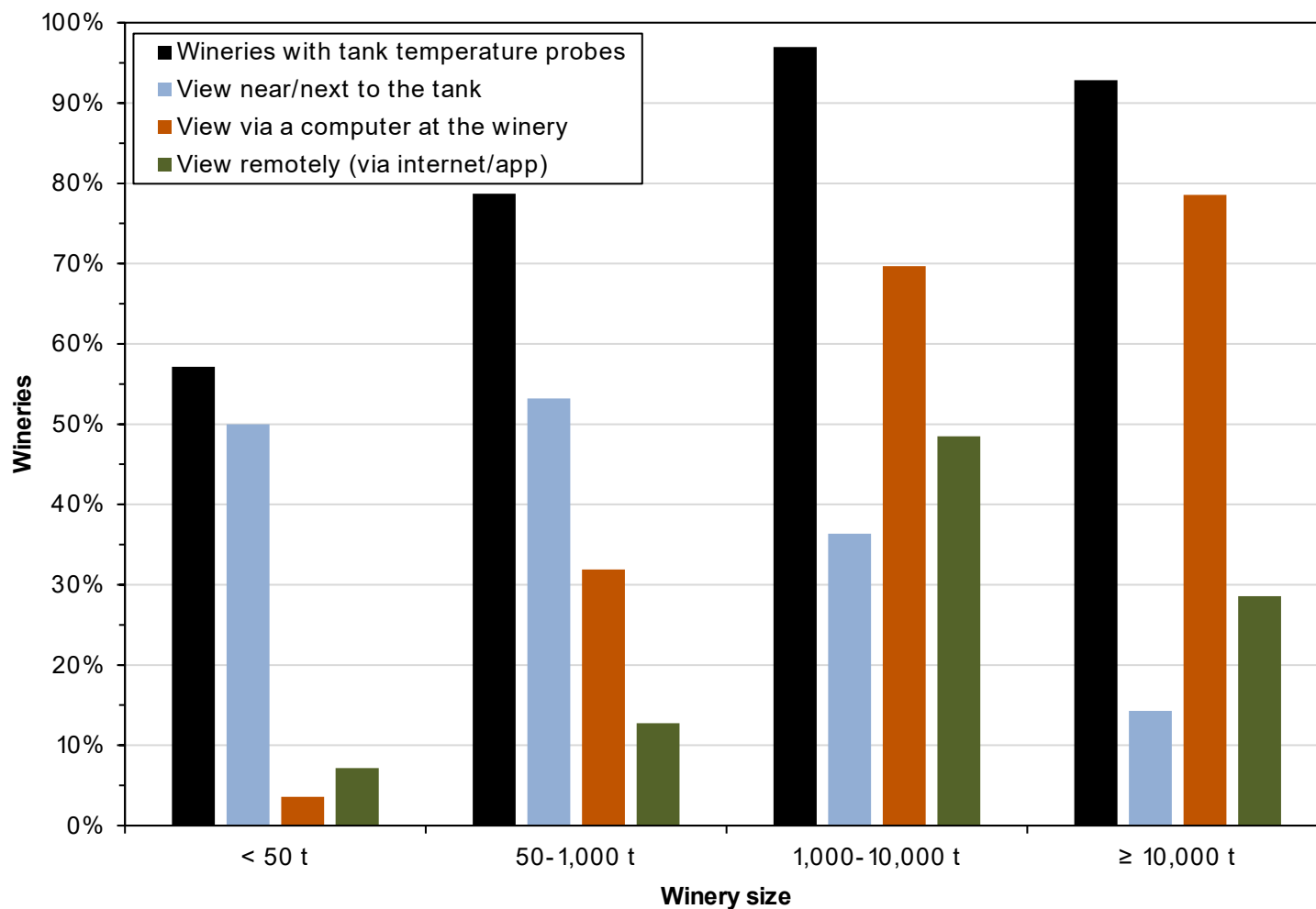
Temperature probes/sensors and automated coolant valve control on tanks



- Large wineries were more likely to have temperature probes in tanks and to be using them for automated cooling control.

*Respondents were asked in the 2022 survey whether they have temperature probes/sensors installed in tanks and whether they are in most or only some tanks. Those with temperature probes were asked whether these probes were part of a system that automatically opened coolant valves to tank jackets based on temperature set-points. This question was not asked in 2016. The plot shows data for 2022.

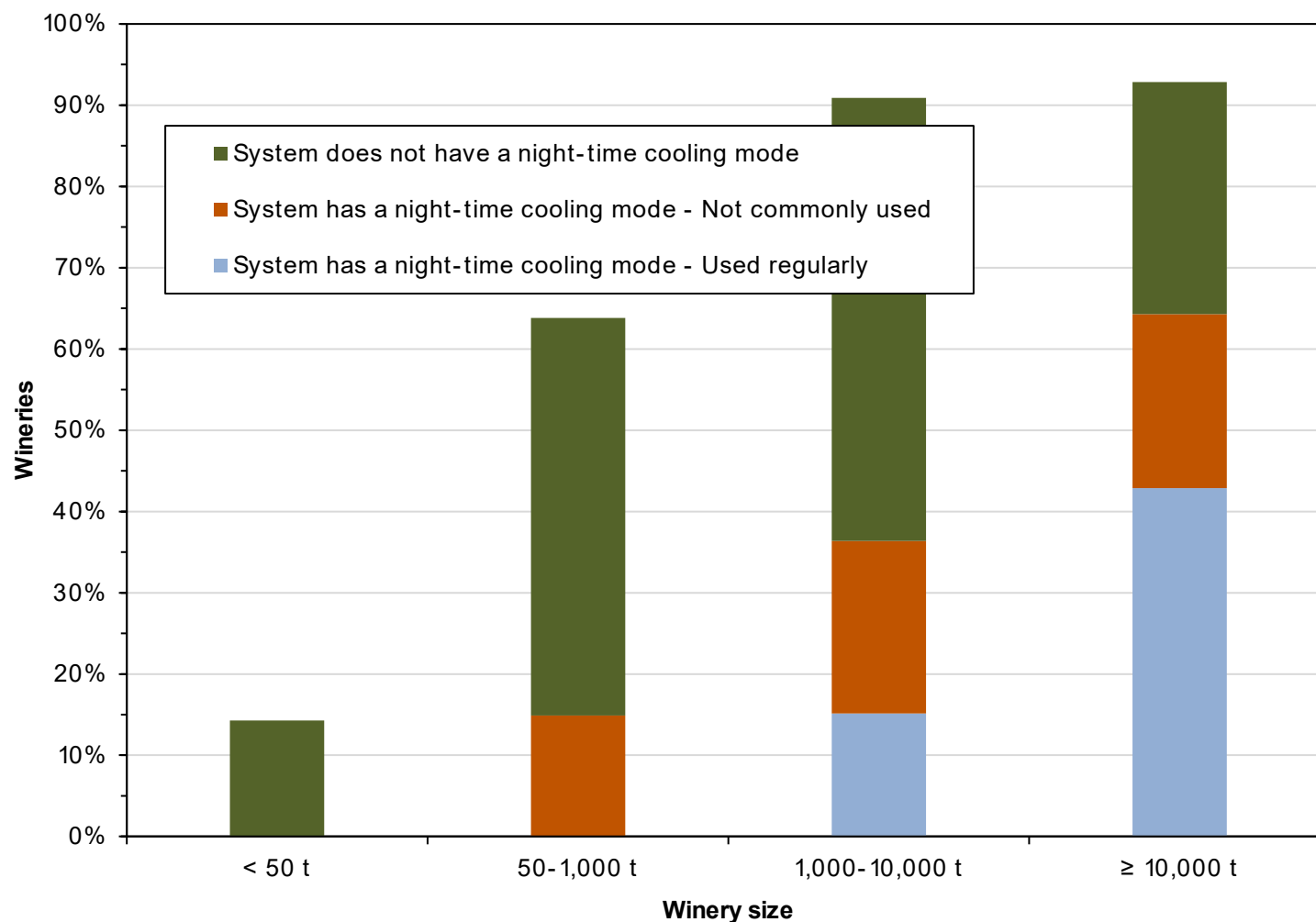
Ways of viewing values from tank temperature probes (used at all)



- Smaller wineries with temperature probes could typically only view temperature data at the tank, while larger wineries were more likely to be able to view data on a computer at the winery.
- Mid-sized wineries were most commonly able to view data remotely, likely reflecting the use of packaged winery temperature control software, as opposed to older site-specific automation solutions in some of the largest wineries.

*Respondents were asked in the 2022 survey whether they have temperature probes/sensors installed in tanks. Those with temperature probes were asked to select where they can view the data. This question was not asked in 2016. The plot shows data for 2022.

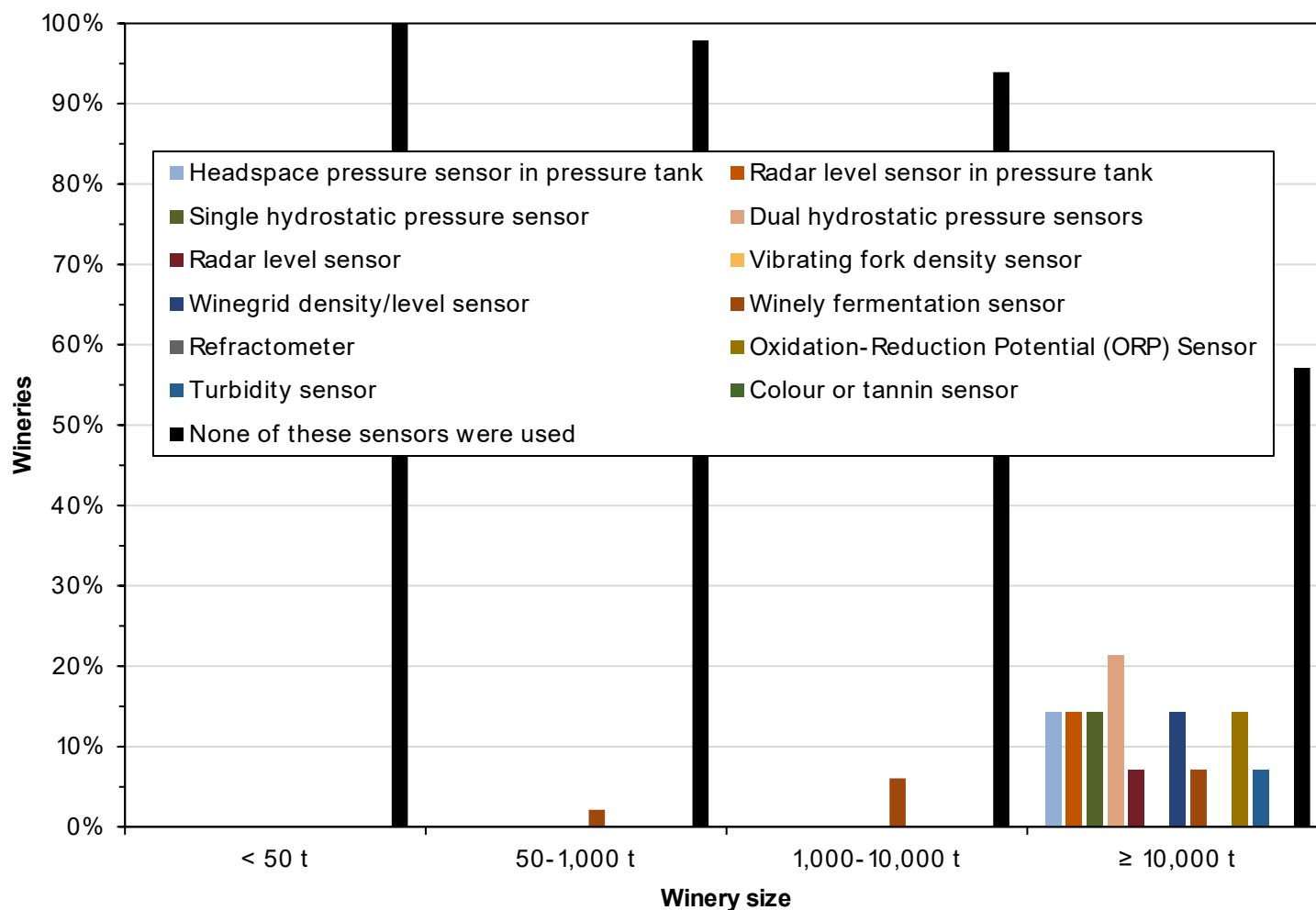
Night-time cooling mode on automated cooling system



- Night-time cooling modes that prioritise cooling at night when electricity is often cheaper and refrigeration plants operate more efficiently, were only part of some systems and were not always used.
- Shifting cooling load by over-chilling slightly when electricity is cheap or available is not just applicable to traditional off-peak night-time electricity tariffs, but also to other arrangements like when there is an excess of solar power, or when grid-power is cheap on spot markets.
- One respondent noted that they wouldn't use night-time cooling mode, because they have solar during the day - the survey question could maybe have been better phrased to incorporate this situation.

*Respondents were asked in the 2022 survey whether they have an automated cooling system and then whether this system has a system to schedule more cooling at night, when electricity is often cheaper and refrigeration more efficient (e.g. night-time cooling mode). This question was not asked in 2016. The plot shows data for 2022.

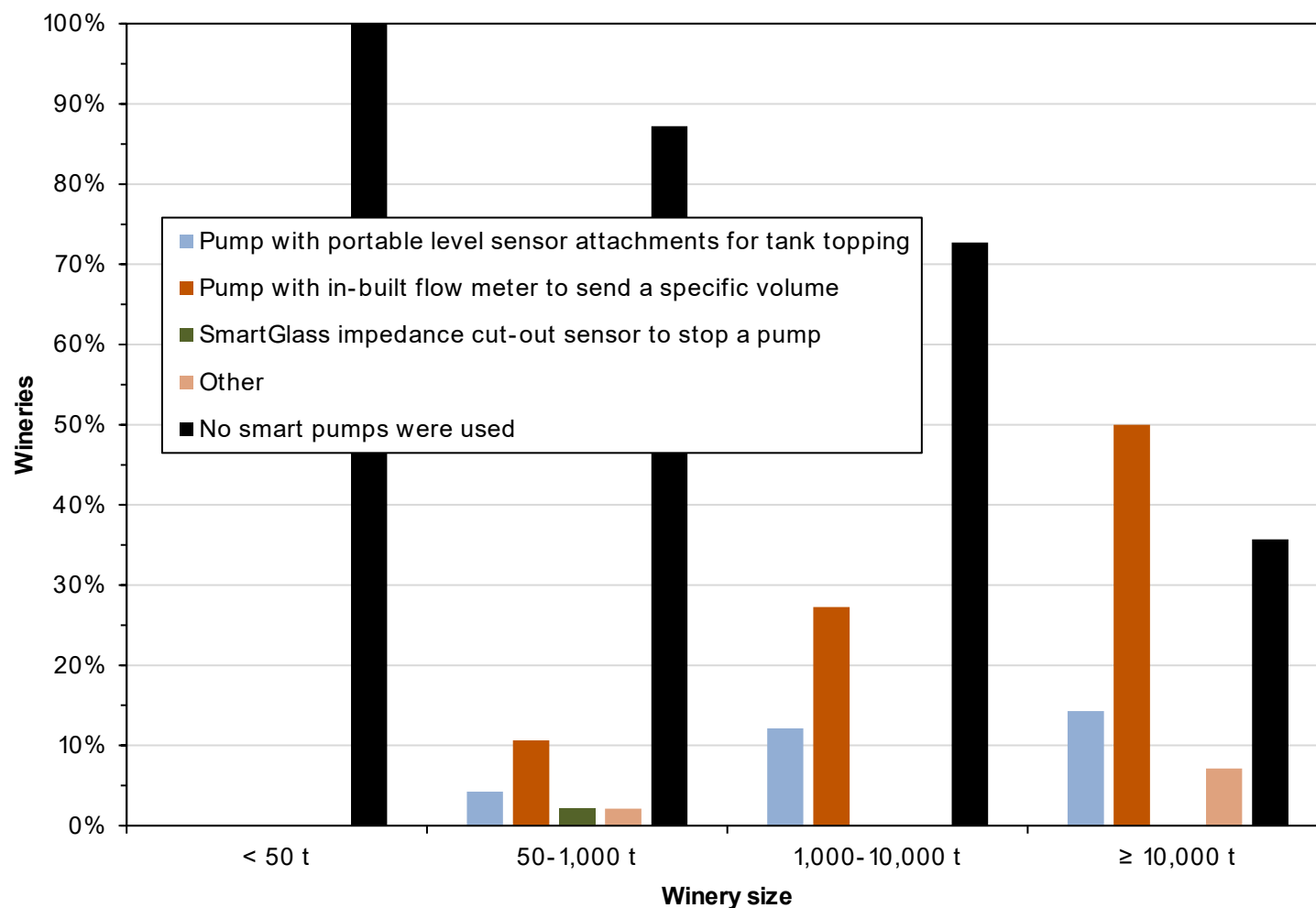
Tank sensors other than temperature probes (used at all)



- Radar and headspace pressure sensors on pressure/sparkling tanks were on multiple tanks as part of permanent installations at some wineries.
- A small number of wineries also had single hydrostatic pressure sensors for level measurement on some tanks as part of older permanent installations.
- Most of the other sensors plotted were temporary installations for trials in 2022, although there have since been installations of dual hydrostatic pressure sensors and radars at a few wineries.

*Respondents were asked in the 2022 survey whether any of the listed sensor types were used. They were advised that lab and portable sensors like radars for use with Rapidfil tank topping systems should be excluded. This question was not asked in the same way in 2016. The plot shows data for 2022.

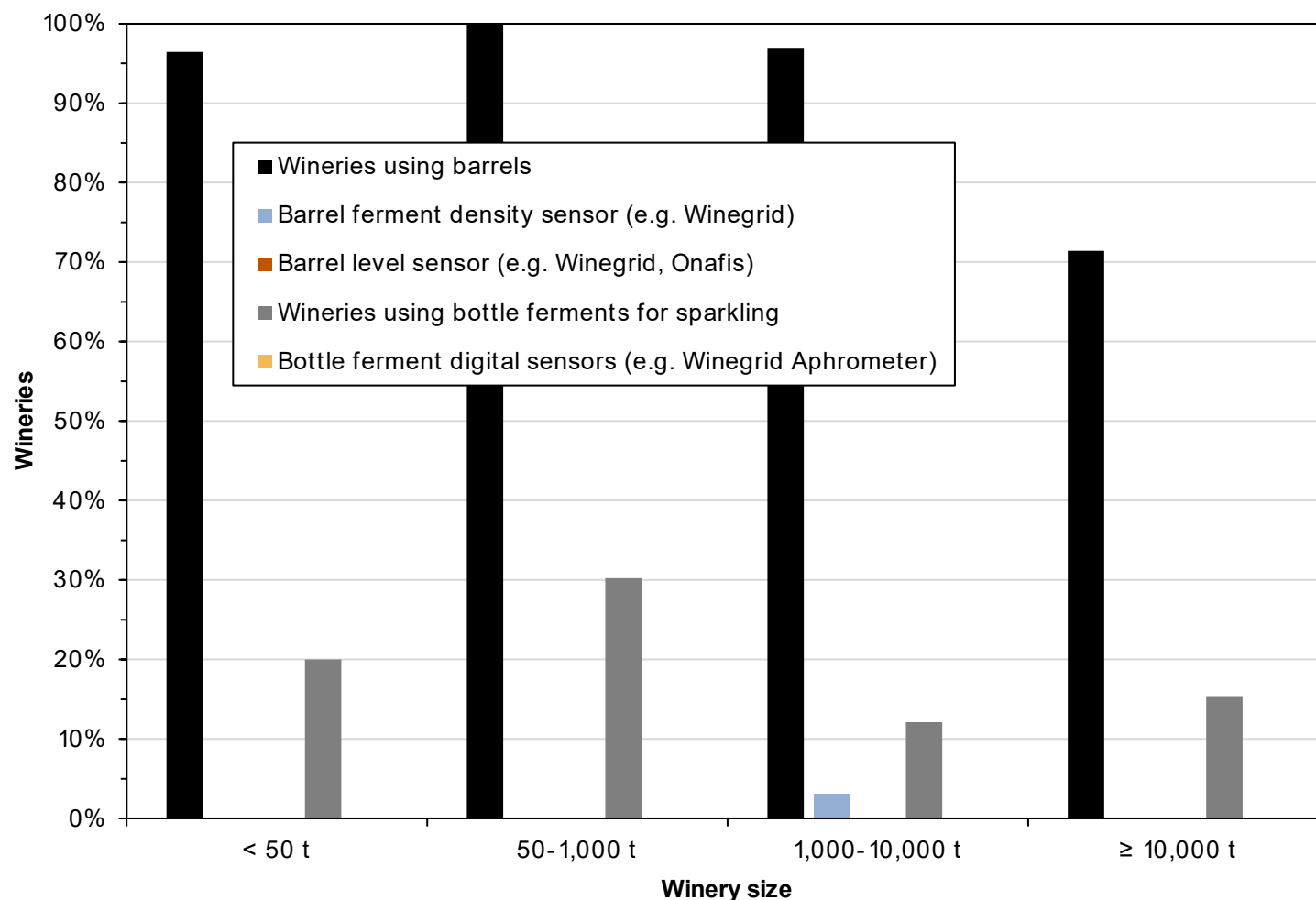
Smart pumps and smart cut-out devices (used at all)



- Pumps with a flow meter to transfer a set liquid volume were the most common smart pump arrangement.
- Under the 'Other' option, a couple of respondents noted automated filling-bowl volume control of feed pumps for their packaging lines, and it is likely that other wineries also had this.

*Respondents were asked whether they used any smart pumps that have flow meters or work in conjunction with sensors to help automate transfers or cut-outs. They were advised to not count barrel automation related sensors since these are considered as part of a separate question. This question was not asked in 2016. The plot shows data for 2022.

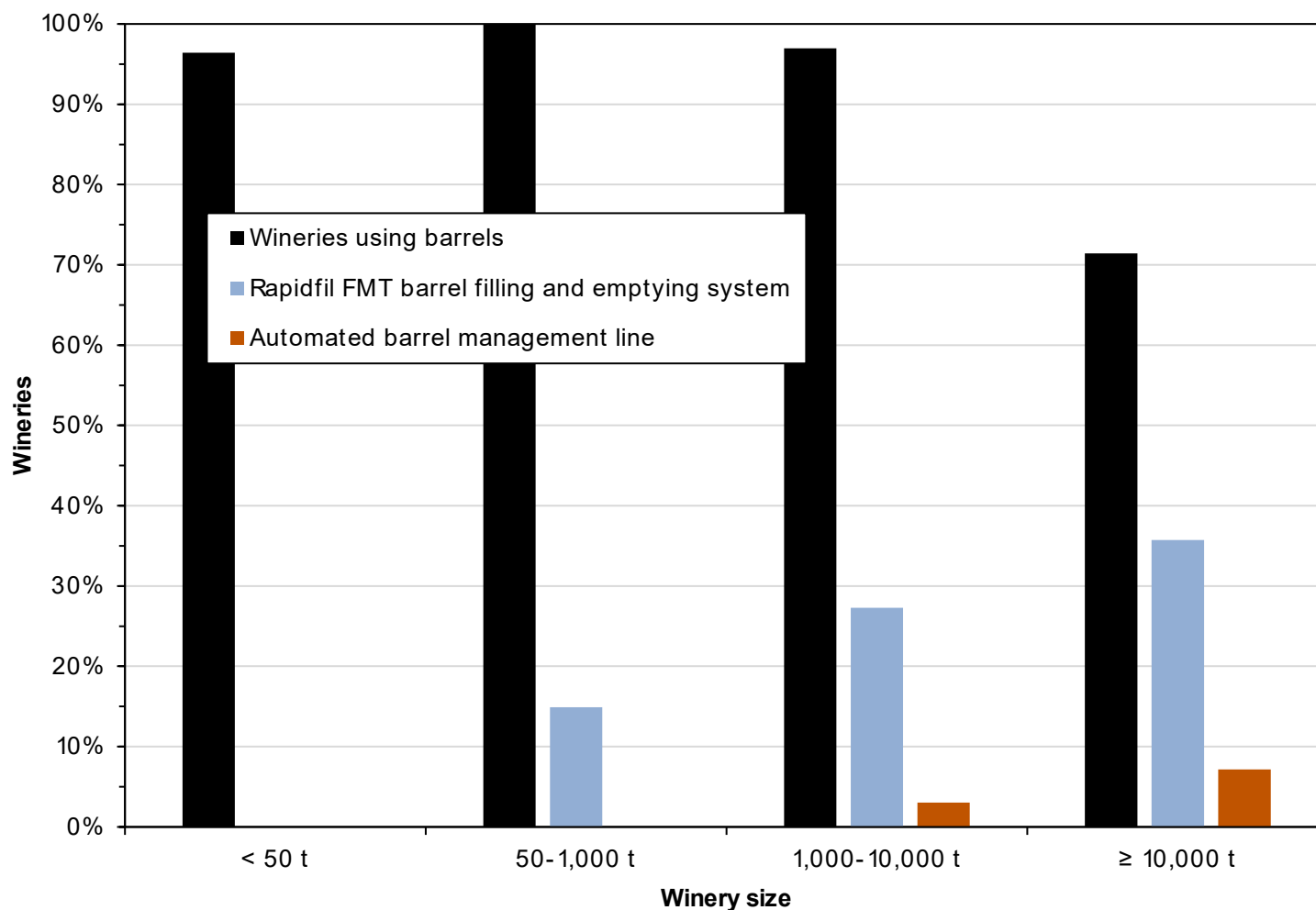
Barrel and sparkling bottle sensors (used at all)



- While most wineries have barrels, only 1 winery had any in-place barrel density or level sensors, and this was only 2 units as part of a trial.
- While many wineries also performed sparkling bottle ferments, none had in-bottle digital aphrometers from Winegrid.
- A couple of wineries noted using traditional basic gauge aphrometers for measuring bottle pressure.

*Respondents were asked in the 2022 survey whether they have any barrels at the site, and if they did then whether any in-place sensors are used for monitoring density or level. Wineries were also asked whether they performed any traditional or ancestral sparkling bottle ferments, and if they did they were asked if they used in-bottle secondary ferment bottle sensors like the Winegrid Aphrometer. This question was not asked in 2016. The plot shows data for 2022.

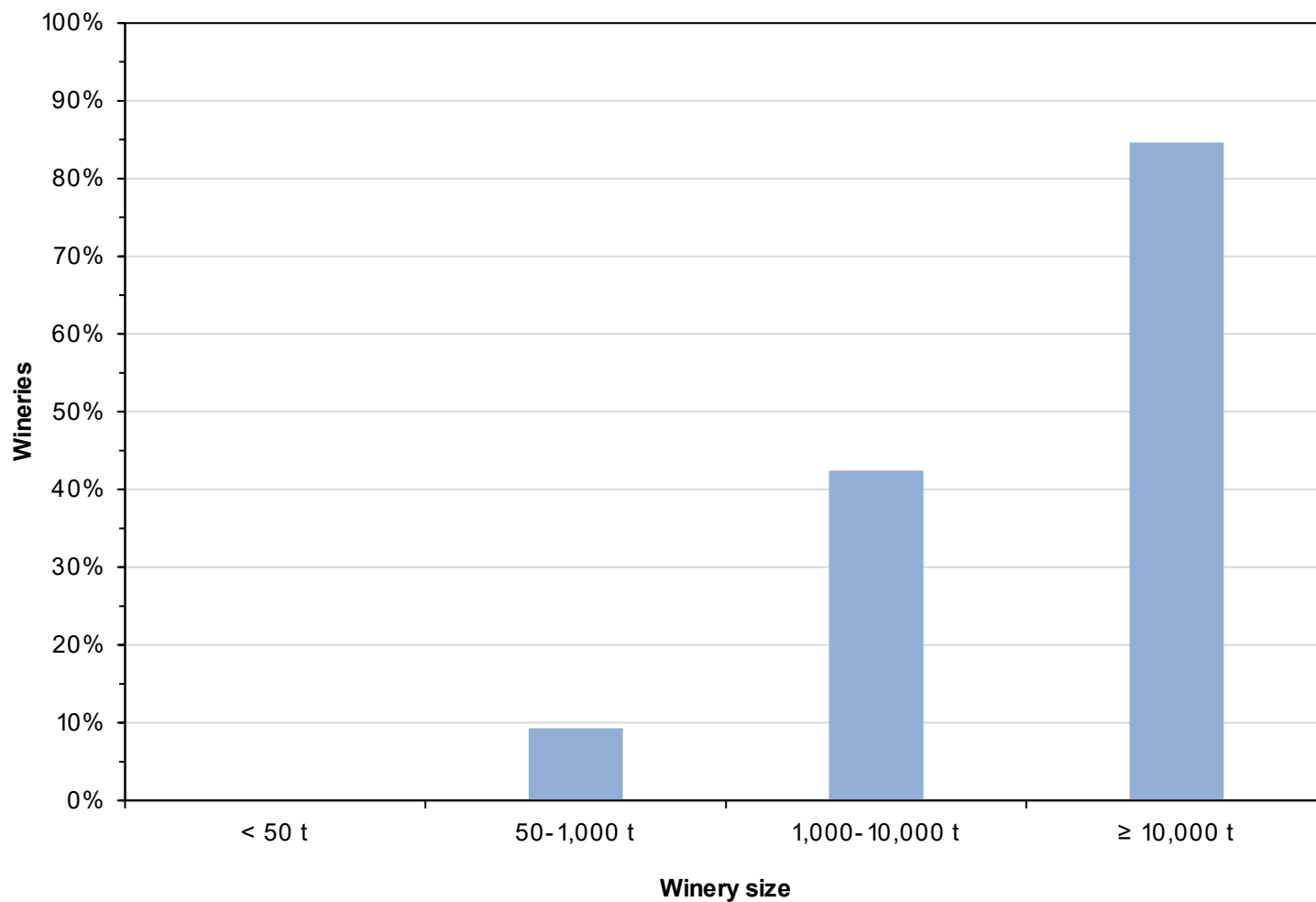
Automated barrel filling and emptying systems (used at all)



- Barrel automation increased with winery size, with the Rapidfil FMT system being most used.

*Respondents were asked in the 2022 survey whether they have any barrels at the site, and if they did they were asked whether any of these systems were used to automate or partially automate barrel filling and emptying at the site. This question was not asked in 2016. The plot shows data for 2022.

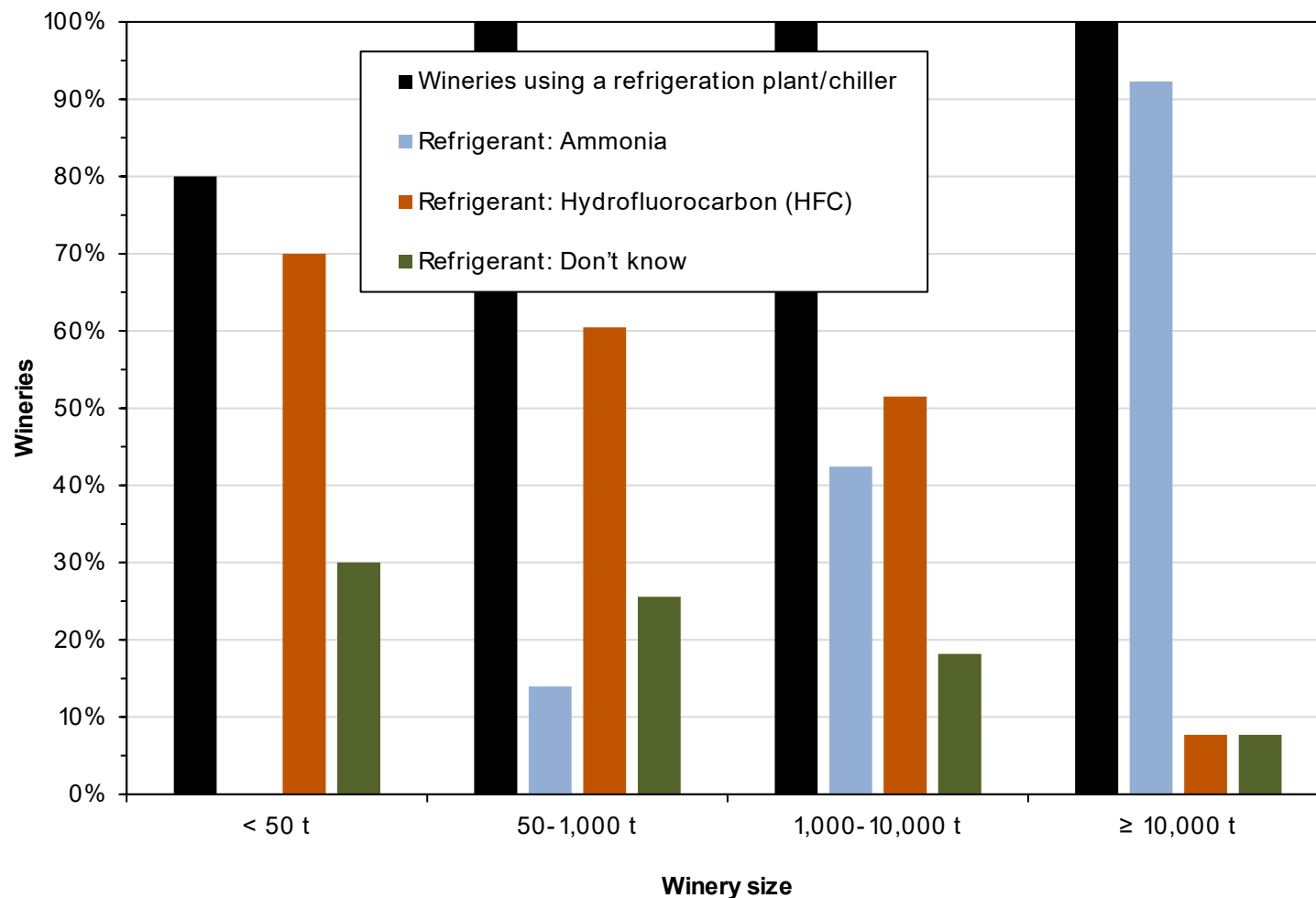
Nitrogen generator at the site



- Larger wineries were more likely to have their own nitrogen generator on-site.
- Purchases of bottled or bulk nitrogen were not covered by the survey.

*Respondents were asked in the 2022 survey whether they have a nitrogen generator on-site. This question was not asked in 2016. The plot shows data for 2022.

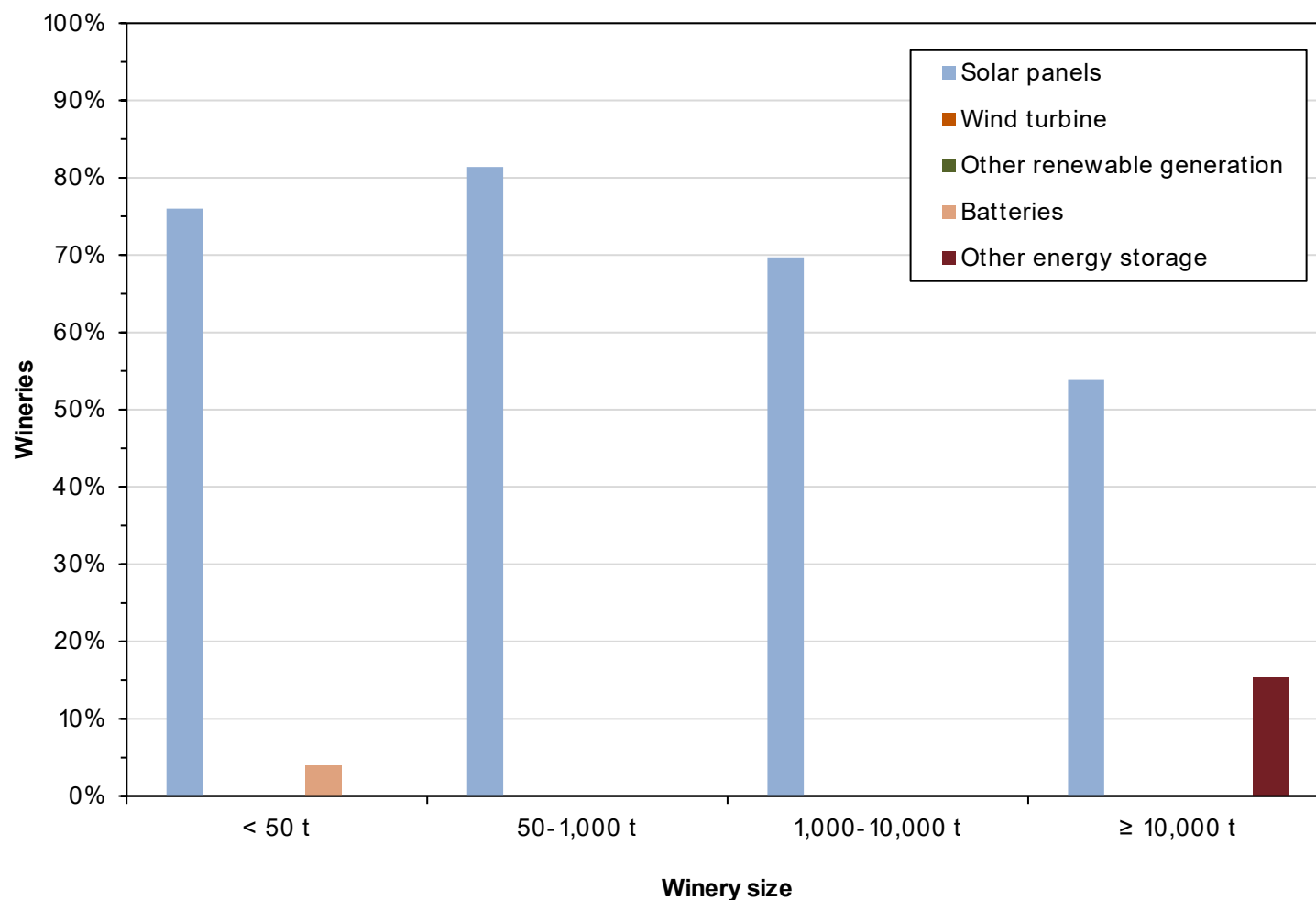
Refrigeration plant/chiller at the site



- All but a few very small wineries had a refrigeration plant/chiller.
- Large wineries predominantly used systems with ammonia refrigerant.
- Smaller wineries used systems with HFC refrigerants or didn't know the refrigerant (generally people will know if their refrigeration plant uses ammonia, but for other refrigerants they are less likely to know without inspecting the system).

*Respondents were asked in the 2022 survey whether they have a refrigeration plant or chiller at the site, and if so to select which primary refrigerant is used. This question was not asked in 2016. The plot shows data for 2022.

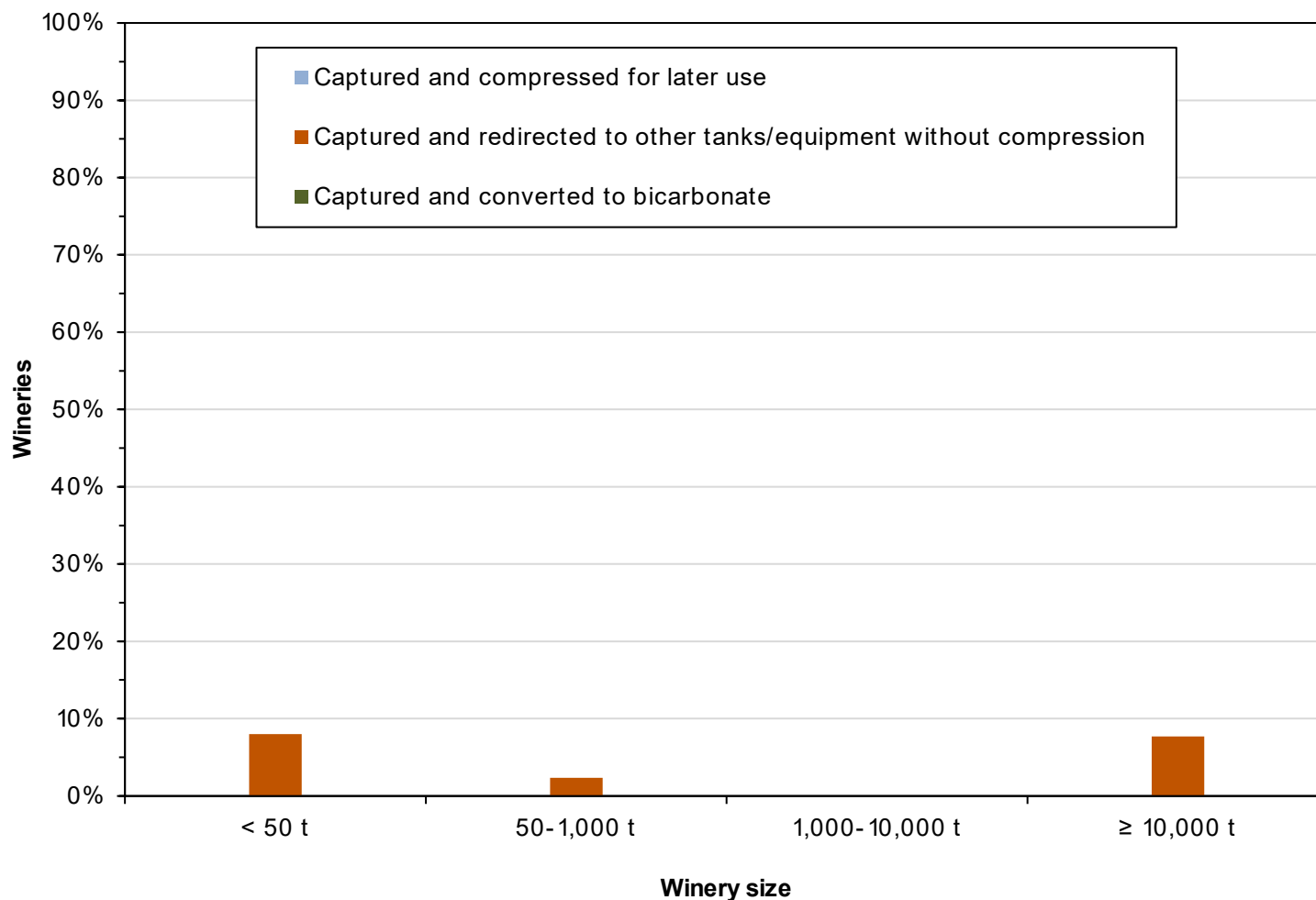
Renewable electricity generation and energy storage at the site



- Most wineries had solar panels at their sites.
- Only 1 respondent had a battery at their site.
- The 'Other energy storage' mentioned at large wineries were hot water storage associated with a large evacuated tube solar hot water system at one site, and an ice storage system at another site.

*Respondents were asked in the 2022 survey to select any renewable electricity generation sources and energy storage installed at the site. Wineries were also asked whether their winery was connected to the electricity grid and all but one small responding winery were connected to the grid. This question was not asked in 2016. The plot shows data for 2022.

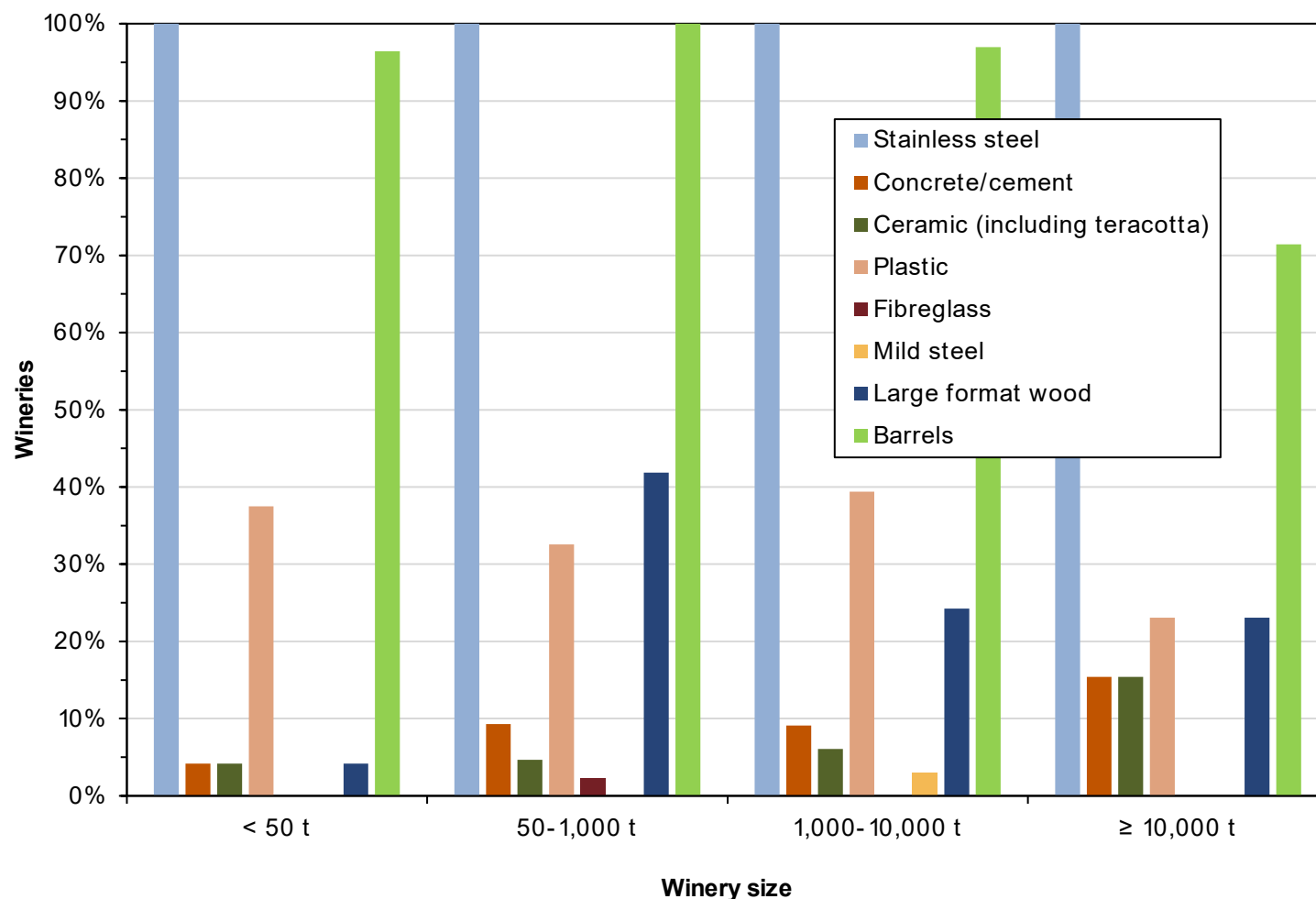
Fermentation CO₂ capture and re-use system at the site



- A small number of wineries captured CO₂ from ferments and redirected it to other tanks or equipment.
- No wineries had systems with compressors or storage.

*Respondents were asked in the 2022 survey whether they had a system to capture and re-use CO₂ from wine fermentations, and to select the type used. This question was not asked in 2016. The plot shows data for 2022.

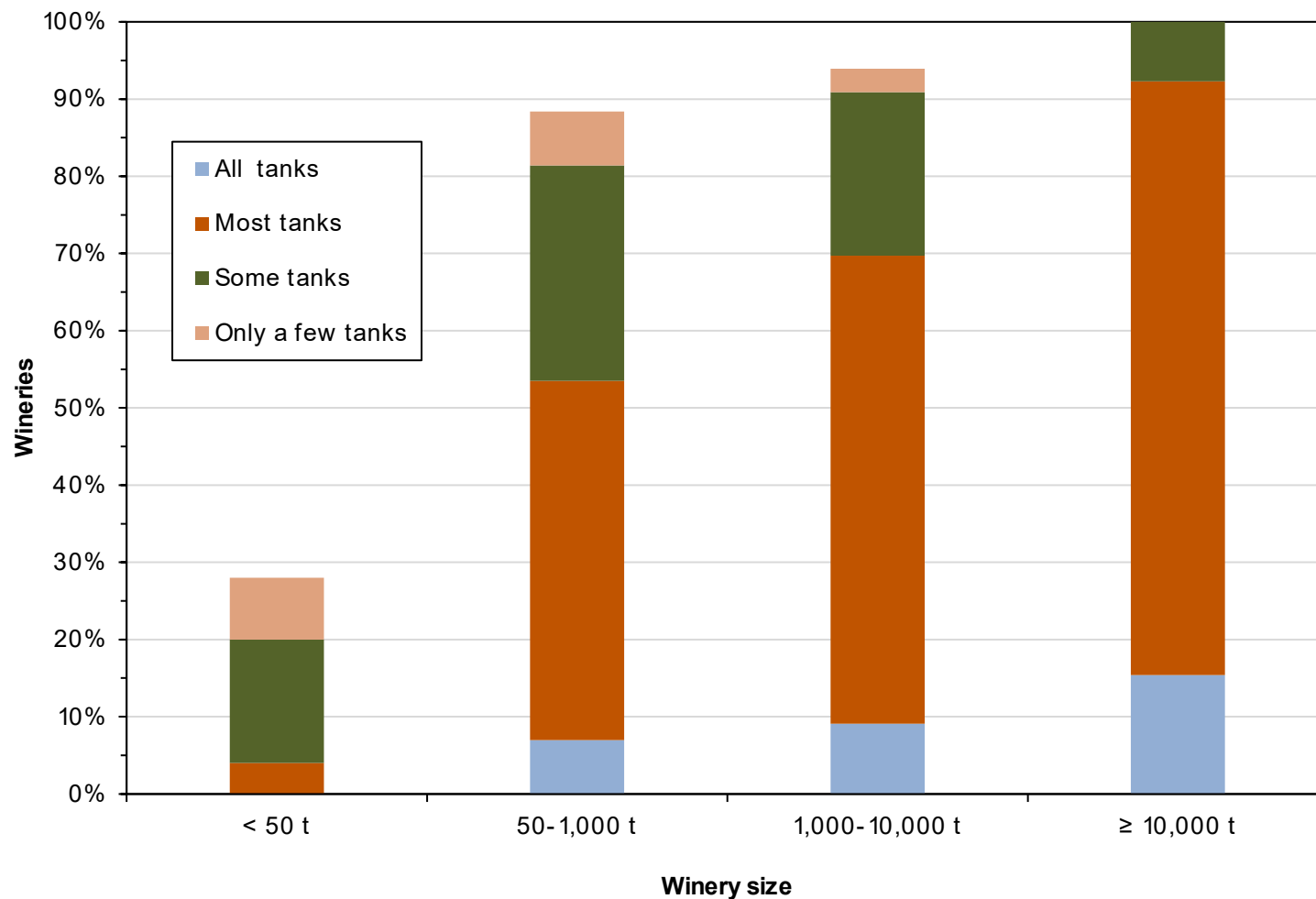
Wine storage tank materials, excluding those used just for ferments (used at all)



- Stainless steel tanks were used by all responding wineries for storage.
- Barrels were also used by most wineries.
- Plastic tanks and large format wood were also used by many.
- The number of wineries using plastic tanks may be slightly higher than shown. The original question listed only plastic IBCs. Multiple wineries responded 'Other' to the question and noted that they used Flexcubes. Those responses have been combined with plastic IBCs into a general plastic category in the plot. More respondents might also have selected plastic if Flexcubes had been listed explicitly.
- Only 1 winery used a fibreglass tank (this has been kept separate from the general plastic category).

*Respondents were asked in the 2022 survey what materials storage tanks at the site (that are used) are made from, excluding those that are only used for fermentation, like open-top concrete tanks. A separate question in the survey asked whether the respondent had any barrels at the site. This data has also been added to the plot since it is another common storage vessel. These questions on vessel materials were not asked in 2016. The plot shows data for 2022.

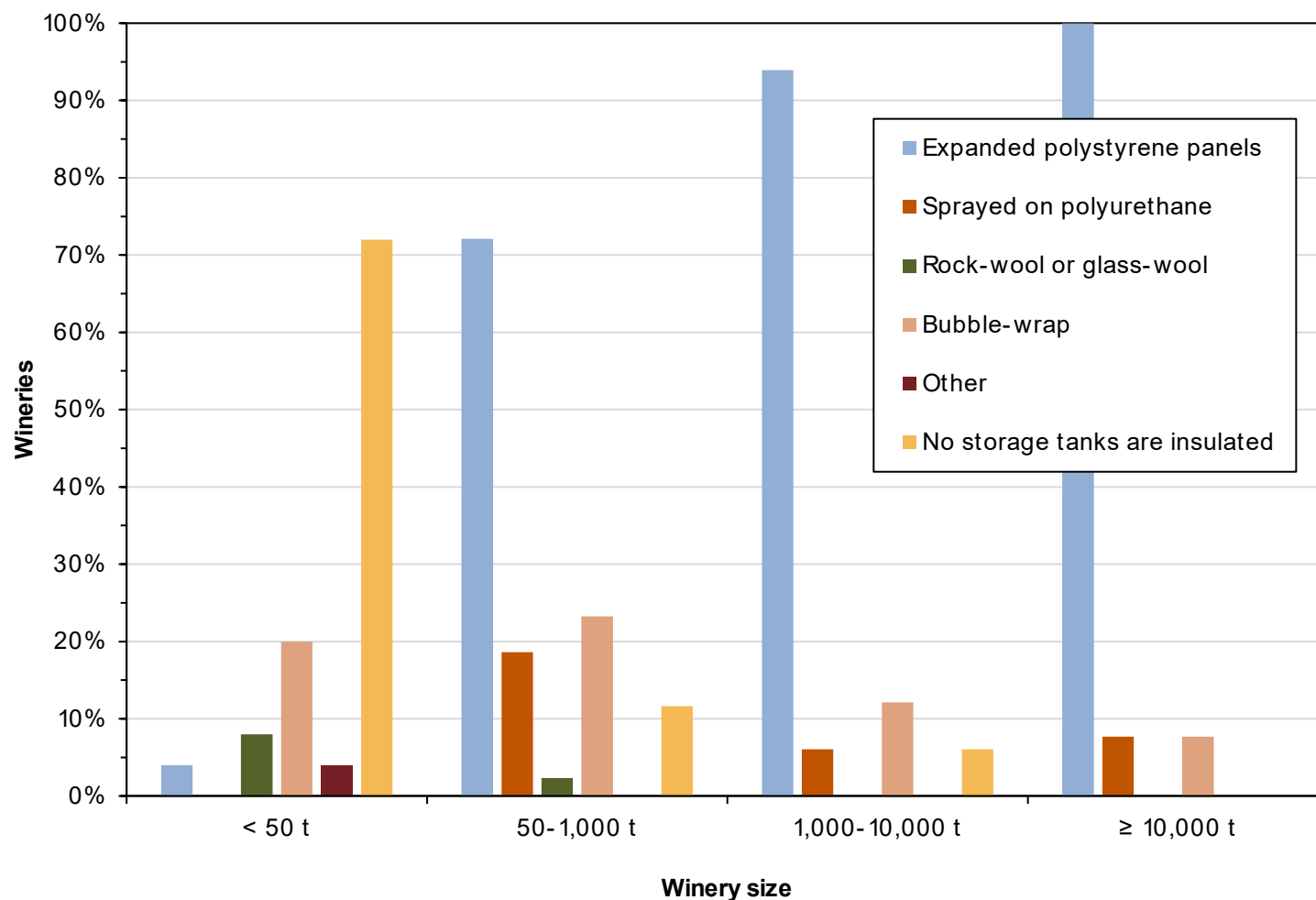
Storage tank insulation



- Most wineries had at least some insulated tanks and with increasing winery size, most tanks tended to be insulated.

*Respondents were asked in the 2022 survey to select what proportion of storage tanks are insulated from the options shown. This question was not asked in 2016. The plot shows data for 2022.

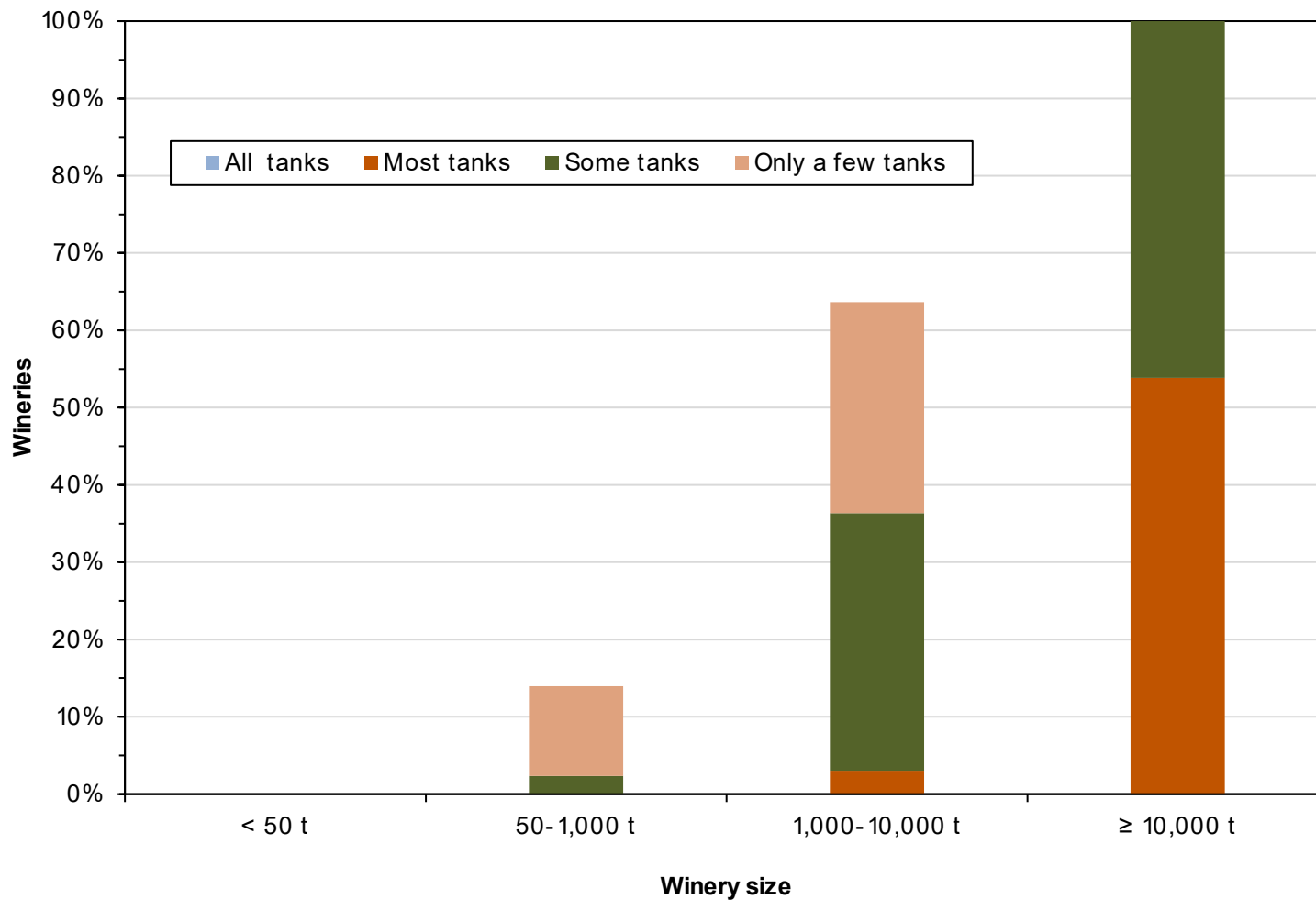
Insulation type on storage tanks (used at all)



- Larger wineries mainly insulate tanks with expanded polystyrene panels (most commonly having white coated aluminium skin).

*Respondents were asked in the 2022 survey to select which insulation materials are fitted to wine storage tanks at the site. This question was not asked in 2016. The plot shows data for 2022.

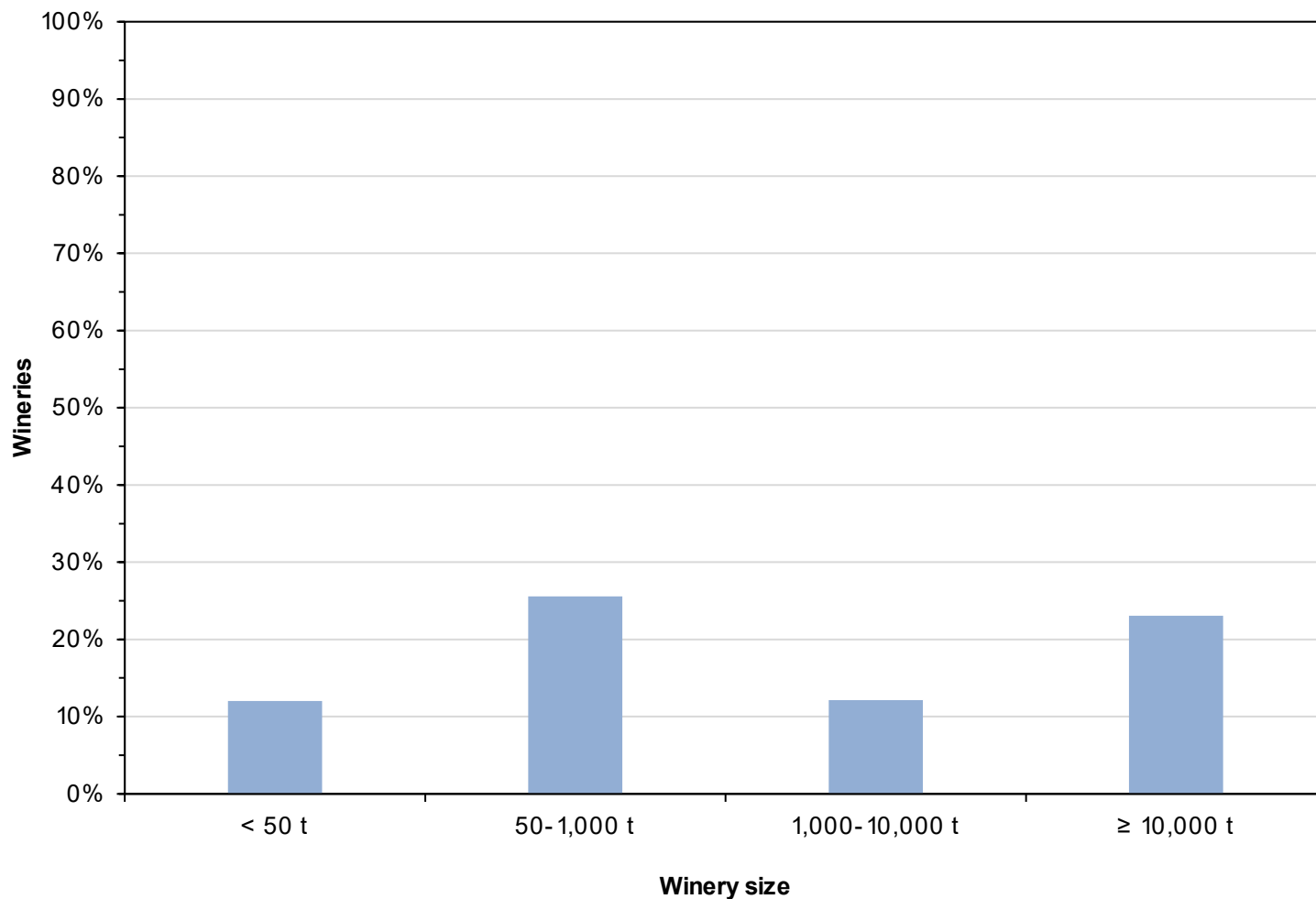
Agitators on wine tanks



- Larger wineries were more likely to have agitators on tanks, but they were less common than tank fit-out choices like insulation (page 178), and temperature sensors and cooling jackets (page 166).

*Respondents were asked in the 2022 survey to select what proportion of wine tanks at the site have agitators. This question was not asked in 2016. The plot shows data for 2022.

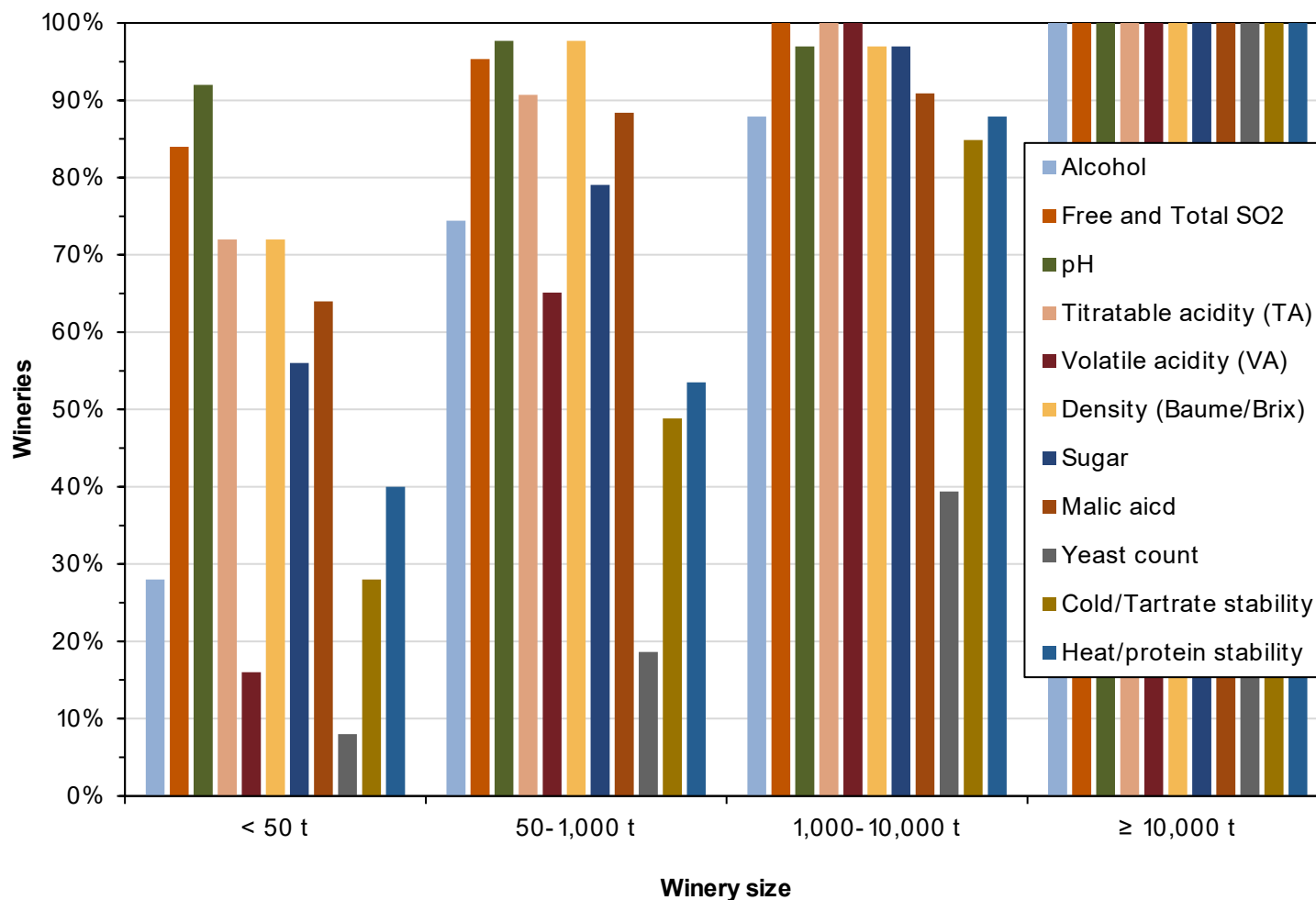
Eggs/Amphorae/Qvevris (used at all for fermentation or storage)



- Eggs/Amphorae/Qvevris were used by 12-26% of wineries depending on winery size.

*Respondents were asked in the 2022 survey whether any eggs/amphorae/Qvevris were used at the site for fermentation or storage. This question was not asked in 2016. The plot shows data for 2022.

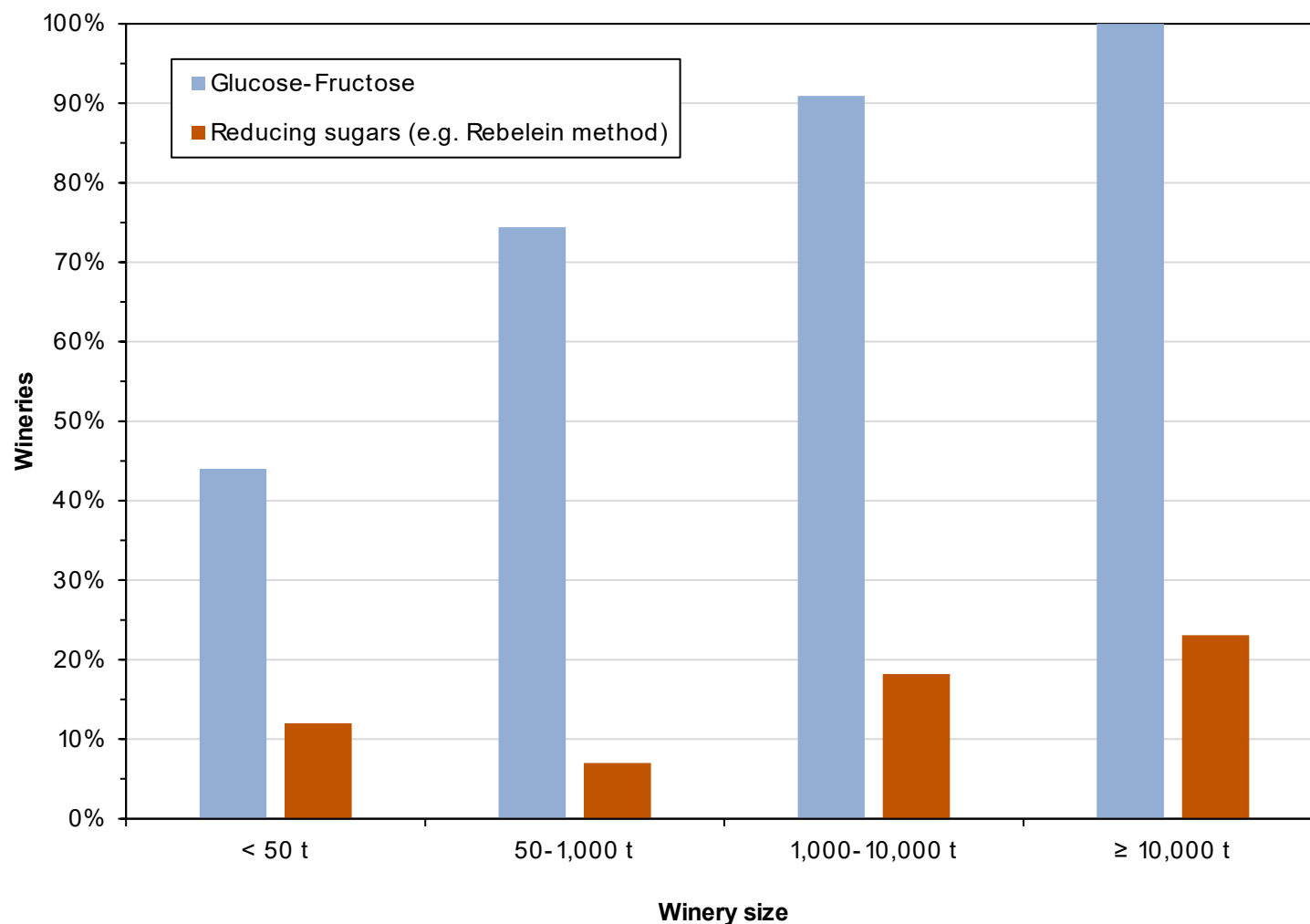
Analyses performed on-site (at all)



- The range of analyses performed on-site increased with winery size, with very large wineries performing all of the listed analyses on-site.

*Respondents were asked in the 2022 survey which of the listed analyses were performed on-site. They were asked not to include analyses performed by external labs. This question was not asked in 2016. The plot shows data for 2022.

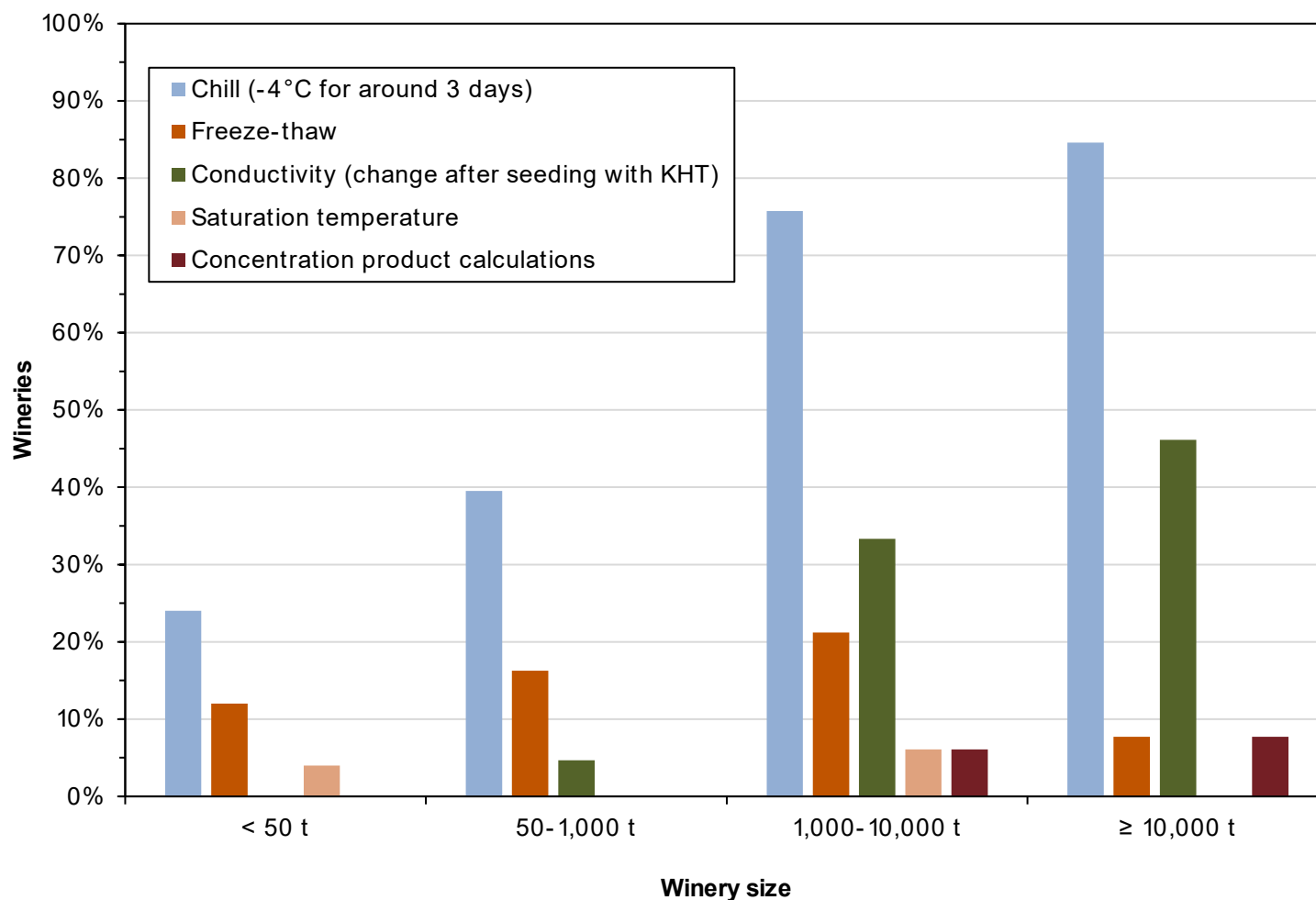
Methods used for measuring sugars on-site (used at all)



- Glucose-Fructose measurement was the main approach to measuring sugars.
- The Glucose-Fructose results presented include responses from a few wineries using techniques (e.g. FTIR, Sentia) that are calibrated against Glucose-Fructose measurements.
- Reducing sugars results presented include one response from a smaller winery that used Clinitest tablets.

*Respondents to the 2022 survey that performed sugar analysis were asked which methods were used. This question was not asked in 2016. The plot shows data for 2022.

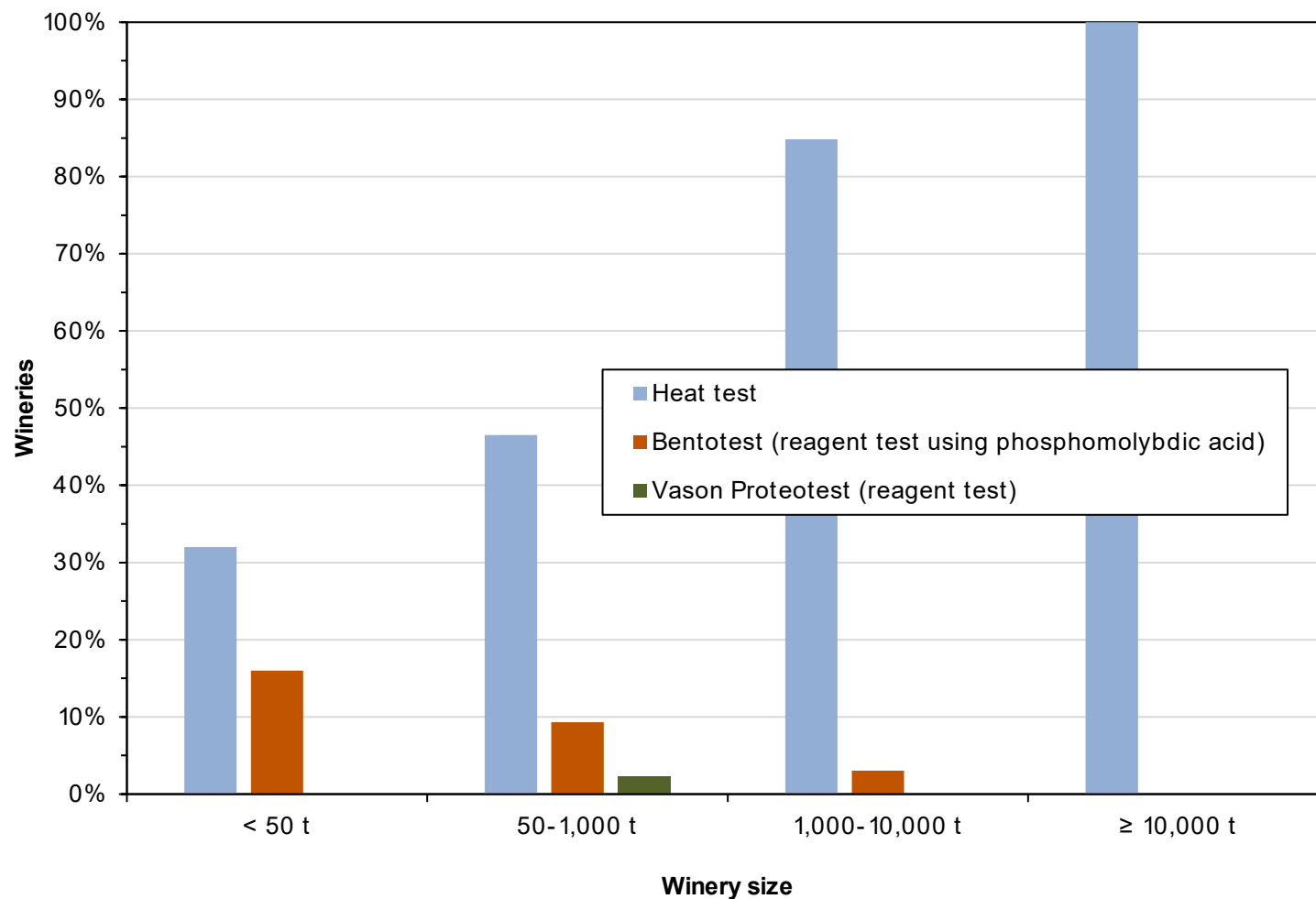
Methods used for measuring cold/tartrate stability on-site (used at all)



- Chill tests were the most common test method employed in all winery size categories (1 winery that used 0°C for 3 days has been included in this category).
- Conductivity tests were also relatively common in larger wineries.
- Concentration product style calculations were used by a small number of larger wineries and were primarily based on potassium measurements.

*Respondents to the 2022 survey that performed cold/tartrate stability tests on-site were asked which methods were used. This question was not asked in 2016. The plot shows data for 2022.

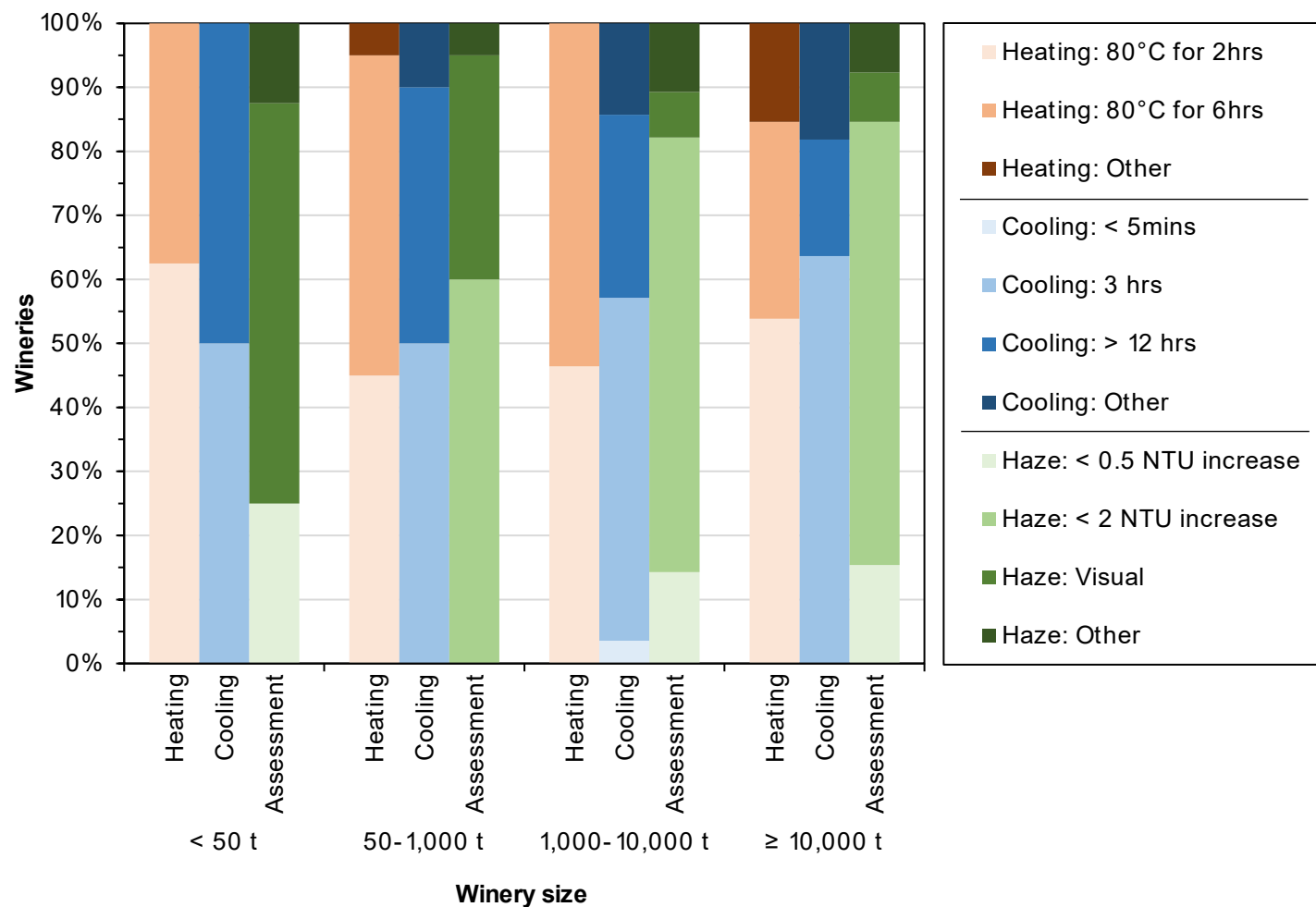
Methods used for measuring heat/protein stability on-site (used at all)



- Heat tests were by far the most common method of assessing heat/protein stability.
- Smaller wineries were more likely than larger wineries to make use of reagent tests.

*Respondents to the 2022 survey that performed heat/protein stability tests on-site were asked which methods were used. This question was not asked in 2016. The plot shows data for 2022.

Heat test conditions



- Heating was split mainly between 2 or 6 hours at 80°C, with a small number of wineries using other times (4, 5 or 8 hours).
- Cooling was most commonly 3 hours or > 12 hours (e.g. overnight). A small number of wineries used other times (1 or 2 hours, or until samples had returned to room temperature).
- An increase in turbidity of < 2 NTU was the most common cut-off criterion for heat stability, although smaller wineries often relied upon visual haze assessment. A few other respondents noted an absolute value of 1 NTU in the final wine as the cut-off criterion.

*Respondents to the 2022 survey that performed heat tests for heat/protein stability tests on-site were asked to select from the options on the heating, cooling and haze assessment criteria used. This question was not asked in 2016. The plot shows data for 2022.

New products/techniques with biggest positive impact in the last 5-6 years

2016 survey (1 st edition)	2022 survey (2 nd edition)
1. Cross-flow filtration (n=71)	1. Cross-flow filtration (n=28)
2. Juice flotation (n=25)	2. Juice flotation (n=17)
3. CMC for cold stabilisation (n=14)	3. Destemming/sorting kit, winery/harvest (n=11)
4. Destemming/sorting kit, winery/harvest (n=13)	4. Auto analysers, Oenofoss, Sentia, etc. (n=10)
5. Co-inoculation for MLF (n=7)	5. KPA or CMC for cold stabilisation (n=9)
6. Refrigeration upgrades (n=6)	6. New membrane presses (n=8)
7. Choice of yeast available (n=5)	7. Steam cleaners/barrel steamers (n=8)
8. Pulsair/air-mixing of red ferments (n=5)	8. Refrigeration upgrades & temp control (n=7)
9. New membrane presses (n=4)	9. Plant-derived fining proteins (n=6)
10. Plant-derived fining proteins (n=4)	10. Pulsair/air-mixing of red ferments (n=4)
11. Oenofoss (n=4)	11. Red-ferment aeration (n=4)

- The most impactful products/techniques were similar in the 2022 and 2016 surveys, with cross-flow filtration and flotation most prominent in both.
- From 2016 to 2022 the focus of cross-flow filtration impact did move slightly towards lees filtration, with 8/28 cross-flow mentions in 2022 citing lees, compared with 9/71 in 2016.
- For flotation, there was an increased impact in large wineries from continuous flotation, with 4/17 flotation references noting continuous flotation in 2022, compared with none in 2016.
- New destemming and/or sorting equipment in-winery or on-harvester was reasonably prominent in both survey editions.

*Respondents were asked which new products or techniques had the biggest positive impact on their operations over the last six years in this 2022 edition of the survey and over the last 5 years in the 2016 edition of the survey. Themes are listed in decreasing order of responses. 73% of survey respondents answered with at least one product/technique for this free-text question in 2022, compared with 67% in 2016, where it was listed as optional, although there were almost twice as many overall survey respondents in 2016 as in 2022.

Technical challenges / emerging technologies where you would like support

2022 survey (2 nd edition)
1. Lees reprocessing, including lees cross-flow filtration (n=7)
2. De-alcoholisation / NOLO wines (n=6)
3. Cold/tartrate stabilisation alternatives to chilling (n=6)
4. Automation (n=5)
5. Heat/protein stabilisation alternatives to bentonite (n=4)
6. Ferment CO ₂ collection and reuse (n=3)
7. In-tank sensors (n=3)
8. Vegan additives/processing aids/techniques (n=3)

- The topic most people wanted help with was equipment for juice and wine recovery from lees.
- De-alcoholisation / NOLO was another common topic in need of support. Some responses mentioned specific aspects including advice on processes & additives, partial but not total de-alc., processing smaller batches, cheaper de-alc. techniques, and NOLO market data to justify investment in equipment.
- Alternative heat and cold stabilisation was also raised, including a few responses interested in specific alternatives like KPA and CMC.
- Automation was another common area where support was desired as were in-tank sensors (if these 2 related categories were combined into a single category, it would have topped this list).

*Respondents were asked what technical challenges or emerging technologies they would like support on. It was an open-text question and responses have been aggregated into categories as best possible. This question was new in the 2022 edition.

Methodology and interpretation

Reference period (unless otherwise stated)

- Vineyard questions refer to grapes grown for the 2022 vintage.
- Winery questions refer to 2022 for vintage-related operations and to 2021/2022 financial year for packaging.
- Some comparisons are made to the first edition of the survey, which related to 2016 for vintage-related operations and to 2015 for packaging.

Used at all?

- Many questions asked whether a practice was used at all (even if just on one block, one batch, etc.).
- The fact that a piece of equipment/additive was used at all should not be interpreted as meaning that all wine was made with that technique.
- Larger sites can 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 was calculated (e.g. % hectares machine-harvested in a whole region).

Size-weighting

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

Property size	Share of ha
< 10 ha	11%
10 – 50 ha	32%
50 – 100 ha	15%
≥ 100 ha	42%

- 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%

- Some bottling is also performed by facilities that do not process grapes.

Number of respondents for each question

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

*SA vineyard size distribution data from the 2022 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 write in a corresponding textbox.
- 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 presented based just on size, given the smaller number of responses in each region, that 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.

Most accurate vineyard data

- Vineyard data for the aggregated weighted categories warm inland, cool/temperate and Australia are likely to be the most accurate because they are based on the largest number of responses.
- 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 contractors.

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 both the first edition of this survey (2016) and ABS data (2015), and a reasonable agreement was found (pages 193-195).

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 could double/halve based on whether a particular vineyard or winery completed the survey.

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.

Spectrum of practices and definitions

- A quantitative survey of this nature must make practices black and white to some extent to allow categorisation and analysis. However, 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 but inevitably some nuances will have been missed.

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.
- This may have occurred to some degree in this survey, but it is likely to be more representative than most because it is not a single topic survey (these tend to attract people passionate about that single topic) and it was distributed via many different channels to reach a broad range of producers and there was a lucky draw prize for completing it.

Average versus aggregates within size categories

- 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 generally used in this final report, but calculations were made by both techniques for winery data and generally showed similar results.

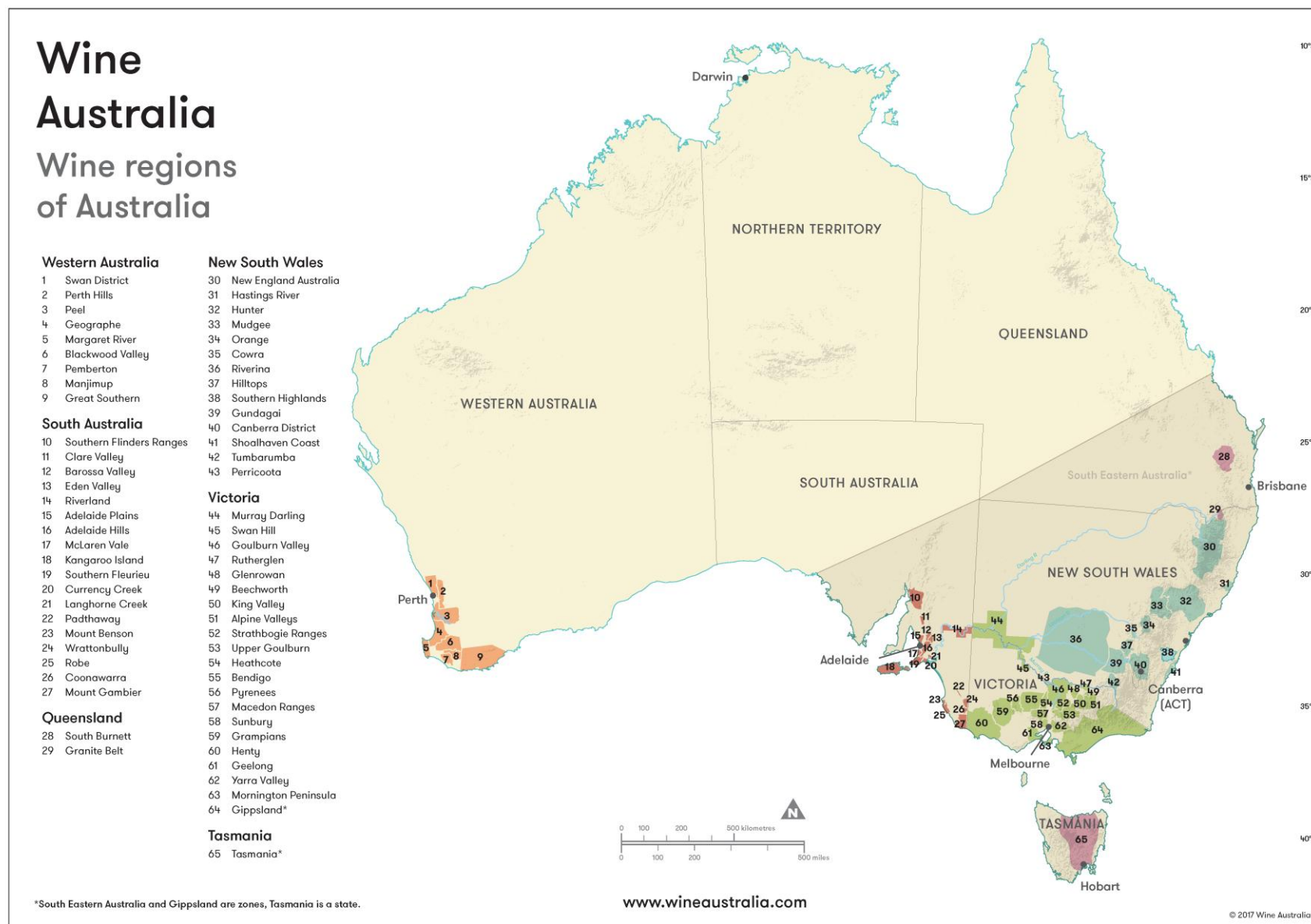
Partial processing

- 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 that 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, the volumes bottled and undergoing secondary fermentation were requested for use in aggregation statistics, so partial processing is not relevant.

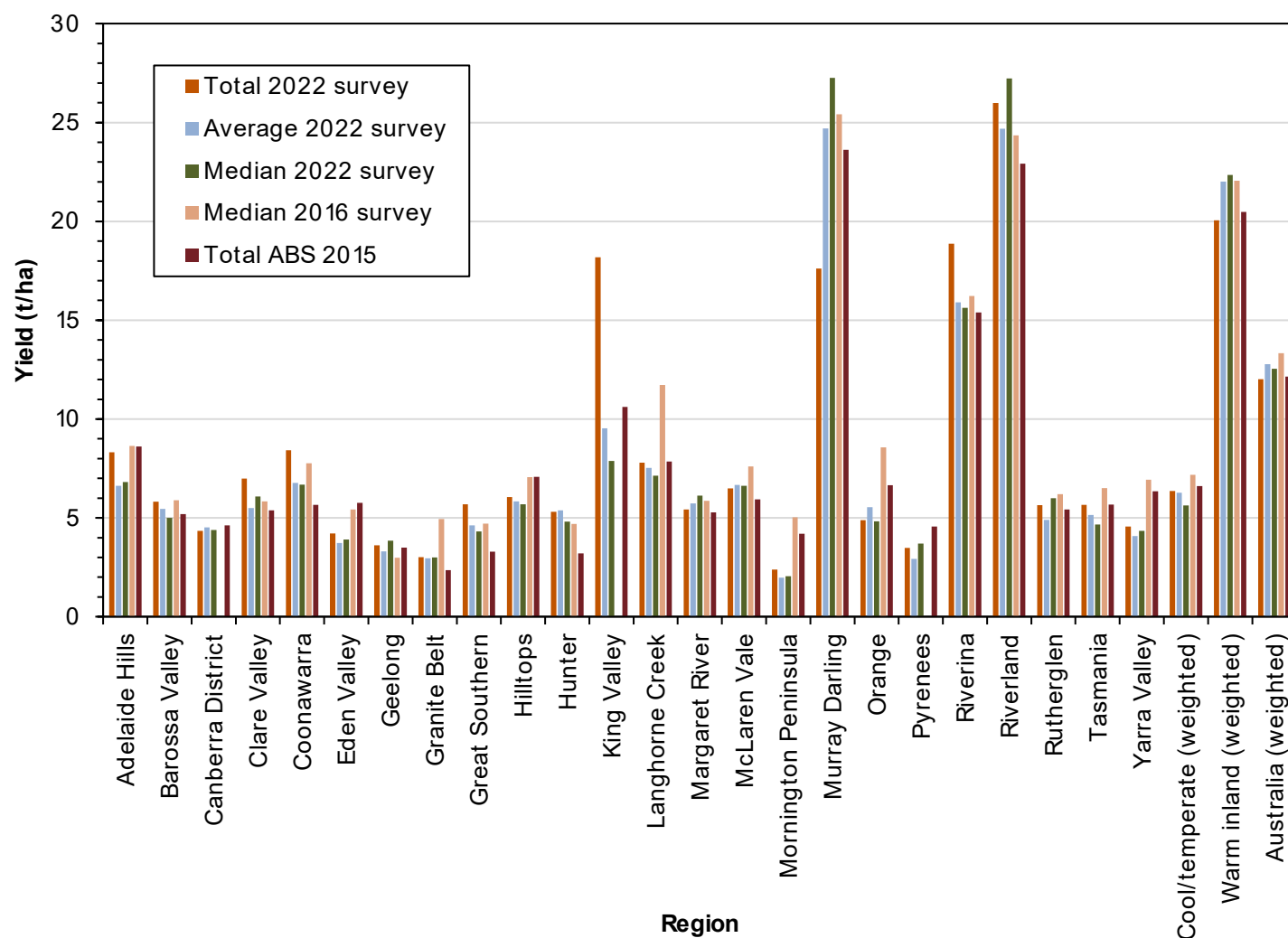
Footnotes in this document

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

Map of Australian wine regions - courtesy of Wine Australia



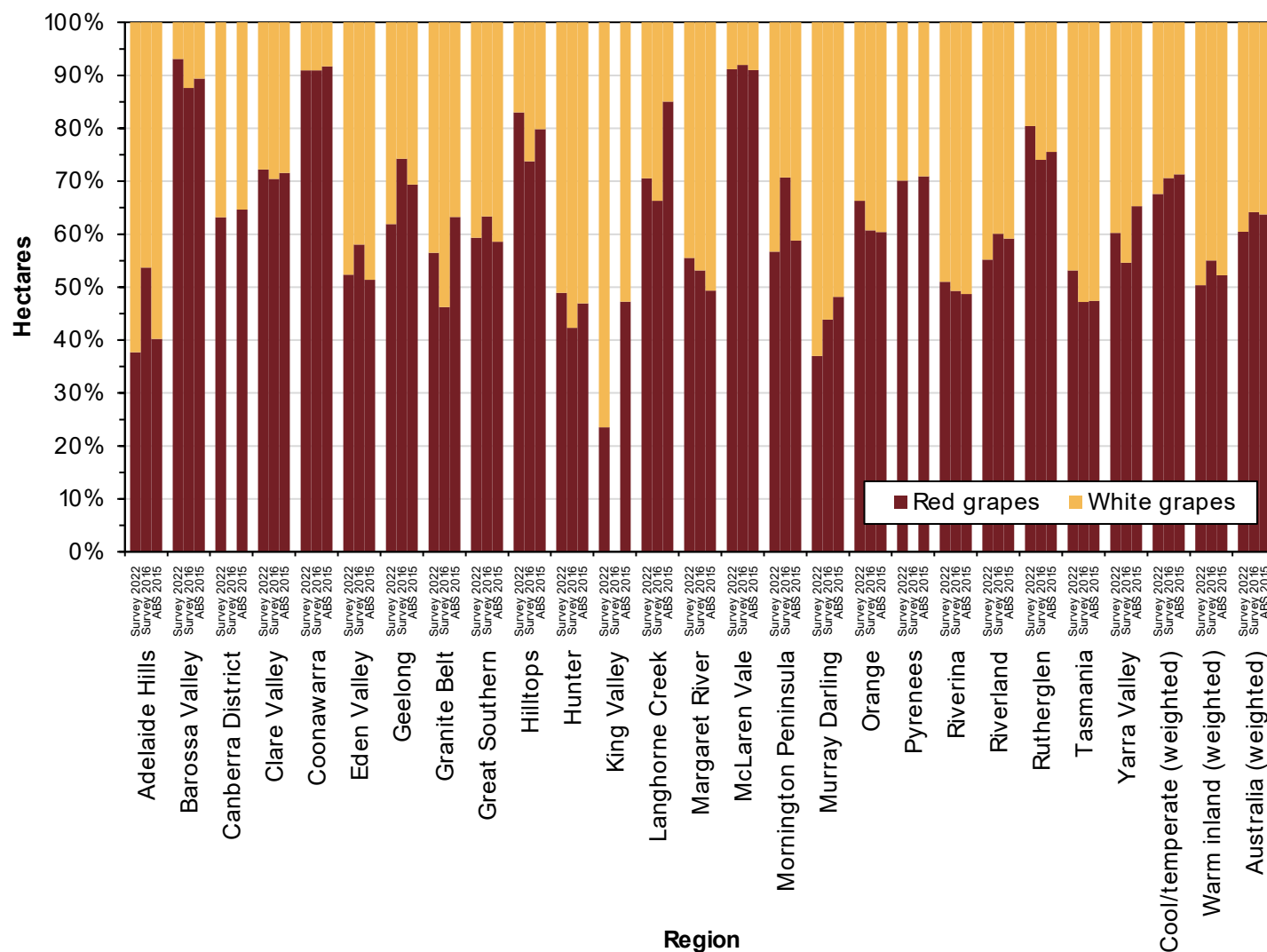
2022 survey yield and comparison with 2016 survey and 2015 ABS data



- 2022 survey yield calculated in different manners followed similar regional trends to 2016 survey and 2015 ABS data.
- The weighted Australian 2022 median survey yield was 6% lower than in the 2016 survey.
- This is consistent with Wine Australia data, where the national grape crush was 6% lower in 2022 than in 2016 (see page 7).
- Overall, the survey appears representative for yield.

*Total yield is the total regional yield, average and median yields are the averages 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 crush data is from its national vintage reports.

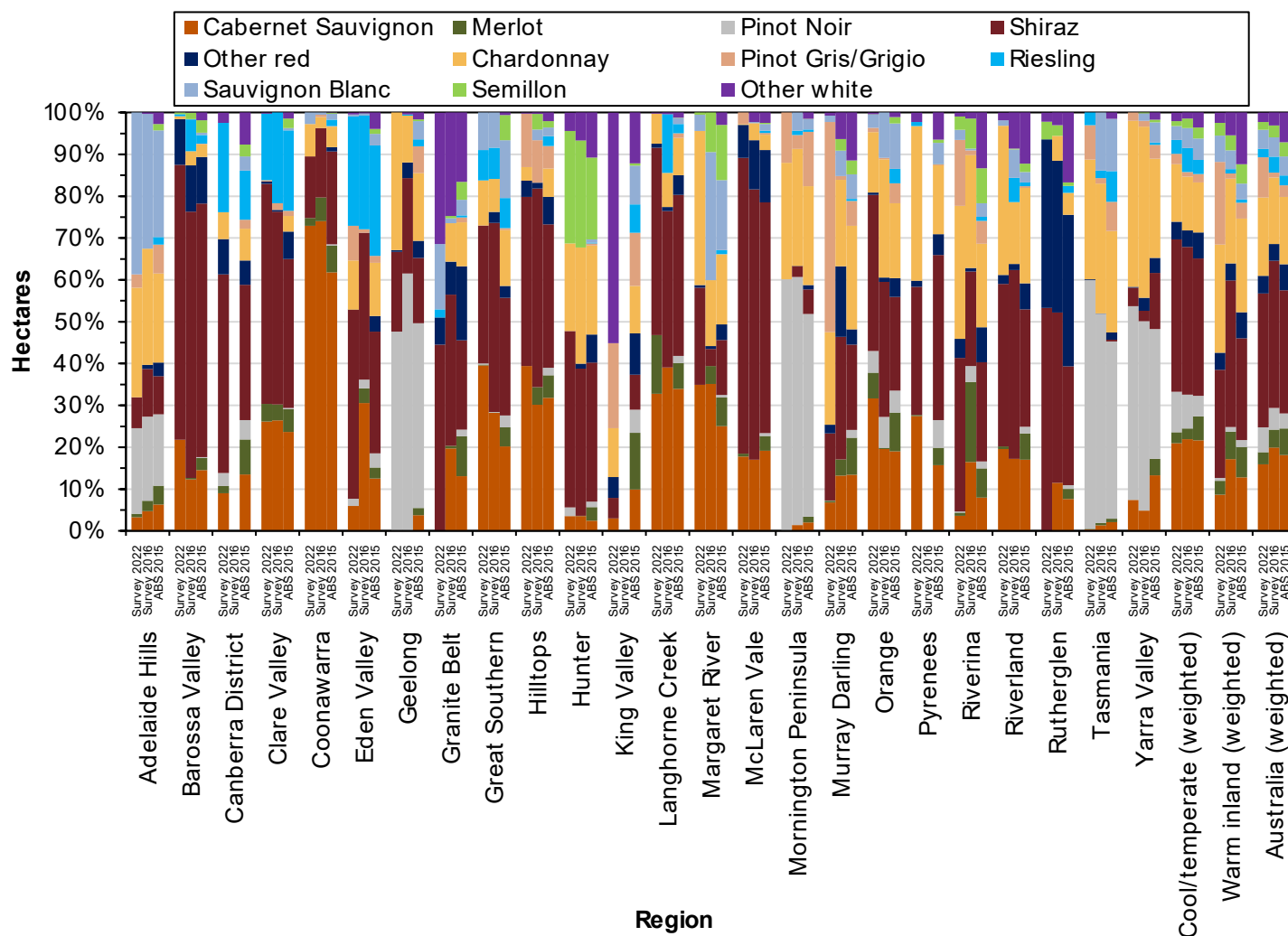
2022 survey colour mix and comparison with 2016 survey and 2015 ABS data



- 2022 survey red-white grape mix followed similar regional trends to 2016 survey and 2015 ABS data.
- 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.

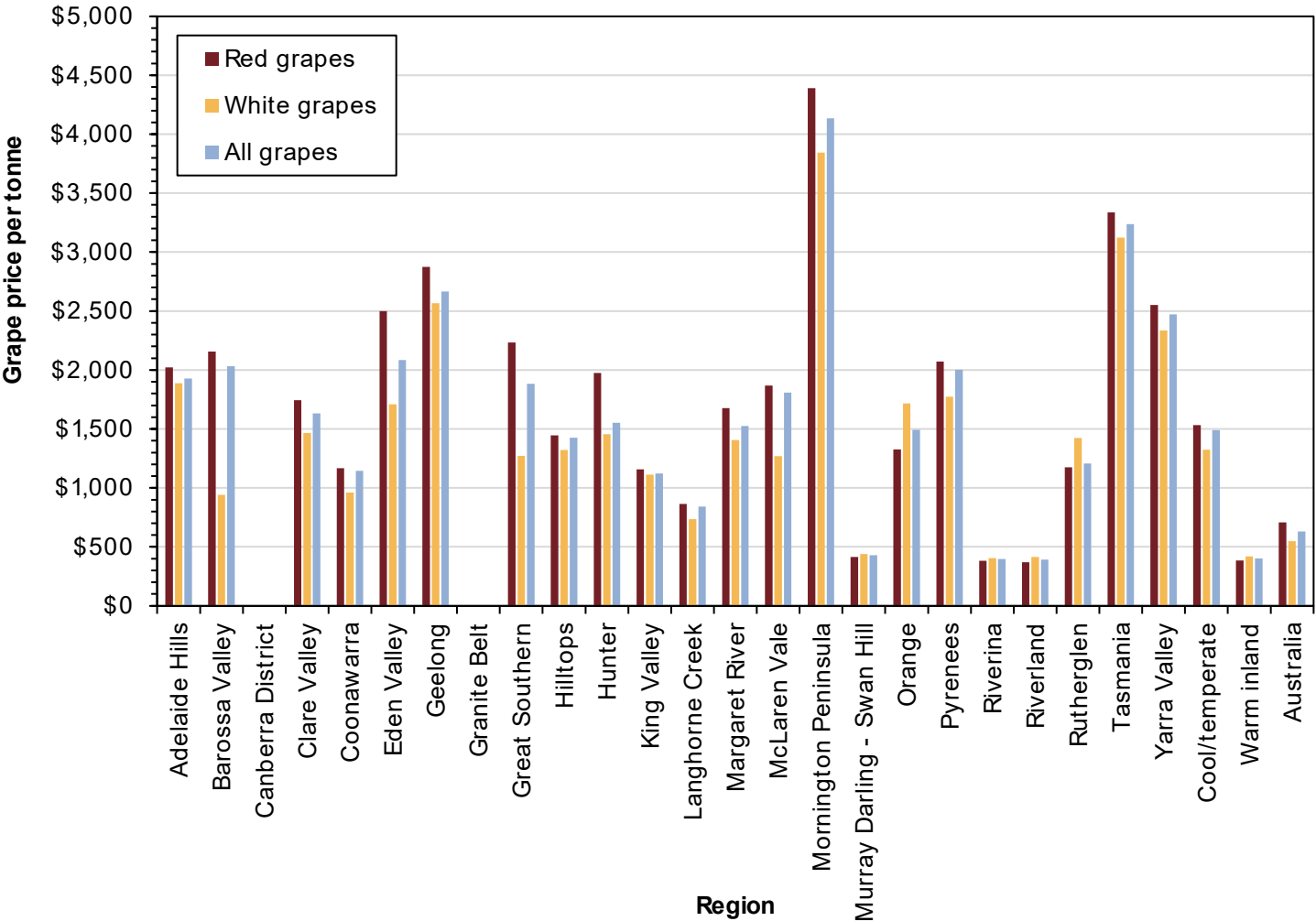
2022 survey varietal mix and comparison with 2016 survey and 2015 ABS data



- 2022 survey grape varietal mix followed similar regional trends to 2016 survey and 2015 ABS data
- 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 approximation 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.

Grape prices from Wine Australia (2022)



	2016	2022
Cool/temperate	\$1,199	\$1,491
Warm inland	\$313	\$402
Australia	\$526	\$630

See page 7 for longer term Australian average prices.

*Wine Australia (2022) National Vintage report.