ISSN: 3029-0724

Review Article

Journal of Environmental Science and Agricultural Research

The Changing Landscape of South Africa Wine Grape Age Distribution

Petri De Beer

Agricultural Economist, Winemaker, Agribusiness Manager City of Cape Town, Western Cape, South Africa

***Corresponding author**
Petri De Beer, Agricultural Economist, Winemaker, Agribusiness Manager City of Cape Town, Western Cape, South Africa.

Received: December 15, 2025; **Accepted:** December 22, 2025; **Published:** December 29, 2025

ABSTRACT

In South Africa a substantial shift in vineyard age distribution have occurred over the past two decades. Following a period of rapid expansion during the early 2000s, total wine grape area declined from a peak of 102,146 ha in 2006 to 87,848 ha in 2024. Concurrently, the proportion of vines older than 20 years increased from 15.9% in 2009 to 35.7% in 2023, indicating reduced rates of replanting. Comparative assessment suggests that South Africa's present vineyard age structure parallels that of major European wine-producing countries, where aging vineyards similarly reflected long-term shifts in planting behaviour and economic pressures.

Using Stellenbosch and Breedekloof as representative viticultural regions, this study characterizes the agronomic, structural, and economic implications of an aging vineyard population. Despite a doubling of vines older than 20 years for several key cultivars between 2015 and 2022, yield trends remained largely stable, with regression analysis indicating minimal correlation between vine age and yield These findings challenge the long-held assumption in South Africa that vine productivity declines predictably after 20 years. Evidence suggests that improvements in pruning systems, enhanced disease-prevention strategies, and the implementation of the PlantSA plant improvement program, particularly the reduction of virus-infected propagation material, have collectively increased vine longevity and sustained yield potential.

This study underscores the need to re-evaluate age-based assumptions in vineyard management. A more holistic framework, integrating plant health, disease status, and economic viability, rather than vine age should guide decisions on vineyard renewal to support the environmental and economic sustainability of the South African wine sector.

Keywords: Landscape, Age Distribution, Pruning, South Africa Wine Grape

Introduction

The long-term sustainability and productivity of the wine industry depend fundamentally on maintaining a robust core of healthy, actively producing vines. Regular vineyard renewal is essential for sustaining yield potential, mitigating disease pressure, and maintaining the economic viability of production systems. However, recent industry data indicate that South Africa's vineyard population has undergone significant structural changes over the past two decades, raising concerns about the sector's capacity to support future production [1]

The rapid expansion associated with the early-2000s red wine boom led to extensive vineyard plantings, reaching a national peak of 102,146 hectares in 2006 [2]. This growth was abruptly curtailed by the 2007–2008 global economic recession, which constrained capital investment and disrupted long-term renewal cycles in the wine sector [3]. Since then, both the rate of new plantings and the replacement of older vines have declined substantially, contributing to a notable shift in vineyard age structure. The proportion of vines exceeding the industry-recommended 20-year replacement threshold has increased, raising concerns about the resilience and productivity of the national vineyard.

Citation: Petri De Beer. The Changing Landscape of South Africa Wine Grape Age Distribution. J Envi Sci Agri Res. 2025. 3(6): 1-8.
DOI: doi.org/10.61440/JESAR.2025.v3.128

By 2024, total vineyard area had declined to 87,848 hectares, a contraction of 14,298 hectares since the 2006 peak [1]. Current projections suggest that this decline may stabilise around 80,000 hectares, although the eventual equilibrium remains uncertain [4]. What is clear is that lower replanting rates place increasing pressure on an aging vine population to sustain national production levels in a competitive global market.

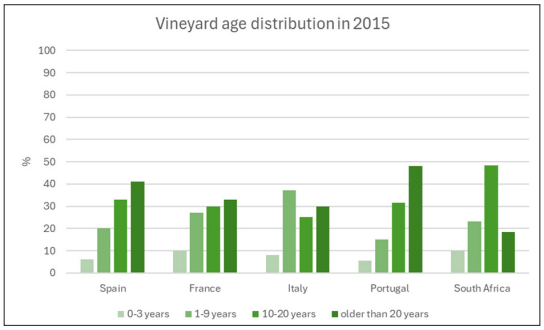
This demographic shift poses a structural challenge for the South African wine industry. While older vineyards can remain productive under certain conditions, they are generally more susceptible to yield variability, vine decline, and disease pressure [31]. As the national vineyard continues to age and contract, the sector must confront two critical questions: What is the current structural state of the vineyard population, and what strategic actions can secure long-term industry resilience?

Age Distribution in the Rest of the World

The age distribution of vineyards varies considerably across global wine-producing regions. In 2015, the most prominent wine-producing countries in Europe exhibited a distinct age profile compared to South Africa (Graph 1), with South Africa lagging approximately a decade behind Europe in terms of vineyard age distribution [5,6]. Notably, South Africa's vineyard age structure in 2023 aligned closely with the European distribution of 2015 [5,6].

Since 2015, European vineyards have undergone notable structural changes. Many traditional wine-growing regions have experienced an increase in the proportion of older vines, often maintained well beyond the conventional economic lifespan [7]. This demographic shift has been attributed to multiple factors, including reduced investment in new plantings, the adoption of sustainable viticultural practices, and economic incentives to produce premium wines from older vines [8].

Despite the relative stabilization of yields, the decline in new vineyard plantings suggests a potential reduction in vineyard hectares and total harvest volumes over the long term in Europe [9]. These trends underline the importance of understanding vineyard age distribution for both short-term production planning and long-term industry sustainability.



Graph 1: Age distribution of vines of major European wine producing countries as compared to South Africa in 2015 [9]

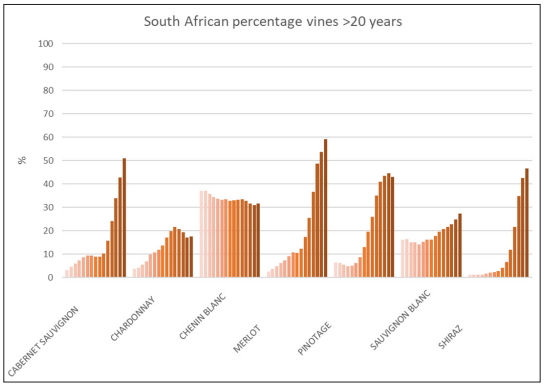
Results

As of 2023, 35.7% of the hectares under wine grape cultivation in South Africa are on vines older than 20 years. This represents a marked increase compared with 2009, when only 15.9% of vineyard hectares were on vines older than 20 years. This shift reflects a long-term trend of declining total vineyard hectares combined with decreasing rates of vine replacement [10].

Two regions in particular, Stellenbosch and Breedekloof, serve as representative zones for analysing broader national patterns in this study. Stellenbosch typifies the coastal, bottled-wine-oriented production model, whereas Breedekloof exemplifies interior, irrigated high-yield production.

An analysis of the age distribution among the seven most economically important cultivars show a disproportionate burden on red grape cultivars (Graph 2). The red vines planted during the early-2000s wine boom are, in many cases, now surpassing the conventional 20-year economic lifespan and remain largely unreplaced [11]. Conversely, many white cultivars (for example Chenin Blanc and Chardonnay) exhibit more favourable age distributions, suggesting more recent replanting or retention of younger blocks [10].

This differential age-profile shift among cultivars correlates with broader market dynamics. In recent years, global and domestic demand for white wine has been more stable compared to red, while red-wine demand has softened a pattern that is beginning to reflect in replanting and renewal strategies within South Africa's wine industry [4].



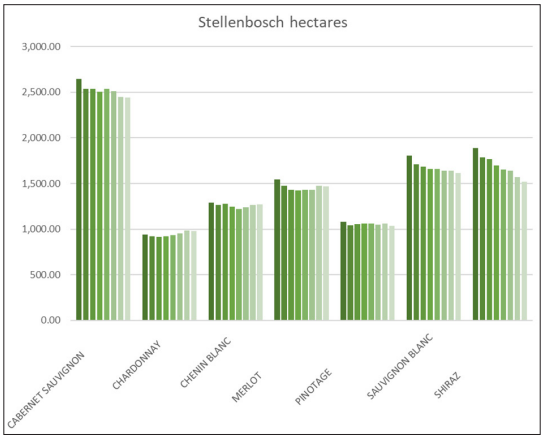
Graph 2: Age distribution of seven cultivars in South Africa from 2010-2023 [30]

Analysis of the two representative production regions, Stellenbosch and Breedekloof, demonstrates that Stellenbosch has closely mirrored the national trajectory of declining vineyard area over the past decade as seen in Graph 2 (Graph 3). As observed at the national scale, this decline has not occurred uniformly across cultivars. Instead, the contraction in Stellenbosch has been disproportionately concentrated in red wine cultivars, with Cabernet Sauvignon and Shiraz exhibiting the most pronounced reductions in planted hectares [10,32].

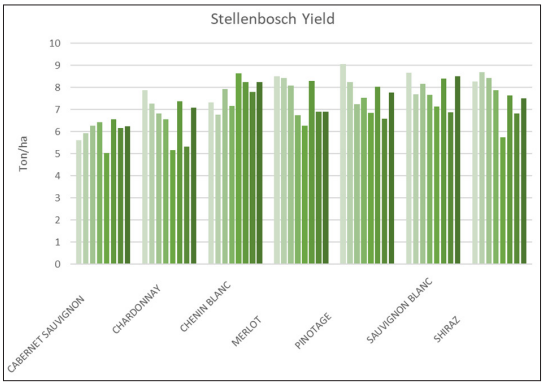
This pattern is corroborated by age-distribution data, which show that the proportion of red-wine vineyards older than 20 years in Stellenbosch has doubled between 2015 and 2022 (Graph 5). Given the historical guideline that South African wine grape vines reach the end of their economic lifespan at approximately 20 years, largely due to cumulative disease pressure, particularly from grapevine leafroll-associated virus (GLRaV), this ageing trend is of considerable significance [13,14].

Despite these structural changes, the yield per hectare in Stellenbosch presents a notable exception to expected industry dynamics. As shown in Graph 4, yields have remained relatively stable when seasonal variability is taken into account. Average yields have declined by only 5.8% over the study period, even as the proportion of vines older than 20 years increased from 24.7% in 2015 to 53.6% in 2022. This suggests that additional factors, such as improved canopy management, targeted disease mitigation strategies, optimized irrigation regimes, and more resilient clonal and rootstock material—may be contributing to yield stability despite an ageing vineyard base [15,16].

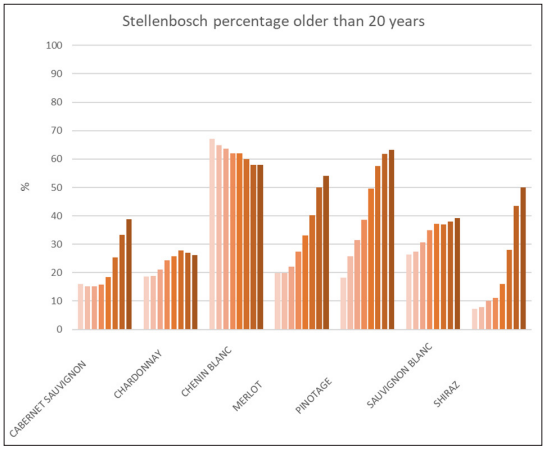
Historically, the South African wine industry has associated vine age beyond 20 years with sharp yield declines, a view reinforced by the established relationship between GLRaV infection, reduced carbohydrate allocation, and diminished berry set and ripening potential [17-19]. Consequently, the 20-year replacement benchmark became a de facto economic standard. The observed yield stability in the presence of an increasingly older vineyard population challenges this convention and indicates the need to re-evaluate assumptions regarding vine lifespan.



Graph 3: The change in Hectares in Stellenbosch from 2015-2022 (SAWIS)



Graph 4: The average yield for seven cultivars in Stellenbosch from 2015-2022 (SAWIS)

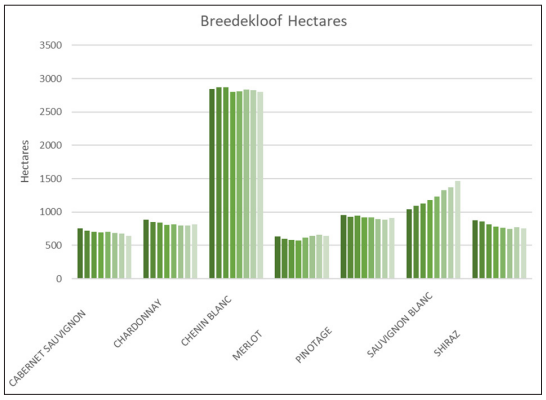


Graph 5: The age distribution of seven cultivars for vines older than 20 years in the Stellenbosch region from 2015-2022 (SAWIS)

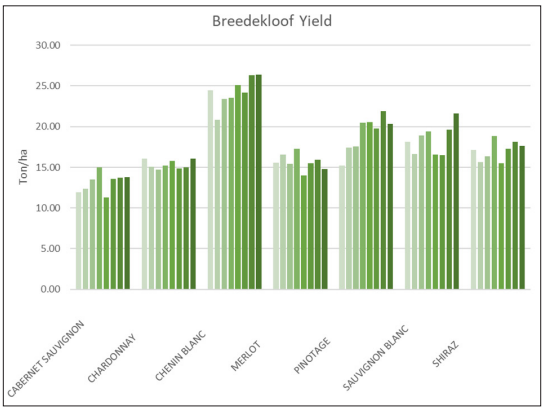
The trends observed in Stellenbosch are not unique to coastal production areas. The Breedekloof wine region, characterised by its strong reliance on high yields to maintain economic viability, demonstrates its own distinctive yet parallel trajectory. Unlike Stellenbosch, Breedekloof recorded a slight increase in total vineyard area between 2015 and 2022 (Graph 6). Traditionally, regions dependent on high yields face greater economic pressure when vineyards exceed 20 years of age, due to the historically documented decline in productivity associated with ageing vines [13,18].

Despite its ageing vineyard profile, yields have increased across all measured cultivars except Merlot during the 2015–2022 period, once seasonal variability is accounted for (Graph 7).

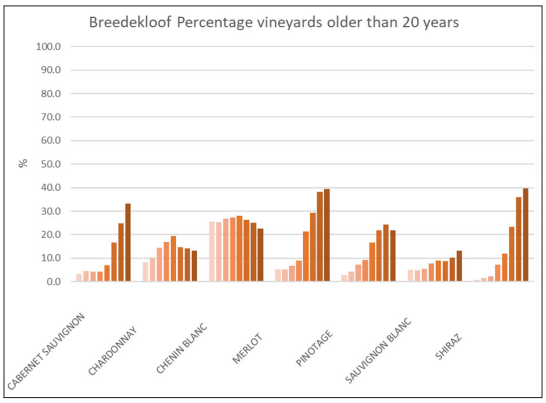
These yield improvements occur in parallel with significant ageing of the region's vineyard base. As in Stellenbosch, five of the seven economically important cultivars in Breedekloof have experienced a doubling in the proportion of vineyards older than 20 years between 2015 and 2022 (Graph 8). The simultaneous increase in both vine age and yield suggests that mitigating factors, may be offsetting the traditionally negative effects that ageing vines experience due to these factors [15,14].



Graph 6: Hectares of seven cultivars in the Breedekloof region from 2015-2022 (SAWIS)



Graph 7: The average yield of seven cultivars in the Breedekloof region 2015-2022 (SAWIS).



Graph 8: Percentage of vines older than 20 years in the Breedekloof region from 2015-2022 (SAWIS)

Historically, the South African wine industry has operated under the assumption that grapevines older than 20 years exhibit a natural decline in productivity, necessitating their replacement to maintain economically viable yields and so most models were setup around this timeframe. However, the empirical trends observed in the Stellenbosch and Breedekloof regions challenge this long-held belief and align with a growing body of international research suggesting that older vines are capable of sustained productivity under appropriate management conditions [20,21].

The shifts in yield patterns have become particularly evident over the past two decades, a relatively short period when considered against the long biological and economic cycles of viticulture.

Economic drivers further influence vineyard retention decisions. Increased demand for premium wines, particularly in coastal regions such as Stellenbosch, has strengthened the perceived value of old-vine fruit, based on the widespread belief that older vines can produce grapes with superior chemical and sensory attributes. Although this premium-driven incentive is less relevant in high-production regions such as Breedekloof, these areas have nonetheless shown a marked improvement in the yields of older vines, suggesting that productivity-driven incentives also support their retention.

South Africa's historically young vineyard age structure that limited scientific research focused on vines older than 20 years until recently [12,6]. Prior to the establishment of the Old Vine Project in 2016, knowledge regarding the performance and management of older vines was largely based on anecdotal observations circulated among growers.

For this study, vineyard data from 2018 to 2024 were analysed. Vineyards were included only if they were at least 20 years old in 2018 and had four consecutive years of complete yield and vineyard information. This resulted in a dataset comprising 460 vineyards in Stellenbosch and 297 in Breedekloof, with ages ranging from 20 to 50 years. Although disease status could not be controlled directly, the large sample size helps to mitigate potential bias from virus-affected or otherwise compromised vineyards [22,23]. Linear regression analyses were conducted to evaluate the relationship between vine age and yield across the full dataset and for major cultivars within each region.

The results (Table 1) reveal no statistically meaningful decline in yield with increasing vine age for vineyards older than 20 years. Across Stellenbosch and Breedekloof, vine age explains only 1–6% of overall yield variation. There was also cultivar specific regression done to eliminate any cultivar variance that might occur between different cultivars. Cultivar-specific regressions for cultivars with sufficient representative vineyards similarly show weak explanatory power, with age accounting for only 10–26% of variation in Chenin Blanc, Sauvignon Blanc, and Colombar. These findings are consistent with studies in California, where older Zinfandel vines showed no significant yield decline compared with younger vines, and in some cases produced higher yields under water-limited conditions due to deeper, more extensive root systems [20].

Economic benchmarking data from the 2024 VINPRO Production Plan Study further indicate that older vines remain financially viable in many cases: 53.7% of Stellenbosch vineyards and 64% of Breedekloof vineyards over 20 years old achieved break-even or better [12]. Notably, profitability in Breedekloof, an irrigated, high-production region focused primarily on bulk wine, cannot be attributed to premium old-vine pricing but instead to the maintenance of sufficient yields. In contrast, Stellenbosch benefits from both adequate yield and value-added premiums associated with bottled old-vine wines [12,8].

Table 1: Regressions of the correlation between age and yield for vines older than 20 years for two cultivars in each in the Stellenbosch and Breedekloof wine of origin areas [12]

n		R^2	Coefficiant (in tons/ha)	P value
460	Stellenbosch all vines older than 20 years	0.06	-0.111497003	0.008953
297	Breedekloof all vines older than 20 years	0.01	0.009530222	0.310628
62	Stellenbosch Chenin Blanc	0.10	-0.133365711	0.104635
56	Breedekloof Chenin Blanc	0.26	-0.42966953	0.05876

88	Stellenbosch Sauvignon Blanc	0.11	-0.09007119	0.205647
53	Breedekloof Colombar	0.14	-0.288969627	0.149403

Discussion

Discussion groups were put together with industry experts to discuss the results, and two contact sessions with specialists in viticulture and plant production were held. These sessions, which included technical representatives from PlantSA and experts from leading viticultural organisations, provided valuable practitioner insight and helped contextualise the empirical trends observed in the dataset. From these interactions, two significant factors emerged as key contributors to the increased longevity observed in South African vineyards:

- the adoption of improved pruning techniques,
- the expanded implementation of the PlantSA plant improvement scheme.

The experts highlighted that improved pruning techniques have been instrumental in reducing trunk wound exposure, limiting fungal infection, and enhancing vascular continuity, all of which have direct implications for long-term vine health and productive lifespan. These observations align with the broader scientific literature, which confirms that pruning wound management and pruning architecture are among the strongest determinants of grapevine longevity and resilience [24,25]. In parallel, the PlantSA plant improvement program, implemented and refined over the past two decades, has played a critical role in supplying disease-free planting material and promoting rigorous phytosanitary standards. The combination of improved pruning and cleaner propagation material has therefore contributed substantially to extending vineyard lifespan across multiple South African wine regions.

Pruning

Improved pruning methods and structured training programs offer a range of positive effects, including reduced disease incidence, enhanced vine balance, and improved longevity. The relationship between decreased vine vigour and subsequent vine mortality, along with the impact and efficacy of management practices on vine health, has been well demonstrated [24]. These findings align with global research showing that pruning-induced wounds are major infection courts for grapevine trunk diseases (GTDs), particularly Eutypa lata, Phaeomoniella chlamydospora, and Botryosphaeriaceae pathogens [25,26]. By minimising large pruning wounds, which serve as primary entry points for pathogenic fungi, the occurrence and progression of GTDs is significantly reduced.

Improved vine health is another well-documented benefit. Maintaining the continuity of the vascular flow allows vines to better transport water and nutrients, leading to improved canopy development, balanced vigour, and more consistent fruit set [28]. These physiological improvements are especially important for older vineyards, where the structural integrity of permanent wood plays a major role in determining ongoing productivity.

One of the major international drivers of enhancing and adapting pruning techniques for older vineyards is the work of Simonit & Sirch. Their systematised physiological pruning approach, widely adopted in Europe and increasingly in New World wine industries, is now recognised as a benchmark for trunk-preserving pruning architecture. In South Africa, the Old Vine Project, under the leadership of Rosa Kruger, has embraced the Simonit & Sirch methodology, significantly improving industry understanding and training around pruning older vines and preserving vascular continuity.

The Simonit & Sirch Method protects older vines from disease by focusing on precision and minimal invasiveness. By avoiding large cuts and preserving the natural flow of sap through permanent structures, the method reduces infection risk and promotes wound occlusion. This is particularly important for older vines, which accumulate pruning wounds and structural stress over decades, increasing their vulnerability to trunk pathogens [24].

According to findings presented by Richard Danko, adherence to the Simonit & Sirch methodology has led to a 60% decrease in stunted and wild shoots, a fourfold increase in sprouted buds, and a doubling of cane weight. Additionally, production from these vineyards increased by 25%. These results are consistent with international observations showing that improved pruning can revitalise older vines, reduce disease progression, and stabilise yield (Songy et al., 2019) [29].

This focused adaptation of pruning and maintenance practices specifically for older vines, combined with improved wound treatments, phytosanitary measures, and winter sanitation, has enhanced vine longevity in multiple South African regions. These practices help maintain structural integrity, reduce cumulative disease burden, and enhance resilience, allowing older vines to continue producing quality fruit for longer periods.

Planting Material

PlantSA launched its plant improvement program for the South African wine industry in 2004. Prior to this initiative, planting material inspections relied primarily on visual assessments for virus detection. The main disease of concern then, as now, was grapevine leafroll-associated virus (GLRaV), which significantly reduces vigour, delays ripening, lowers anthocyanins, and reduces yield [30,19]. Although no formal statistics exist for total hectares historically infected in South Africa, Rosa Kruger, founder of the Old Vine Project, estimates that at least 70%, and possibly up to 80%, of the vineyard area was infected to some degree. This widespread infection has long been cited as a primary cause of reduced vineyard lifespan, inconsistent production, and delayed maturation.

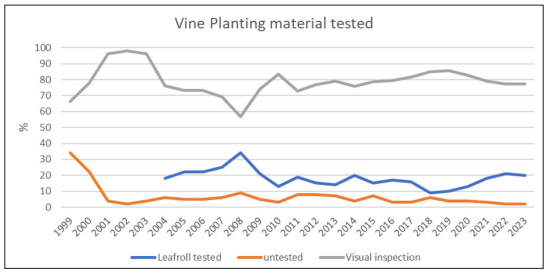
One of the key strategies for controlling leafroll virus implemented through the PlantSA plant improvement scheme has been the rigorous testing of propagation material, combined with ongoing field sanitation and rogueing programs. As illustrated in Graph 9, the proportion of planting material originating from untested sources dropped from 34% in 1999 to less than 2% in 2023. This represents a profound improvement in propagation hygiene.

These gains were further supported by decreasing testing costs, improved laboratory capacity, and greater producer awareness.

As of 2023, approximately 20% of vines provided to the industry originated from ELISA tested and confirmed virus-free material, a figure expected to rise as producers increasingly prioritise clean material. While 77% of vine cuttings were visually inspected for leafroll virus and trunk diseases. International evidence shows that starting with clean plant material dramatically increases the productive lifespan of vineyards and reduces long-term disease management costs [22,31].

These advancements have enabled older vines to maintain structural integrity and resilience, reducing virus pressure and allowing them to remain productive for longer. The focus on controlling leafroll virus and other graft-transmissible pathogens, combined with the rigorous implementation of science-based plant improvement programs, has collectively enhanced the longevity and productivity of South African vineyards.

These findings highlight the critical role of the PlantSA plant improvement program in transforming vineyard health, stabilising production, and extending vineyard lifespan through strategic disease management and improved propagation practices.



Graph 9: Percentage of vine plant material tested for viruses in material provided to the South African wine industry for propagation (PlantSA)

Economic Interplay Between New Vineyard Plantings and Old Vines

The interplay of new vineyard plantings versus older vineyards is characterised by a well-recognised inverse relationship: new vineyard plantings often decline during low-profit periods, while high-profit cycles drive replanting activity. These cycles are closely aligned with fluctuations in consumer demand for specific cultivars, input affordability, and broader economic conditions.

During low-profit cycles, the wine industry faces significant challenges in financing vineyard renewal. The economic constraints of these periods often lead producers to delay replanting decisions, opting instead to maintain aging vineyards despite rising maintenance costs and declining vigour. This tendency has been documented in international studies, where periods of sustained low grape prices result in region-wide ageing of vineyard stock [32,33]. Deferred replanting can eventually lead to a gradual decline in overall vineyard productivity and grape quality, further constraining profitability and perpetuating financial pressure.

Conversely, during high profit cycles the industry commonly experiences substantial increases in vineyard replanting. Higher margins provide producers with the flexibility to renew vineyard assets; however, global data show that replanting tends to follow broader structural shifts in the wine sector rather than short-term profitability alone. According to long-term trends, vineyard renewal and establishment cycles are driven by changing market demands, regional economic pressures, and evolving production patterns, contributing to the redistribution of vineyard area observed across traditional and emerging wine-producing regions [7]. This strategic replanting aims to capture market trends, improve vineyard uniformity, and enhance long-term profitability.

However, the economic sustainability of old vineyards introduces an important paradox. While replanting surges during high-profit cycles, older vineyards often remain economically competitive or even improve in profitability during such periods. Factors contributing to this include:

- The established reputation and quality consistency associated with older vines
- The premium pricing frequently achieved by wines labelled or marketed as originating from old vines
- The stability of yield and quality, when vines are healthy, which reduces production risk
- The debt incurred from planting old vines has now been fully repaid, alleviating the financial burden on producers.

These characteristics mirror international findings that old vineyards also generate premium value through perceptible wine quality attributes such as concentration, phenolic balance, and terroir expression [34].

Thus, the emerging narrative is one of strategic economic management, rather than simple biological inevitability. Replanting decisions are primarily driven by profitability and market preference, while the retention of older vineyards is motivated by quality, regional identity, and economic opportunity.

Overall, a dynamic but delicate balance must be maintained. A healthy wine sector requires both strategic replanting to remain competitive and the preservation of older vineyards that offer cultural, qualitative, and economic value [35-37].

Conclusion

Forecasting the future trajectory of the global wine industry remains inherently complex due to the interplay of shifting consumer preferences, economic pressures, and evolving production dynamics. Nevertheless, current international trends provide valuable insights into how consumption patterns are changing and what these shifts imply for long-term vineyard management and industry sustainability.

Globally, per capita wine consumption in traditional markets continues to decline, even as consumers demonstrate a growing willingness to spend more per bottle. This movement toward premiumization reflects a qualitative rather than quantitative approach to wine consumption. At the same time, efforts to expand into emerging markets have yielded limited success, constrained by economic, cultural and demographic differences that challenge traditional market strategies. These patterns,

combined with heightened global economic pressures, have intensified the difficulty of maintaining strong demand for entry-level wines, a segment historically crucial for sustaining large vineyard areas.

These economic realities have contributed to a reduction in vineyard hectares worldwide and, consequently, to an increase in the relative share of older vines. This demographic shift emphasizes the need to extend the productive lifespan of existing vineyards. Not only is this essential for stabilizing production volumes, but it also provides an opportunity to capitalize on the distinctive qualitative attributes commonly associated with older vines. The central challenge for producers is therefore to harness the potential advantages of older vineyards while mitigating their age-related risks.

This context underscores the need to critically reassess the definition, management and strategic role of old vines within contemporary viticulture. As demonstrated in this study, vine age alone is an unreliable predictor of productivity or economic viability. Instead, a more comprehensive framework is required, one that integrates plant health, disease status, vineyard environment and the economic realities of wine production. Such a multidimensional approach offers a more accurate basis for determining when vines should be replaced and how long they can be sustainably maintained.

Adopting this broader perspective will enable producers and industry bodies to make informed decisions that align with both short-term operational needs and long-term strategic objectives. Ultimately, integrating agronomic and economic considerations into vineyard age management will enhance the resilience, competitiveness and sustainability of the wine industry, ensuring its ability to meet evolving market demands while maintaining high standards of quality.

References

1. SAWIS. Status of Wine-Grape Vines. 2024. https://www.sawis.co.za/info/download/Wingerdstand_infographic_2024_FA.pdf.
2. SAWIS. South African Wine Industry Statistics. 2009. https://www.sawis.co.za/info/download/book_2009_web.pdf.
3. Anchor Capital. Anchor Agri View: SA wine industry's positive momentum eroded by Covid-19 and lockdowns. 2021. https://anchorcapital.co.za/local-research/anchor-agri-view-sa-wine-industrys-positive-momentum-eroded-by-covid-19-and-lockdowns/.
4. Wines of South Africa (WoSA). South African Wine Industry Statistics. 2025. https://www.wosa.co.za/sa/stats_sa_industry.php.
5. International Organisation of Vine and Wine (OIV). Grapevine Trunk Diseases: A review. Paris: OIV Publications. 2016. https://www.oiv.int/public/medias/4650/trunk-diseases-oiv-2016.pdf
6. SAWIS. South African Wine Industry Statistics. 2015. https://www.sawis.co.za/info/statistics.php.
7. Ohana-Levi N, Netzer Y. Long-term global trends in vineyard coverage and fresh grape production. Agriculture. 2023. 13: 1976.
8. Priilaid D, Steyn J. Evaluating the worth of nascent old vine cues for South African wines', International Journal of Wine Business Research. 2020. 32: 283-300.
9. OIV. State of Vitiviniculture in the World 2023. Paris: International Organisation of Vine and Wine. 2023. https://www.oiv.int/what-we-do/statistics.
10. SAWIS. Status of Wine Grape Vines – 2023 Infographic. 2023. https://www.sawis.co.za/info/statistics.php.
11. Hunter JJ, Bonnardot V. Suitability of some climatic parameters for grapevine cultivation in South Africa, with focus on key physiological processes. South African Journal of Enology and Viticulture. 2011. 32: 137-154.
12. Vinpro. Vinpro Cost Guide 2024/2025. Paarl: Vinpro. Available at: https://vinpro.co.za/wp-content/uploads/2024/06/Kostegids-2024-2025-ONLINE-converted.pdf.
13. Pietersen G, Oosthuizen T, van Rensburg A, van Rensburg M, Lottering D. Control of grapevine leafroll disease spread at a commercial wine estate in South Africa: a case study. American Journal of Enology and Viticulture. 2013. 64: 296-305.
14. Maree HJ. Grapevine leafroll-associated virus 3. Frontiers in Microbiology. 2013. 4: 82.
15. Halleen F, Fourie PH. An integrated strategy for the proactive management of grapevine trunk disease pathogen infections in grapevine nurseries. South African Journal of Enology and Viticulture. 2016. 37: 146-157.
16. Dry PR. Canopy management for fruitfulness. Australian Journal of Grape and Wine Research. 2000. 6: 109-115.
17. Montero R, Mundy D, Albright A, Grose C, Trought MC, et al. Effects of Grapevine Leafroll associated Virus 3 (GLRaV-3) and duration of infection on fruit composition and wine chemical profile of Vitis vinifera L. cv. Sauvignon blanc. Food Chemistry. 2016. 197: 1177-1183.
18. Naidu RA, Maree HJ, Burger JT. Grapevine leafroll disease and associated viruses: a unique pathosystem', Annual Review of Phytopathology. 2015. 53: 613-634.
19. Naidu R, Rowhani A, Fuchs M, Golino D, Martelli, GP. Grapevine Viruses. San Diego: Academic Press. 2015.
20. Riffle VL. Vine age affects vine performance, grape and wine chemical and sensory composition of cv. Zinfandel from California', American Journal of Enology and Viticulture. 2022. 73: 277-293.
21. Carbone A, Quici L, Pica G. The age dynamics of vineyards: Past trends affecting the future. Wine Economics and Policy. 2019. 8: 38-48.
22. Li J, Troendle J, Gómez MI, Ifft J, Golino D, et al. Returns to public investments in clean plant centers: A case study of leafroll virus-tested grapevines in support of cost-effective grape production systems. Journal of Wine Economics. 2022. 17: 209-224.
23. Industry SW. The front line of Leafroll Management, Wineland Media. 2024. https://www.wineland.co.za/the-front-line-of-leafroll-management/.
24. Eskalen A, Úrbez-Torres JR. Grapevine Trunk Diseases: Current Management Strategies. 2019.
25. Senthilkumar S, Vijayakumar RM, Soorianathasundaram K, Durga Devi D. Effect of pruning severity on vegetative, physiological, yield and quality attributes in grape (Vitis vinifera L.): a review. Current Agriculture Research Journal. 2015. 3: 42-54.

26. Bertsch C, Ramirez-Suero M, Magnin-Robert M, Larignon P, Chong J, et al. Grapevine trunk diseases: complex and still poorly understood. Plant Pathology. 2013. 62: 243-265.
27. Mondello V. Management of grapevine trunk diseases: knowledge transfer, current strategies and innovative strategies adopted in Europe. Phytopathologia Mediterranea. 2018 57: 369-383.
28. van Leeuwen C, Roby J-P, de Rességuier L. Soil-related terroir factors: a review. OENO One. 2018. 52: 173-188.
29. Danko R. Možnosti transformace pěstitelských tvarů a řezu Révy Vinné Podle Metody Simonit & Sirch. Mendel University Press. 2024. 1-67.
30. Rayapati N, O'Neil S, Walsh D. Leafroll disease impact on grapevine performance', Plant Disease. 2008. 92: 168-178.
31. Golino D. The economic impact of clean plant programs. American Journal of Enology and Viticulture. 2019. 70: 139-147.
32. FTI Consulting. Macro-economic impact of the wine industry on the South African economy. Report prepared for the South African Wine Industry Information and Systems (SAWIS). 2021.
33. Kaplan J, Travadonm R, Cooper M, Hillis V, Lubell M, et al. Identifying economic hurdles to early adoption of preventative practices: The case of trunk diseases in California winegrape vineyards', Wine Economics and Policy. 2016. 5: 127-141.
34. Van Leeuwen C, Seguin G. The concept of terroir in viticulture', Journal of Wine Research. 2006. 17: 1-10.
35. International Organisation of Vine & Wine (OIV) (n.d.) Statistic. https://www.oiv.int/what-we-do/statistics.
36. Karlsson B. South Africa: vineyard acreage shrinking, Chenin Blanc still in the lead, irrigation popular, BKWine Magazine. 2022. https://www.bkwine.com/news/south-africa-acreage-shrinking/.
37. van Leeuwen C. The Science of Terroir. Dordrecht: Springer. 2020.