

A report for:



From Challenges to Potential: The Evolution of Hokkaido's Viticulture:

**Crafting a Sustainable Future for Japan's Northern
Vineyards**

by Rikiya Ueno
2023 Nuffield Scholar

January 2025
Nuffield International Project No 2308

Supported by:



From Challenges to Potential: The Evolution of Hokkaido's Viticulture: Crafting a Sustainable Future for Japan's Northern Vineyards

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Scholar Contact Details

Rikiya Ueno

Organisation Wein Campus

Rilkestrasse 5, 67433, Neustadt an der weinstrasse

Phone: +49 155 10374571

Email: rikiya_ueno_personal@outlook.com

In submitting this report, the Scholar has agreed to Nuffield International publishing this material in its edited form.

NUFFIELD INTERNATIONAL Contact Details:

Nuffield International

Address: PO BOX 495, Kyogle, New South Wales, Australia 2474

Contact: Jodie Redcliffe

Title: Chief Executive Officer

Mobile: (+61) (0) 408 758 602

Email: jodie.redcliffe@nuffield.com.au

Executive Summary

北海道は、日本最北端の島として、冷涼な気候条件を活かしたワイン産地として国際的な注目を集めつつある。本研究は、北海道のワイン産業の発展の歴史、その独自性、直面する課題、持続可能な発展に向けた戦略を包括的に分析し、同地域が世界的なワイン産地としての地位を確立する可能性を探るものである。

北海道の冷涼な気候、少ない雨量、昼夜の寒暖差、火山由来の肥沃な土壌、長い日照時間は、ブドウ栽培に理想的な条件を提供している。また、冬季の積雪を利用したブドウ樹の保護する手法といった地域特有の技術により、ピノ・ノワールやメルローなどのヨーロッパ系品種の栽培が可能となっている。さらに、在来種であるヤマブドウを基にした交配品種「ヤマサチ」の育成は、北海道独自のワイン生産を実現しており、国内外で高い評価を得ている。

しかし、気候変動は北海道のワイン産業に対し、機会とともに多くの課題をもたらしている。気温の上昇は特定のブドウ品種の栽培を可能にする一方、熟成期間の短縮や酸度の低下といったバランスの取れたワイン生産の課題を引き起こしている。また、害虫の増加や降雨パターンの変化は農作業管理の複雑化を招いており、生産者たちは遅摘みやキャノピーマネジメント、新たな品種の試験栽培といった適応策を講じている。

加えて、労働力不足は北海道のワイン産業における深刻な課題である。特に、収穫や剪定といった労働集約的な作業において顕著であり、高コストや技術の普及不足がこの状況を悪化させている。他の海外主要産地で一般的な委託サービスが北海道では未整備であることも、産業の効率性向上を阻む要因となっている。

本研究では、ドイツ、フランス、ニュージーランドなど主要ワイン産地を訪問し、先進的な機械化技術、持続可能な農業管理、気候変動への適応戦略に関する知見を得た。ドイツの高度な機械化、ニュージーランドの労働力の対策、フランス・ブルゴーニュ地方の気候変動への対応策は、北海道が直面する課題に対する解決策を示唆している。

結論として、北海道のワイン産業が直面する課題を解決するためには、地域特性を活かした革新的な技術や国際的な協力の導入が不可欠である。本研究は、北海道が高品質なワイン生産を通じて世界市場で競争力を高める可能性を示すとともに、その実現には地域社会の協力と持続可能性を重視した包括的戦略が必要であることを強調する。

Hokkaido, Japan's northernmost island, has emerged as a key region in the nation's wine industry, gaining recognition for its cool-climate viticulture and high-quality wine production. This study explores the evolution of Hokkaido's wine industry, its unique practices, challenges, and strategies for sustainable growth, highlighting its potential to become a globally recognized wine region.

Hokkaido's cool climate, mineral-rich volcanic soils, and long daylight hours provide ideal conditions for grape cultivation. These factors, combined with innovative practices like snow burial for winter vine protection, have enabled the successful production of European grape varieties such as Pinot Noir and Merlot. Additionally, native hybrid varieties like Yamasachi

have been developed to reflect the region's unique terroir, contributing to its distinct winemaking identity.

Climate change has had both positive and negative impacts on Hokkaido's viticulture. Warmer temperatures have extended the growing season, facilitating the cultivation of noble grape varieties, but accelerated ripening has challenged the production of balanced wines. Increased pest and disease pressures, coupled with erratic rainfall, have further complicated vineyard management. Despite these challenges, Hokkaido's growers have demonstrated adaptability through late pruning, canopy management, and experimentation with new grape varieties.

Labor shortages represent a significant bottleneck, particularly for tasks like harvesting and pruning. High costs and limited access to advanced vineyard technologies exacerbate this issue, hindering mechanization adoption. The absence of vineyard contracting services, common in other wine regions, highlights an untapped opportunity to enhance efficiency and address labor demands.

International research provided valuable insights into potential solutions. Visits to Germany, France, New Zealand, and other wine regions revealed practices like advanced mechanization, sustainability-focused vineyard management, and climate adaptation strategies. Germany's efficient vineyard technologies, New Zealand's regenerative viticulture, and Burgundy's innovations for coping with climate change offer actionable ideas for Hokkaido's wine industry.

This study emphasizes the importance of leadership, collaboration, and innovation in addressing Hokkaido's challenges and capitalizing on its strengths. By adopting labour-saving technologies, promoting contracting services, and bridging knowledge gaps through international partnerships, the region can elevate its standing in the global wine market.

With its distinctive terroir, innovative practices, and commitment to quality, Hokkaido is poised to become a leading wine region. By balancing tradition with innovation, it can navigate the complexities of climate change and industry dynamics, achieving sustainable growth and international recognition.

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Foreword

It's a story rooted in my upbringing on a small family crop farm in northern Hokkaido, Japan, where I was born as the eldest son. Surrounded by crops, farming has been a constant part of my life.

Our farm spans around 35 hectares, cultivating rice, seed potatoes, wheat, soybeans, sugar beets, and asparagus. In earlier years, before we expanded, our farm also grew a variety of vegetables, which were more profitable than staple crops. My father's philosophy was to diversify—to spread risk and balance the workload across multiple crops and vegetables. While I didn't fully understand the importance of diversification as a child, my perspective changed as I became more involved in agriculture over the years.

The idea of diversification eventually led me to viticulture, though this insight came much later. Growing up, Hokkaido's winters brought deep snow, forcing most crop farms to close for the season. Farmers typically took on seasonal jobs such as clearing snow from highways and train tracks. In my mid-20s, I chose a different path, embarking on a working holiday in Australia, where the seasons were opposite to Japan's.

Over three seasons in Australia, I worked on various crop farms—tomatoes, potatoes, and cereals—as a tractor driver. Back then, I was a typical beer drinker, but during my stay, I was introduced to local wines, which sparked my interest. Toward the end of my time in Australia, I visited the Yarra Valley and its stunning wineries. The beauty and allure of the place planted a seed in my mind: viticulture and winemaking as another form of agriculture.

Upon returning to Japan, I began exploring the world of wine. My curiosity led me to a working holiday in Germany and later in New Zealand, where I gained firsthand experience in vineyards and wineries. These experiences solidified my passion and ambition.

Now, I am pursuing a master's degree in Viticulture and Enology at the Weincampus in Germany. My goal is to prepare myself to introduce grape growing and winemaking to my home in Hokkaido. This endeavour represents both a continuation of my family's farming heritage and a new chapter of diversification, inspired by my global journey.

Acknowledgments

I would like to express my heartfelt gratitude to the Nuffield Scholarship Program for providing me with this invaluable experience that has enriched my life.

I extend special thanks to:

- My family, for their unwavering support and for taking care of our farm during my travels.
- All the members of Nuffield Japan and Nuffield International, for welcoming me into the Nuffield family and supporting me throughout the two-year program.
- Norinchukin Bank, for their generous sponsorship.
- The incredible people who graciously hosted me during my visits.

Lastly, I would like to give my deepest thanks to Nuffield CEO, Mr. Maeda, who introduced me to the Nuffield program. His encouragement and inspiration have been invaluable since the day we met.

Abbreviations

AOC	Appellation d'Origine Contrôlée
DRL	Die Dienstleistungszentren Ländlicher Raum
FAO	Food and Agriculture Organization
IoT	Information of Technology
OIV	International Organisation of Vine and Wine (Organisation Internationale de la Vigne et du Vin)
SWNZ	Sustainable Winegrowing New Zealand

Objectives

Exploring the Challenges Faced by Grape Producers in Hokkaido

The primary objective of this study is to investigate and understand the key challenges faced by grape producers in Hokkaido. By identifying and analysing these challenges, the study aims to provide actionable insights and recommendations to support the sustainable growth and development of the region's wine industry. The specific objectives are as follows

1.Understanding and Adapting to Climate Change

Investigating the dual effects of climate change on Hokkaido's viticulture, including opportunities for new grape varieties and challenges such as shifting growth patterns, increased pest pressure, and extreme weather events.

2.Labor Management and Mechanization

Analysing the critical labour shortages faced by Hokkaido vineyards and exploring solutions such as mechanization, regional contractor models, and innovative tools to enhance efficiency and reduce manual labour dependency.

3.Quality Management and Regional Identity

Identifying practices to maintain and improve grape quality under evolving climatic and agricultural conditions, while developing a distinct identity for Hokkaido wines through education, innovation, and adherence to high standards.

Chapter 1: Introduction

Japanese winemaking has experienced remarkable growth over the years, with its origins rooted in Yamanashi Prefecture, where viticulture began during the Meiji era (JapanWine, 2021). Early winemakers in Yamanashi faced significant challenges, including selecting suitable grape varieties and refining winemaking techniques (Shizuku, 2024). Through decades of experimentation and perseverance, they eventually mastered the cultivation of *Vitis vinifera*, the grape species commonly used in high-quality wine production. Japanese breeders have also succeeded in breeding original hybrid grape varieties tailored to the local climate, with some gaining international recognition and registration with the International Organisation of Vine and Wine (OIV) (Japan Wine, 2021).

Hokkaido's journey into winemaking began in the 1960s in the Tokachi region, where local wild grape varieties were initially used. By the 1980s, Yoichi, another key area, emerged as a significant wine region. Originally, Yoichi's vineyards were primarily focused on exporting wine grapes to the main island (Municipal Employees' Labor Union, N/D). However, the effects of climate change and a growing interest in cold-climate viticulture transformed Hokkaido into an attractive destination for winemakers. Today, it stands as Japan's second-largest grape-producing region after Yamanashi.

Recent years, Hokkaido's wine industry has gained international recognition, with some producers earning awards at prestigious global wine competitions. These accolades have drawn the attention of the international wine community, further cementing Hokkaido's reputation as an emerging force in high-quality winemaking. This growing recognition is paving the way for stronger ties with the global wine industry and positioning Hokkaido as a region to watch in the world of viticulture.

High-quality grapes are the cornerstone of producing exceptional wine. As Hokkaido strengthens its position in the Japanese wine industry, advancements in viticultural practices and the consistent production of stable, high-quality grapes will play a crucial role in its progress toward becoming a premier wine region.

This study examines the challenges grape producers in Hokkaido face and explores future strategies to support the region's growth. Drawing from the author's Nuffield travel experience, the analysis provides insights into how Hokkaido can address these challenges, leverage its unique climate, and solidify its standing in Japan's wine industry. By focusing on innovation and quality, Hokkaido aims to elevate its reputation and achieve recognition as a leading wine region.

Chapter 2: Introduction of Viticulture in Hokkaido

2.1 Historical Development

Hokkaido has become a key player in Japan's wine industry, producing approximately one-third of the nation's grapes by weight. Over the past six decades, winemaking on the island has flourished, with 71 wineries now (October, 2024) established across the region. Due to its cold and snowy environment, early vineyards focused on cultivating cold-hardy grape hybrids, which laid the foundation for its wine industry (Japan Kuru, 2021).

Hokkaido's journey into viticulture began in 1876 with the establishment of the Kaitakushi Winery in Sapporo. However, it wasn't until the 1960s, with the introduction of Tokachi Wine in Ikeda Town, that significant progress was made in modern winemaking (Cataldo, 2023.). The late 20th century marked a period of rapid growth, as pioneering wineries began establishing vineyards in the Sorachi and Shiribeshi subregions. Today, areas such as Yoichi and Furano have become synonymous with high-quality wine production, solidifying Hokkaido's reputation as a key wine region in Japan (Hokkaido University, 2022.).



Figure 1 Japan wine region (Japan wine trading, Regions of Japan: <https://iapanwines.global/ja/about-iapan-wine/>)

2.2 Historical Background

Early Experiments (1960s-1970s)

Winemaking in Hokkaido began in earnest during the 1960s with initiatives like the Tokachi Wine Project in Ikeda Town. This project focused on cultivating grape varieties suitable for cold climates, partnering with local farmers to promote grape cultivation. Varieties like Kiyomai and Yamasachi, bred from native Japanese mountain grapes, were introduced to adapt to Hokkaido's unique environmental challenges. (Yasui, 2019)

In 1975 (Showa 50), the Hokkaido Central Agricultural Experiment Station conducted a survey to identify grape varieties suitable for winemaking in Hokkaido. This research focused on selecting optimal varieties for cold climates, leading to the designation of "semi-recommended varieties" such as Kerner and Müller-Thurgau. (Osamura, 2024)

Government Support and Expansion (1970s-1980s)

Recognizing the potential for economic diversification, the Hokkaido government, along with local towns like Yoichi and Ikeda, began offering financial support, research funding, and incentives for farmers to plant vineyards. The town of Ikeda notably pioneered the Tokachi Wine Project in the 1970s, marking one of Japan's first large-scale wine production initiatives in a cold region.

Development of Sorachi and Shiribeshi (1990s)

By the 1990s, Sorachi and Shiribeshi emerged as key sub-regions within Hokkaido due to

their ideal conditions for grape growing. In the late 1970s, as prices for apples and grapes declined, Yoichi in Shiribeshi sought economic alternatives. Local cooperatives and farmers began exploring wine grape cultivation, guided by Shiro Ogano, a local agricultural researcher who cultivated over 100 varieties and advised farmers for over two decades. (Yoichi Town Municipal Employees' Labor Union, N/A)

In 1983, Sapporo Wine provided 600 grape seedlings to Yoichi farmers, leading to contracts with wineries from Hokkaido and Honshu. Initially focusing on government-recommended varieties, Yoichi later embraced Kerner grapes, which became a hallmark of the region's wines. (Yoichi Town Municipal Employees' Labor Union, N/D) Today, Yoichi is Hokkaido's leading wine grape producer, recognized nationally for quality grapes supplied to wineries across Japan.

Rise of the Wine Academy, Hokkaido Wine Platform, and Laboratory for Nouvelle Vague of Hokkaido (2000s-2010s)

In the early 2000s, the establishment of the Hokkaido Wine Academy marked a pivotal moment for the region's wine industry. Founded to foster local expertise, the academy offered specialized training in viticulture, winemaking, and wine tourism. By equipping local farmers and winemakers with advanced knowledge, the academy played a significant role in raising the overall quality of Hokkaido wines. Its graduates have gone on to lead some of the most successful wineries in the region, contributing to the industry's rapid growth. (Hokkaido University, 2023)

The Hokkaido Wine Platform, launched in 2022, further enhanced collaboration within the industry. This initiative brought together wineries, grape growers, researchers, and government agencies to address challenges such as sustainability, climate adaptation, and market expansion. The platform also promoted the branding of Hokkaido wines, emphasizing the region's unique terroir and high-quality production standards. (Sustainable Terroir Hokkaido)

In April 2021, the Hokkaido Wine Nouvelle Vague Laboratory was established to provide an interdisciplinary space for exploring a wide range of topics, including wine, agriculture, food, marketing, and town development. This innovative laboratory also supports Hokkaido Sustainable Wine Studies, a unique course at Hokkaido University open to all graduate students. The course integrates sustainability principles with wine studies, preparing students to tackle challenges in viticulture, winemaking, and regional development while contributing to the growth of Hokkaido's wine industry. (Hokkaido University,2022)

In 2022, the Centre of Education and Research for Hokkaido Wines was launched to further strengthen research and education. This centre serves as a comprehensive hub for wine studies, building on the contributions of the Hokkaido Wine Nouvelle Vague Laboratory to elevate winemaking standards and innovation in the region. (Hokkaido University, 2023)

2.3 Economic and Tourism Impact

Hokkaido's prominence in wine production is closely tied to its vast agricultural land, which has encouraged large-scale vineyard cultivation. Known for its high-quality agricultural output, the region has successfully extended its expertise to the wine industry.

Tourism also has the potential to play a pivotal role in Hokkaido's wine success. The proximity of wine regions like Yoichi and Furano to internationally renowned ski resorts creates an excellent opportunity for wine tourism. Additionally, Hokkaido's appeal as a summer vacation and "coolcation" retreat enhances its attractiveness. However, despite these advantages, wine tourism in Hokkaido remains largely untapped. This growing interest from domestic and international tourists has driven infrastructure development, strengthening local

wineries and solidifying Hokkaido's status as a premier wine tourism destination (Sustainable Japan, 2023).

2.4 Recognition and Future Potential

Hokkaido's wines have gained increasing recognition both in Japan and internationally. In 2018, the region was officially designated as a wine-producing area by Japan's National Tax Agency, allowing wines meeting strict quality standards to carry the prestigious "Hokkaido" label. This designation has significantly boosted the region's reputation for producing boutique, high-quality wines (Wines of Hokkaido, 2022).

As Hokkaido continues to evolve, it is carving out a distinct identity within Japan's burgeoning wine industry. From its agricultural heritage and innovative viticultural practices to its commitment to quality, Hokkaido remains a key player in the global wine community. By combining tourism appeal with agricultural excellence, it is not only thriving as a wine region but also cementing its status as a trusted brand in Japan's food and beverage sector.

2.5 Geography and Climate

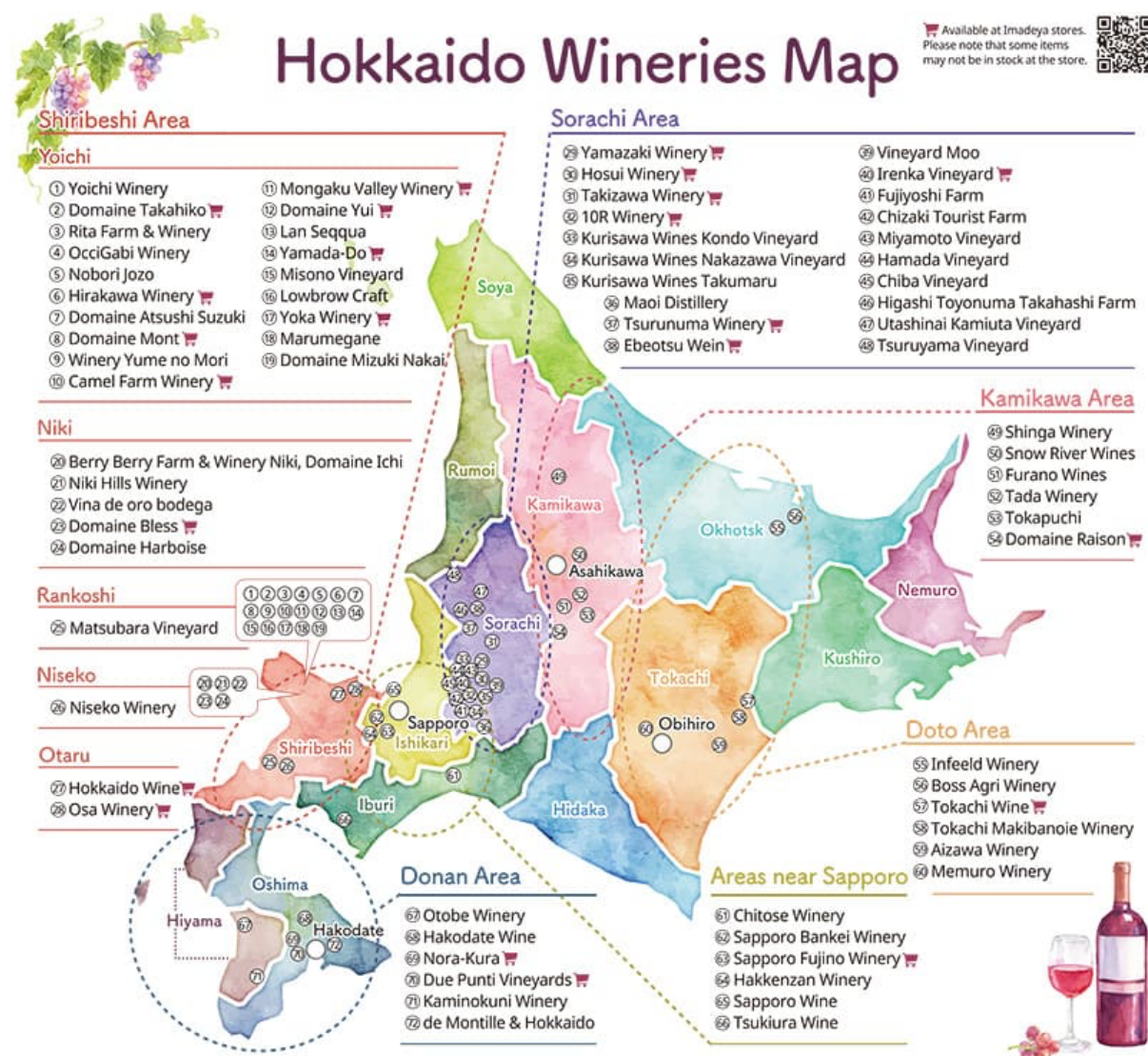


Figure 2 Hokkaido Wineries Map (Sustainable Japan, Hokkaido's terroir crafts Japan's next great wines(2024)). Resorce; <https://sustainable.japantimes.com/satoyama/140>

Climate: A Cool-Climate Paradise for Grapevines

According to the Köppen climate classification, Hokkaido's climate is predominantly humid continental, with parts of the southern coast exhibiting oceanic or humid subtropical characteristics. The island experiences significant seasonal temperature variations, with frosty winters and heavy snowfall in some regions, while summers are mild and less humid than southern Japan. In August, average temperatures hover around 20°C, with long daylight hours that encourage slow and even grape ripening.

Soil: The Foundation of Hokkaido's Terroir

Hokkaido's soils, shaped by its volcanic history, are diverse and well-suited for viticulture. These mineral-rich soils provide excellent drainage, essential for high-quality grape cultivation. Around 30% of Hokkaido's soil has volcanic origins, contributing to the unique flavor profile of its wines.

Yoichi: Maritime Climate and Mineral-Rich Volcanic Soils

Located on the western coast near the Sea of Japan, Yoichi features volcanic clay mixed with gravel and sand atop andesite parent rock, which ensures superior drainage. This combination produces wines with complex minerality and structure, particularly in varieties like Pinot Noir and Kerner.

Takahiko Soga, one of Japan's top Pinot Noir producers, highlights the unique connection between Japan's volcanic soil and its culinary heritage. "In regions like Burgundy, where the soil is limestone-based and the water is hard, dashi doesn't naturally emerge," Soga explains. "But in Japan, the volcanic soil and soft water give wines a richness and balance that reflect our culinary traditions" (*The Cellar, 2021*).

Sorachi: Continental Climate and Volcanic Influence

Furano

Located in the southern part of Kamikawa, in central Hokkaido, Furano features a continental climate with a mix of soil types. While the lower-altitude areas are characterized by infertile tuffaceous gravel the upper-altitude regions contain more fertile soils, enriched by volcanic ash deposits. These upper-altitude soils provide better nutrient availability, supporting balanced vine growth and producing wines with refined complexity and minerality.

Mikasa, Iwamizawa, Naganuma

Situated in south-central Sorachi at the eastern edge of the Ishikari Plain, these areas share a latitude with Bordeaux, France. The region combines the influences of the Sea of Japan's coastal climate and inland continental climate, which supports a variety of viticultural practices.

At higher altitudes, the soils are more fertile due to increased organic matter and volcanic ash content, which enhances vine health and grape quality. In contrast, the lower-altitude soils remain clayey, nutrient-poor, and weakly acidic, with shale and sandstone compositions, creating a diverse terroir that yields wines with both intensity and balance.

Hakodate: Coastal Alluvial and Volcanic Mix

At the southern tip of Hokkaido, Hakodate benefits from volcanic and alluvial soils and the moderating influence of the Tsugaru Strait. The region experiences less snowfall and milder winters compared to other parts of Hokkaido, providing a stable environment for vine safety. These conditions result in wines with crisp acidity and clean fruit expression, reflecting its maritime-influenced terroir.

Climate and Soil Synergy: The Key to Hokkaido's Wine Quality

- **Slow Ripening:** Cooler temperatures and long daylight hours allow grapes to develop intense aromas and balanced acidity. sugar-acid balance and aromatic intensity in grapes.
- **Diurnal Temperature Variation:** Large day-night temperature differences enhance the development of complex flavors, balanced acidity, and aromatic intensity in grapes.
- **Distinctive Soil Profiles:** Volcanic and alluvial soils impart depth, freshness, and minerality to the wines.

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- **Lower Summer Humidity:** Reduces disease pressure, crucial for cool-climate varieties.
- **Snowpack Insulation:** Protects vines from extreme winter temperatures, ensuring survival in sub-zero conditions.

Rain fall and humidity in Hokkaido wine regions

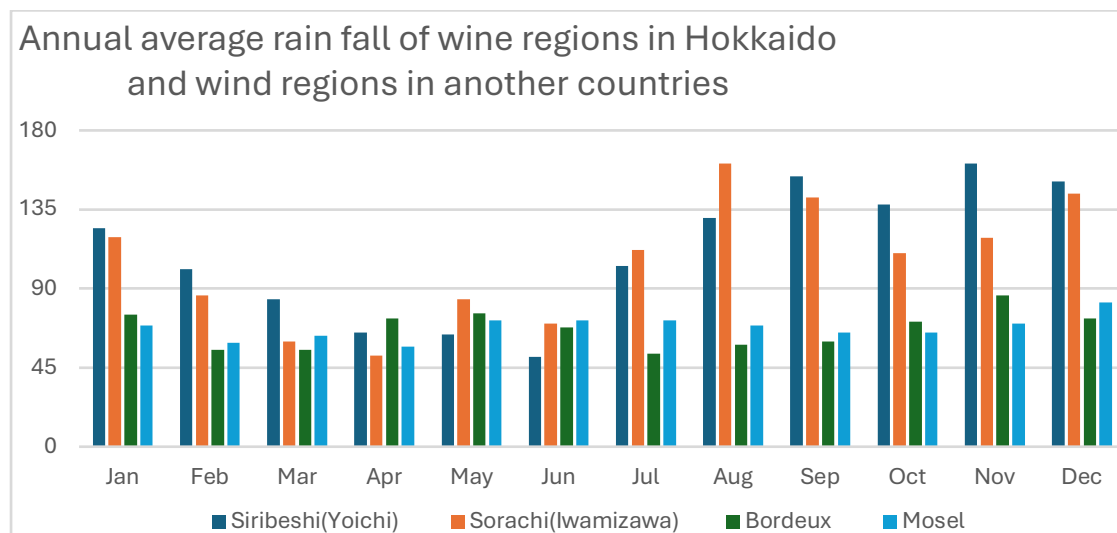


Table 1 First Chart (Rainfall): "Comparison of Annual Average Rainfall in Wine Regions: Siribeshiyoichi, Sorachiwamizawa (Hokkaido), Bordeaux, and Mosel (1991–2021 Data from Climate-Data.org and 1991–2020 Data from Japan Meteorological Agency)

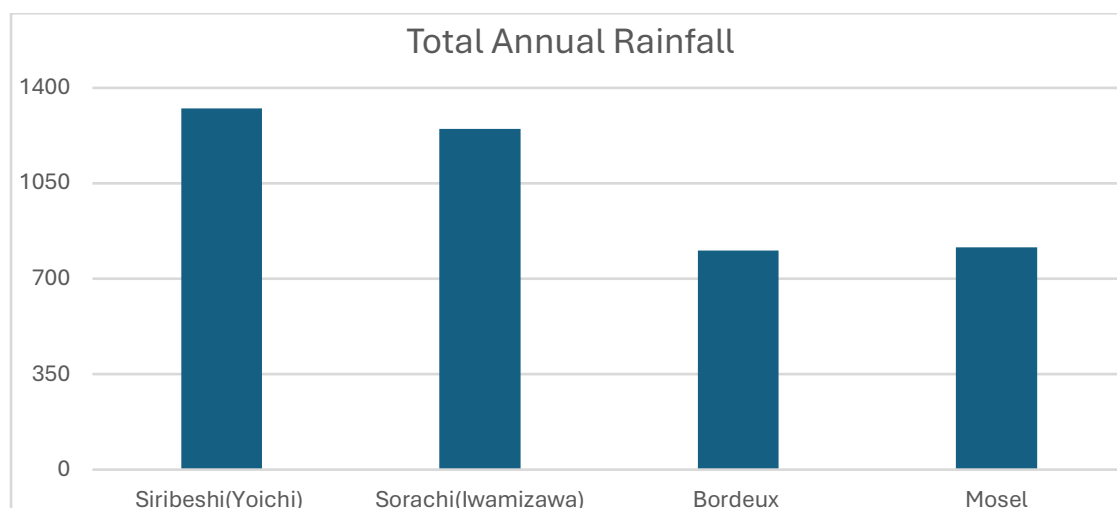


Table 2 Total Annual Rainfall in Wine Regions: Siribeshiyoichi, Sorachiwamizawa (Hokkaido), Bordeaux, and Mosel (1991–2021 Data from Climate-Data.org and 1991–2020 Data from Japan Meteorological Agency)

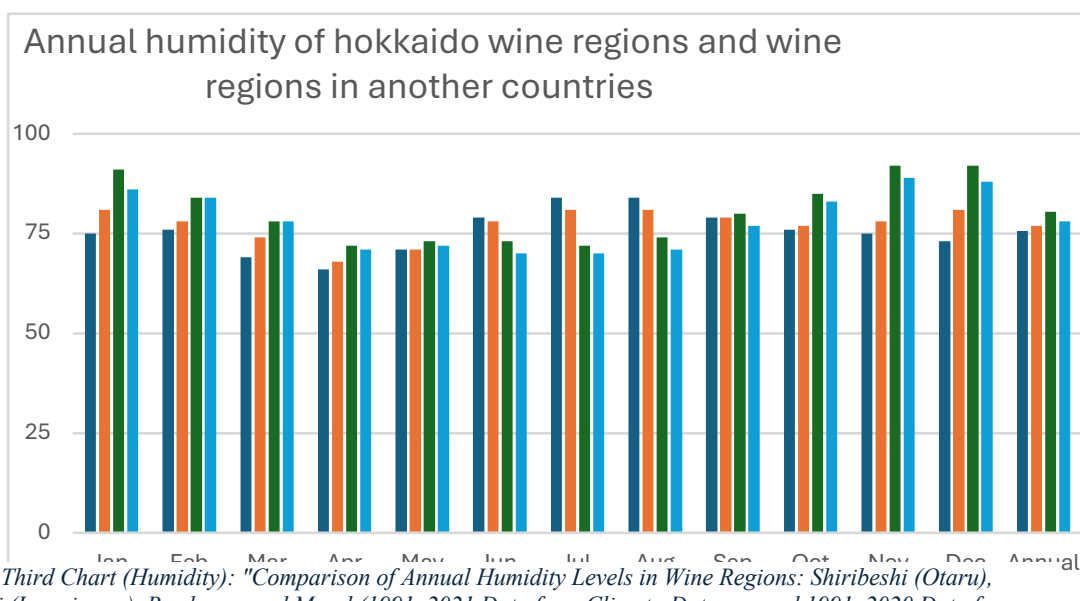


Table 3 Third Chart (Humidity): "Comparison of Annual Humidity Levels in Wine Regions: Shiribeshi (Otaru), Sorachi (Iwamizawa), Bordeaux, and Mosel (1991–2021 Data from Climate-Data.org and 1991–2020 Data from Japan Meteorological Agency)"

The wine regions of Hokkaido, including Yoichi, Iwamizawa, and Hakodate, experience annual rainfall levels ranging from 1,164 mm to 1,301 mm, which is significantly higher than major wine regions like Mosel and Bordeaux, where annual precipitation averages around 800 mm. While Hokkaido has less rainfall compared to southern Japan, it is still categorized as a relatively high-precipitation region. During the growing season (April to October), rainfall in Hokkaido's wine regions typically stays below 700 mm, offering a manageable balance for viticulture.

However, the higher precipitation levels combined with elevated summer humidity mean that the risk of diseases and pests is notably higher. These conditions are conducive to fungal diseases, such as powdery mildew and botrytis, as well as pest infestations, which pose significant challenges for vineyard management.

Hokkaido's humidity pattern is also unique: summers are more humid than in Bordeaux and Mosel, increasing disease pressure, while winters are less humid, contrasting with the consistently higher winter humidity in European wine regions. This climatic combination presents both challenges and opportunities for winemaking in Hokkaido, requiring careful vineyard practices to maintain vine health and ensure high-quality wine production.

2.5 Profile of Hokkaido viticulture

Transition of Cultivation Area and Harvest Volume

The cultivation area for winemaking grapes in Hokkaido has seen notable fluctuations over the past decade, ranging from 353.4 hectares in 2017 to a peak of 403.7 hectares in 2010. Despite some declines, the area appears to be stabilizing around 380 hectares in recent years. Correspondingly, harvest volumes have varied between 1,200 to 1,800 tons, reflecting the sensitivity of production to climatic and agricultural conditions.

- 2010 vs. 2020 Comparison: The harvest volume increased from 1,454.1 tons in 2010 to a high of 1,832.0 tons in 2020, despite the slight decrease in cultivation area. This suggests improvements in viticulture practices or higher yields per hectare.

Regional Distribution of Grape Cultivation (2020)

In 2020, Shiribeshi emerged as the largest contributor to grape production, accounting for 192.1 hectares of the total cultivation area and producing 750.2 tons of grapes. Sorachi follows, with significant contributions from importance of processing-exclusive varieties tailored to the region's unique climate and soil conditions.

Transition of Cultivation Area for Major Grape Varieties

Pinot Noir has shown consistent growth in cultivation, increasing from 16.8 hectares in 2010 to 40.1 hectares in 2020, reflecting its growing popularity and suitability to Hokkaido's cool climate. Other key red varieties such as Zweigelt and Yamasachi have remained relatively stable, while some traditional hybrid varieties, like Seibel 13053, show a slight decline, possibly due to a shift toward premium vinifera varieties.

Growth in Wineries

The number of wineries in Hokkaido has grown significantly, from 16 in 2010 to 71 in 2024, showcasing a flourishing wine culture and increasing investment in local wine production. This growth aligns with the region's focus on enhancing wine quality and expanding market presence.

Table 4 Transition of Cultivation Area and Harvest Volume for Winemaking Grapes (Exclusive Varieties). Data Source: Hokkaido Agricultural Promotion Division.) Data Source: Hokkaido Agricultural Promotion Division

Year	Area (Hectares)	Harvest Volume (Tons)
2010	403.7	1,454.1
2015	371.2	1,323.6
2016	368.0	1,429.1
2017	353.4	1,375.9
2018	363.4	1,237.7
2019	387.8	1,549.8
2020	383.1	1,832.0

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Table 5 Production Status by Promotion Bureau in Reiwa 2 (2020) Data Source: Hokkaido Agricultural Promotion Division. .Data Source: Hokkaido Agricultural Promotion Division

Region	Area (Hectares)	Harvest Volume (Tons)	Type
Hokkaido	383.1	1,832.0	Processing-exclusive variety
Shiribeshi	192.1	750.2	Processing-exclusive variety
Sorachi	90.4	506.8	Processing-exclusive variety
Tokachi	65.4	261.1	Processing-exclusive variety
Hiyama	40.3	176.0	Processing-exclusive variety
Other	32.4	73.3	Processing-exclusive variety

Table 6 Transition of Cultivation Area for Major Grape Varieties in Hokkaido Data Source: Hokkaido Agricultural Promotion Division(Note: For brevity and clarity, not all tables and varieties are fully listed here.) .Data Source: Hokkaido Agricultural Promotion Division

Variety	2010	2015	2016	2017	2018	2019	2020
Pinot Noir	16.8	20.2	27.7	29.0	32.2	40.5	40.1
Zweigelt	45.8	40.5	39.3	38.2	39.1	37.5	38.8
Yamasachi	15.2	16.2	17.0	20.9	21.3	21.9	23.1
Seibel 13053	46.4	28.2	30.2	20.7	18.9	17.1	18.5
MHAM	4.4	9.3	7.9	12.4	11.5	15.5	14.9
Merlot	7.0	11.4	10.7	10.5	13.5	13.8	13.8
Kiyomi	14.4	11.9	12.3	12.7	11.1	11.0	11.7
Yamabudo	6.7	6.4	8.8	7.3	6.8	5.8	2.5
Rondo	0.6	11.0	8.9	11.2	11.1	1.7	11.1
Others	24.0	42.8	34.8	31.9	32.4	45.1	38.1
Total Red Wine Varieties	181.3	197.9	197.6	194.8	197.9	209.9	212.6

Table 7 Transition of the Number of Wineries in Hokkaido .Data Source: Hokkaido Agricultural Promotion Division

Year	Number of Wineries
2010	16

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Year	Number of Wineries
...	...
2019	47
2020	53
2024	71

Table 8 Distribution of Red and White Wine Varieties by Total Cultivated Area (Year 2020: Red: 213 ha, White: 167 ha).
Data Source: Hokkaido Agricultural Promotion Division

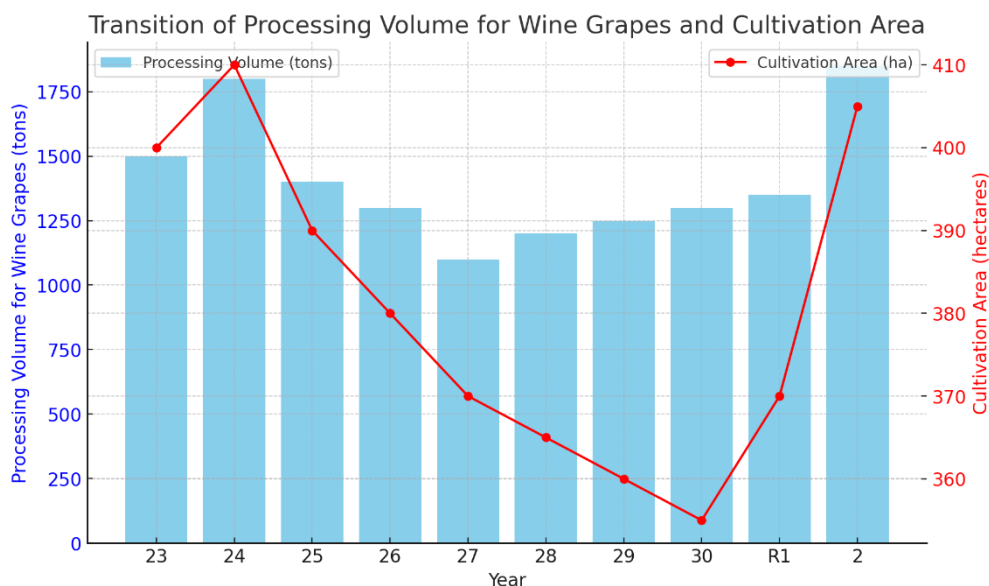
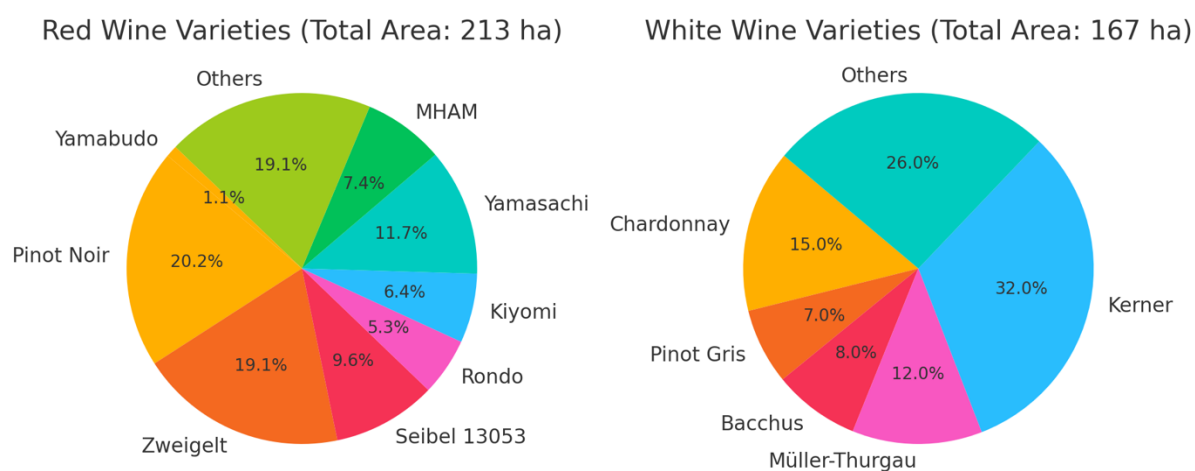


Table 9 Transition of Processing Volume for Wine Grapes (Tons) and Cultivation Area (Hectares) Over the Years . Data Source: Hokkaido Agricultural Promotion Division
The volume of wine grapes processed in Hokkaido for exclusive processing varieties shows yearly fluctuations due to harvest variations but generally trends between 1,200 to 1,800 tons in recent years.

2.6 Unique features of Hokkaido's viticulture

Positive impact of Climate change

According to the Hokkaido Agricultural Research Center, the study of temperature variation shows that in Hokkaido's main wine-producing regions, Yoichi (Shiribeshi) and Mikasa (Sorachi), average temperatures from April to October have exhibited a clear upward trend from 1980 to 2015, based on agricultural meteorological data. Since 1998, these regions have experienced rising temperatures, particularly in the summer months (June-August), aligning with the ideal range for cultivating Pinot Noir, which thrives at an average temperature of 14–16°C during the growing season(Hirota et al,2017).

Traditionally, Pinot Noir was cultivated mainly in warmer areas like Yoichi and Sorachi, while other regions were considered too cool. However, rising temperatures are now enabling previously unsuitable areas—such as Sapporo (Ishikari), Kamifurano (Kamikawa), and Kitami (Okhotsk)—to successfully grow Pinot Noir. Since 2010, these areas have consistently recorded average temperatures above 14°C, positioning them as viable sites for quality Pinot Noir production (Hirota et al,2017).

.In contrast, certain regions, like Ikeda in Tokachi, remain too cool for stable Pinot Noir cultivation, with temperatures below the 14°C threshold(Hirota et al,2017). Memuro in Tokachi, where grape cultivation has recently begun, is gradually reaching this temperature mark in some years, though conditions remain less consistently warm than in areas like Kitami and Sapporo (Hirota et al,2017)..

These findings highlight significant temperature variations across Hokkaido, affecting grape variety suitability and cultivation strategies. Warmer areas are increasingly meeting ideal conditions for Pinot Noir, indicating new viticultural opportunities shaped by climate change.

Adaptation to Heavy Snow: A Unique Feature of Hokkaido's Viticulture

Hokkaido's viticulture is heavily influenced by its substantial winter snowpack, with regions such as Shiribeshi and Sorachi experiencing annual snow depths of 130 to 190 cm (Hokkaido Research Organization). While Shiribeshi typically avoids temperatures dropping below -10°C (Yoichi Council), both regions can occasionally face much colder conditions. Despite these harsh winters, grapevines are effectively protected by leveraging the deep snowpack as a natural insulator.

During winter, vines are buried under snow, which acts as a natural "blanket," insulating them from extreme cold. Within the snowpack, temperatures remain stable, typically between -3°C to -4°C, even when ambient temperatures fall significantly lower. This natural insulation prevents the vines from freezing, allowing them to survive and thrive in such challenging conditions.

This unique snow-burial technique allows farmers in Hokkaido to successfully cultivate cold-sensitive European varieties such as Sauvignon Blanc and Merlot, which would otherwise struggle in the region's severe winter climate. Such practices are rare among wine regions globally, making Hokkaido's approach to viticulture truly distinctive.

To accommodate snow-burial, vines are typically trained on a 45-degree single cordon system, allowing them to be easily buried under the snow. Before winter, the wires tying the vines must be untied, and all wires must be lifted to the top of the posts to prevent them from breaking under the weight of the snow. Once spring arrives, the vines and wires are re-tied, adding significant extra labor compared to standard viticulture. Despite these challenges, this

method ensures the survival of vines and reflects the innovative and adaptive practices of Hokkaido's winemakers.



Figure 3 Vines Trained in a Single Cordon with an Angle to Facilitate Burial in Snow (Yoichi)

Hokkaido's Unique Grapes

Hokkaido is home to native wild grape varieties like Yamabudo (*Vitis coignetiae*), which thrive in the island's cold climate. These wild grapes, characterized by small berries, vibrant red pigmentation, and high acidity, are well-suited to the region's rugged conditions. (NRIB,2019) While traditional Yamabudo was not ideal for winemaking due to challenges like high seed content and moderate tannin levels, its resilience and aromatic qualities made it a strong candidate for hybridization.

According to Tokachi wine, in 1978, breeders began a project to create a grape variety that embodied Hokkaido's terroir while overcoming Yamabudo's limitations. By crossing Seyve Villard 13053, a French hybrid known for its hardiness and productivity, with Yamabudo, they developed Yamasachi, a red wine grape with exceptional traits. Yamasachi inherits cold resistance from Yamabudo, allowing it to thrive in Hokkaido's harsh winters without protective measures. The grape also produces wines with distinctive aromas, high acidity, and deep red hues, suitable for long-term aging and reflecting Hokkaido's unique climate and soil. Its resilience to cold and pests also reduces labor requirements, making it practical for cultivation in the region.

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Today, Yamasachi is recognized as Hokkaido's flagship wine grape, symbolizing the region's commitment to developing a distinct winemaking identity. Widely embraced by local wineries, Yamasachi wines reflect the island's unique terroir and natural heritage. Its recent inclusion in the International Organisation of Vine and Wine (OIV) list underscores its importance as a world-class variety, elevating Hokkaido's reputation as a premier wine-producing region.

Chapter 3: Challenges of Hokkaido viticulture

Since 2020, I have been exploring Yoichi, one of Hokkaido's key wine regions, and working under one of its pioneers, Mr. Ochi, who runs OchiGabi Winery alongside his wife. At their winery, they cultivate a wide range of grape varieties, including both cool-climate and more vigorous German varieties, as well as noble French varieties such as Pinot Noir, Chardonnay, and Gewürztraminer. Over time, they have observed consistent ripening in these noble varieties, leading to a gradual reduction in the production of German varieties.

However, Mr. Ochi remains concerned about the long-term impacts of climate change. Despite these concerns, Yoichi's cool climate presents an opportunity to experiment with traditionally warmer-climate varieties, such as those from Bordeaux, to adapt to future climatic changes.



Figure 4 Ochigabi Winery Vineyard Scenery

3.1 Recurring Challenges in Hokkaido Viticulture

While working in Yoichi, I had the opportunity to interact with other producers and noticed several recurring challenges:

1. **Labor Shortages:** Many producers face difficulties finding sufficient workers to manage their vineyards. This labour shortage is a major bottleneck in vineyard management and expansion.
2. **Lack of Viticulture Information:** As Hokkaido's wine industry is still emerging, there is limited availability of region-specific knowledge and technical guidance for grape growers.
3. **Impact of Climate Change:** Producers are observing changes in ripening conditions, which influence their choice of grape varieties. The warming climate is driving a shift toward French varieties like Pinot Noir, which thrive in these evolving conditions.

Region	Number of Wineries
Shiribeshi	6
Sorachi	4
Oshima	1
Tokachi	2
Other Areas	3 (Sapporo, Iburi, Unknown)

3.2 Study Objectives

This study sought to investigate the challenges faced by grape growers in Hokkaido and identify potential solutions to support the development of this nascent industry. Surveys were conducted with 16 grape growers from the Shiribeshi, Sorachi, Oshima, and Tokachi regions, focusing on: Here's the updated table with "Number of Wineries" instead of "Number of Locations":

- **Labor Management:**

- Investigating the critical labour shortages faced by growers and how these impact vineyard operations and expansion.
- Exploring potential strategies to attract, retain, and efficiently manage a vineyard workforce, including the role of mechanization and seasonal labour programs.

Table 10 Winery Distribution and Survey Sample Numbers by Region

- **Climate Challenges:**

- Understanding how climate change is shaping grape variety choices and vineyard management practices.
- Assessing grower awareness and preparedness for climate adaptation, including experimenting with warmer-climate varieties and modifying vineyard techniques to address extreme weather conditions.

- **Quality Management:**

- Examining how growers ensure consistent grape quality under varying climatic conditions.
- Exploring how vineyard practices, harvest timing, and grape variety choices contribute to the production of premium wines.

3.3 Labour

From the survey results, the labor shortage in Hokkaido vineyards is evident, with 81% of producers highlighting its impact. Below is a detailed explanation of how specific vineyard tasks are affected by this shortage, emphasizing the interplay of climate, regional practices, and task-specific challenges.

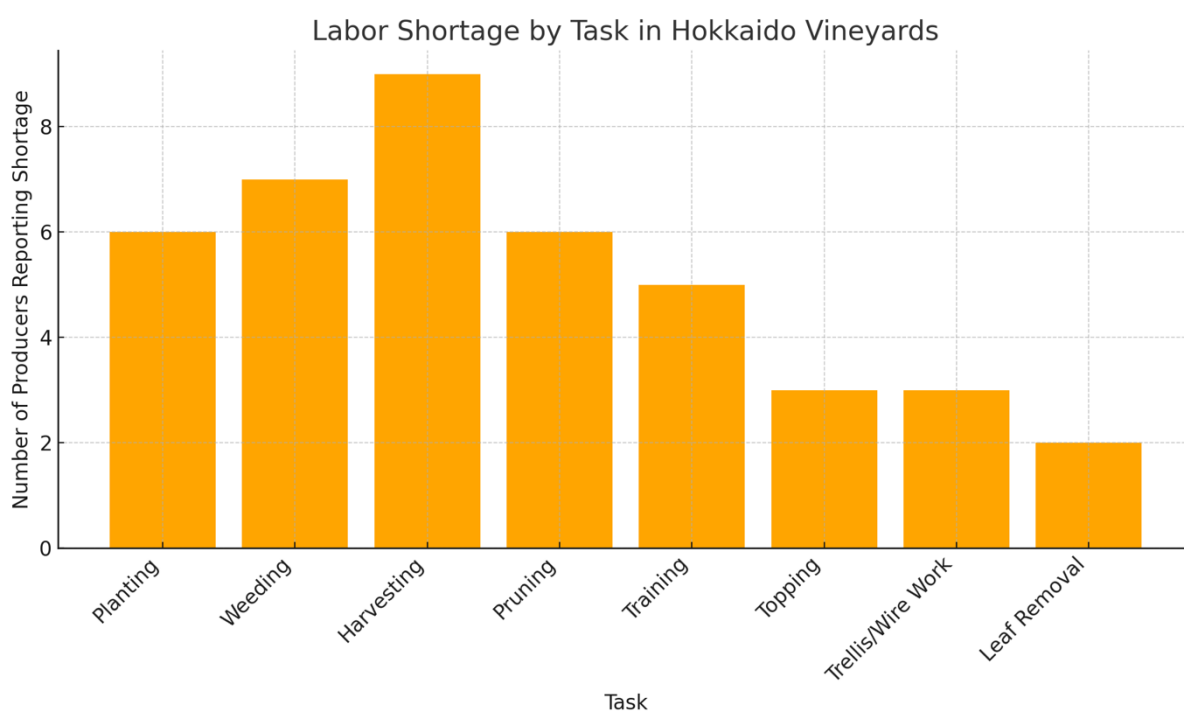


Table 11 Labor Shortage by Task in Hokkaido Vineyards (Based on Survey Conducted by the Author)

The graph illustrates the reported labour shortages in various tasks within Hokkaido vineyards. Key findings are:

1. **Harvesting** is the most significantly affected task, with the highest number of producers (9) reporting shortages. This reflects the critical and time-sensitive nature of grape harvesting.
2. **Pruning and Weeding** are moderately impacted, with 7 and 6 producers respectively highlighting labour shortages. These tasks are vital for vine maintenance and soil health.
3. **Training** also shows a notable impact, reported by 6 producers. It requires skilled labour for proper canopy management.
4. **Topping, Trellis/Wire Work, and Leaf Removal** are less affected, reported by fewer producers (3–5). These tasks may be less urgent or more flexible in timing.

Harvesting

Harvesting grapes at the right time is critical, as it determines the desired wine style. This task is particularly time-sensitive because, once ripened, grapes need to be picked as soon as possible to retain optimal acidity and sugar levels. Climate change has had a mixed impact on harvesting in the region. On the other hand, the warming climate has provided a positive opportunity for Hokkaido to grow noble varieties, such as Chardonnay and Pinot Noir, which were previously difficult to cultivate due to the region's cooler climate. However, some producers are already experiencing the negative impacts of these changes. In particular, the harvesting window has become shorter, as acidity levels drop more rapidly than before. Producers and consultants from the Shiribeshi region have noted that this accelerated ripening process makes it increasingly difficult to manage harvest timing effectively. While climate change has opened new possibilities, it also threatens the delicate balance required for high-quality wine production, further complicating labor management during harvest.

Pruning

Pruning is another labor-intensive task significantly influenced by Hokkaido's climatic conditions, particularly in the Shiribeshi and Sorachi regions. Heavy snowfall, starting as early as November and peaking by late December, restricts pruning activities until March or April, when the snow recedes. This delay in access to the vineyards forces growers to complete pre-snowfall pruning or conduct pre-pruning to reduce spring workload and minimize damage to canes. Additionally, deep snow causes damage to trellis wires, necessitating extra labor to adjust wires either by lifting or lowering them before snowfall. The unique regional practice of using the one-sided cordon method, where trunks are buried under snow for protection, adds to the complexity. Leaving unpruned canes buried in snow increases the risk of breakage, pushing producers to prioritize pruning before snow accumulation.



Figure 5 Pulling Post-Pruned Canes Out of the Trellis on a Snowy Day

Weeding

Weeding is a common struggle among Hokkaido producers due to the region’s higher rainfall and humidity compared to other premium grape-growing regions. These conditions promote vigorous weed growth, often requiring one or two additional weeding sessions compared to other regions. While essential for vineyard management, the frequency and intensity of this task add significantly to the labour demand.

Topping

Hokkaido’s climate not only accelerates weed growth but also results in more vigorous vines, requiring topping one or two extra times compared to other regions. Fortunately, many producers utilize tractor-mounted implements for this task, which alleviates some of the labour burden. As a result, while topping is more frequent, it is generally not as problematic compared to tasks like pruning and weeding.

Leaf Removal

Leaf removal is crucial in Hokkaido to maintain fruit health by improving airflow and reducing the risk of disease. Surprisingly, many producers did not report significant labour shortages for this task. However, this may be because leaf removal is often deprioritized compared to essential tasks like pruning, weeding, and harvesting. One producer in Yoichi mentioned a desire to complete all leaf plucking but noted they rarely have the time or workforce to finish it. Since growers can choose to forgo leaf removal without immediate consequences, it is often seen as less critical.

The survey results indicate that the majority of respondents are experiencing significant labour shortages. This issue not only hampers their ability to expand vineyard operations but also affects the quality of grape production. To address these challenges, respondents have adopted a variety of strategies. The graph below illustrates the measures being implemented, with the most common approaches including hiring local residents, mechanization, and utilizing volunteers.

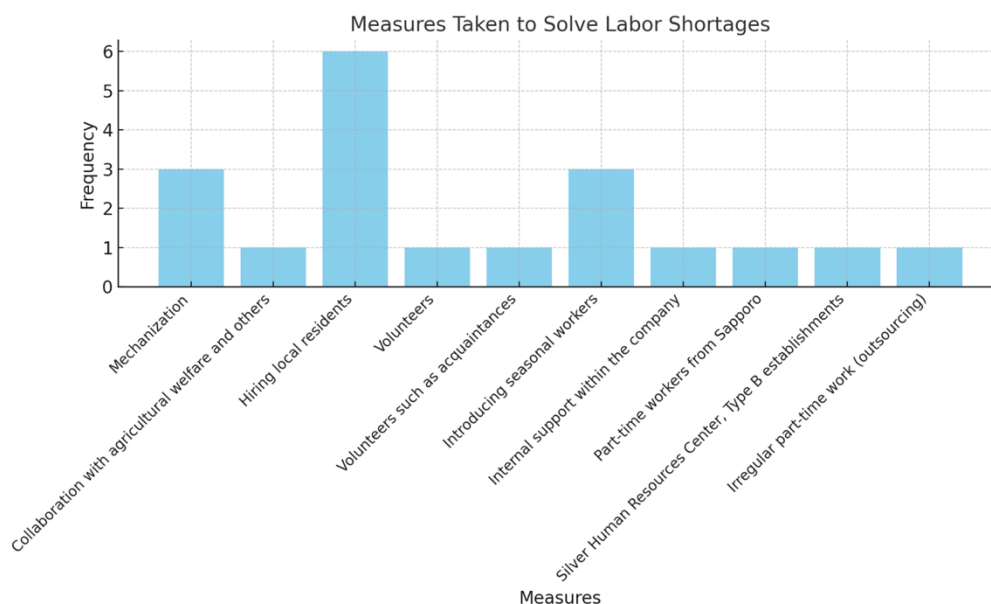


Table 12 Measures Taken to Address Labor Shortages in Vineyards (Based on Survey Conducted by the Author)

The survey reveals that labour shortages remain a significant challenge for most respondents, limiting their ability to expand vineyard operations and maintain grape quality. To address these issues, a variety of strategies have been implemented. The graph below illustrates the

measures taken by respondents, with the most common solutions including hiring residents, mechanization, and engaging volunteers.

It is important to note that some responses reflect overlapping categories or nuanced interpretations. For instance, hiring residents could refer to either full-time or part-time employment, depending on the specific needs and resources of the vineyard. Similarly, mechanization is often paired with other strategies, such as engaging seasonal workers, to balance manual labour with automation. This overlap highlights the complexity of labour management in viticulture, where a combination of methods is often required to address shortages effectively.

The diversity of responses underscores the adaptability of vineyard managers in mitigating labour challenges and sustaining vineyard productivity.

Case of Yoichi

According to statistics published by Yoichi Town, the total population of the town, which peaked at 28,659 in 1960, experienced a temporary increase in 1980 but has been steadily declining since. In the 2015 national census, the population was recorded at 19,607. Based on future population projections, the total population of the town is expected to decrease to 9,848 by 2045, roughly 50% of the 2015 population.

Additionally, projections by the National Institute of Population and Social Security Research indicate that the working-age population will be surpassed by the elderly population between 2035 and 2040. By 2045, the working-age population is expected to decrease to 4,163, approximately half of the current figure.

However, there is evidence that the wine industry is contributing to an increase in population, as more people are moving to the area to become winemakers. While the wine industry is likely serving as a catalyst for population growth, it is expected that finding additional workers locally to accommodate the expansion of grape production will become increasingly difficult in the next 10 years.

3.4 Challenges for Mechanization in Hokkaido

Mechanization serves as a viable solution when the demand for labour is high, but an adequate labour force is unavailable. While Japan is known for its advanced mechanization in many industries, viticulture remains relatively underdeveloped in this regard. According to the survey, 21% of producers reported adopting mechanization to address labour shortages. However, 78% indicated that the high costs of accessing such technology pose a significant barrier.

This challenge is exacerbated by the fact that most vineyard technologies are imported from Europe. Recent global issues, such as inflation in energy and materials since the COVID-19

pandemic, combined with the depreciation of the Japanese yen against major currencies like the USD and the Euro, have made it increasingly difficult for producers to invest in new machinery. For example, a local dealer, Case IH, reported that tractor prices have increased by approximately 40-50% since the pandemic. At the same time, farmers' incomes have not risen at a comparable rate, as observed on my own farm.

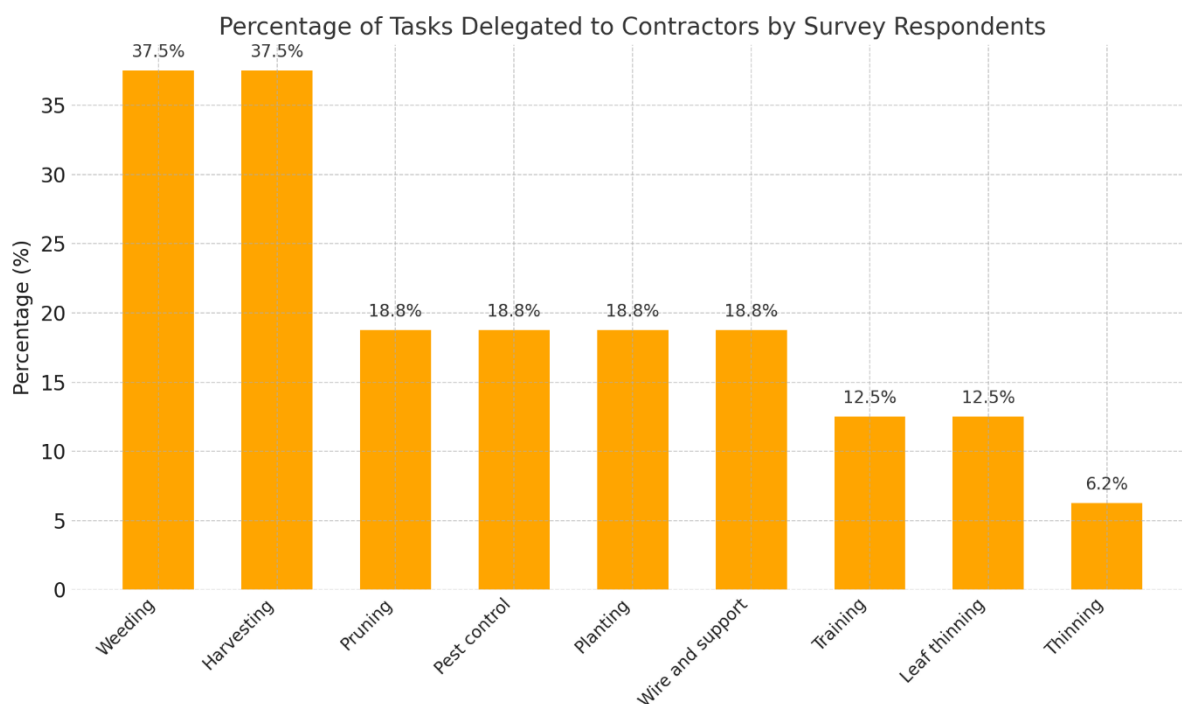
Viticulture tractors are compact yet require high horsepower and advanced hydraulic systems to handle specialized vineyard implements. Despite the growing demand for these tractors, major manufacturers such as New Holland and Case IH do not distribute this type of equipment in Japan due to the lack of contractual agreements. Consequently, producers are unable to access machinery essential for vineyard operations. Although demand for such equipment is rising, the wine industry in Japan is not yet perceived as a sufficiently large market to attract investment from major machinery manufacturers.

Contractors

In the global agricultural industry including Hokkaido, contracting services for activities such as harvesting, drilling, and spraying crops using machines are widely adopted, especially by smallholders, older farmers without successors, or those who do not wish to invest in new machinery. Similarly, in major wine regions abroad, vineyard contractors are a common feature, providing specialized services for vineyard tasks such as pruning, canopy management, harvesting, and spraying. These contractors play a crucial role in addressing labour shortages and ensuring operational efficiency, particularly during peak seasons.

However, in Hokkaido's viticulture industry, despite the recognition of labour shortages, there are currently no official contractors operating as businesses to provide such services. This highlights a gap in the local market and an opportunity for the introduction of a contracting service model, drawing inspiration from successful examples abroad.

The survey aimed to understand how much interest there is among 16 grape producers in Hokkaido in utilizing contracting services for vineyard tasks. The respondents were asked to indicate which categories of tasks they would consider outsourcing to contractors if such services were available.



From my personal observation, wineries in Hokkaido often prioritize investments in winemaking over vineyard management, potentially underestimating the foundational role of premium grape production. Labor shortages and inefficiencies in vineyard operations highlight the need for solutions like vineyard contracting, a common practice in major wine regions. Contracting services can save time on labor management, reduce costs, and enhance operational efficiency by outsourcing tasks like pruning, spraying, and harvesting. Implementing contracting in Hokkaido would allow producers to focus on winemaking innovation while improving grape quality and sustainability, strengthening the region's competitiveness in the global market.

3.5 Negative Affect of climate change

In an earlier chapter, the positive effects of climate change on Hokkaido's viticulture were discussed, such as longer growing seasons and improved suitability for certain grape varieties. However, several negative impacts have also become evident.

A producer from Yoichi, along with a local public agronomist, highlighted a decrease in crucial grape acids like tartaric and malic acid, particularly in varieties such as Pinot Noir.

Table 13 Percentage of Vineyard Tasks Delegated to Contractors by Survey Respondents

This issue arises from warmer conditions, which accelerate ripening and lead to lower acidity levels, potentially compromising the desired balance in wine quality.

Furthermore, 75% of survey respondents observed that vine growth stages are starting earlier in the season. This trend is concerning for two reasons: it disrupts the balance between sugar and acidity levels during the final stages of growth, complicating decisions around optimal harvest timing, and it increases the risk of early frost damage. Frost, which can harm young vine buds, poses a threat to both yield and grape quality, a problem that is already prevalent in some European wine regions.

Rising temperatures have also led to an increase in pests and diseases, with 53% of producers reporting greater pressure in these areas. As a result, vineyard management has become more labor-intensive, requiring additional spraying and leaf plucking. These extra steps make organic farming more challenging, despite growing demand for organic wines driven by consumer preferences and environmental awareness.

Additionally, changes in precipitation patterns are creating further difficulties. According to the Japan ministry of agriculture and fishery (2024), the annual frequency of hourly rainfall exceeding 50mm has increased approximately 1.5 times compared to the period from 1976 to 1985. Such intense rainfall events have several adverse effects on vineyards. They can lead to soil erosion, waterlogging, and increased disease pressure, and they also contribute to issues such as unfertile fruits and fruit bursting. Bursting fruits, in particular, can lead to an increased risk of rot and further loss of quality, posing additional challenges for vineyard management.

While the Japanese government aims to cultivate 25% of agricultural land organically by 2050, achieving this goal in Hokkaido's vineyards presents significant challenges. Balancing the increasing demand for environmentally friendly farming with the practical difficulties posed by climate change—such as earlier growth stages, frost risks, rising pest pressures, and extreme rainfall—underscores the complexity of maintaining sustainable viticulture in the region.

Chapter 4: Research Travel

After identifying the challenges faced by Hokkaido's viticulture, I travelled to wine regions such as Germany, France, Canada, Chile, and New Zealand to explore potential solutions and gain new ideas that could be applied to Hokkaido. These travels provided valuable insights into diverse viticultural practices and innovations.

Additionally, I had the privilege of gaining hands-on experience in two renowned wine regions: the Mosel Valley in Germany and Central Otago in New Zealand. The Mosel is celebrated for its Riesling, while Central Otago is renowned for its Pinot Noir. Both regions are located at relatively high latitudes and share a cool climate similar to that of Hokkaido.

Germany, as part of the Old World, boasts a long history of winemaking, deeply rooted in tradition and heritage. In contrast, New Zealand, as a New World wine region, has a comparatively shorter history of viticulture, characterized by modern techniques and innovation. This contrast offered a unique perspective on how both traditional and contemporary approaches can contribute to the development of viticulture in a cool-climate region like Hokkaido.

4.1 What I Learned from Germany

Germany was a key destination in my research journey for several reasons:

1. Advanced Agricultural Mechanization

German agricultural engineering, including viticultural technology, is among the most advanced in the world and widely adopted internationally. Observing these technologies in action, such as precision pruning tools and efficient harvesting equipment, demonstrated their potential for improving vineyard productivity and reducing labor requirements. For instance, in flat vineyards, mechanization has reduced labor hours by up to 90% since the 1950s (Schreieck, 2016). These insights are particularly relevant for Hokkaido, where mechanization could address challenges like labor shortages.

2. Long History and Wealth of Experience

With centuries of winemaking tradition, Germany has accumulated extensive knowledge and data on cool-climate viticulture. This long history has resulted in a deep understanding of practices that optimize grape quality and vineyard sustainability (Schultz, 2016). This wealth of experience reinforced the value of historical data and tradition in shaping successful viticultural practices.

3. Experiencing the Impacts of Climate Change

Germany's cool-climate vineyards are increasingly experiencing the impacts of climate change. This shift has brought both challenges and opportunities, such as the ripening of grape varieties that traditionally struggled in cooler climates (Schultz & Hofmann, 2018). Observing how German winemakers are navigating these changes—balancing traditional methods with modern techniques—provided valuable insights into how Hokkaido could prepare for similar climatic shifts.

4.1.1 Clemens Technology



Figure 6 Head Office of Clemens Technologies in Wittlich, Germany

Germany has been highly successful in mechanization. For example, in flat-terrain vineyard sites, labor hours have reportedly decreased by 90% since 1950 due to advancements in viticultural mechanization (Schrieck, 2016). Additionally, mechanical harvesting is widely adopted in Germany, showcasing the efficiency and practicality of modern technologies in viticulture.

During my time in Germany, I had the opportunity to visit the headquarters of CLEMENS Technologies, a leading manufacturer of viticulture and agricultural machinery. Since its establishment in 1952, CLEMENS has significantly contributed to the mechanization of viticulture, exporting 80% of its products to over 35 countries. The company's international marketing team has been instrumental in expanding their reach, particularly into New World wine regions.

CLEMENS offers a diverse range of products, including tools for soil management—such as under-vine cultivation equipment and mulchers—and canopy management tools like topplers, leaf removers, and pre-pruners. This visit provided valuable insights into advanced mechanization techniques employed in German viticulture and highlighted their potential for enhancing efficiency and productivity in other wine-growing regions.

Undervine Management

CLEMENS' undervine management tools are designed to meet a variety of needs. Modern farmers, in their pursuit of sustainability, adopt diverse soil management approaches. For instance, no-till methods are used to accumulate organic matter, while under-vine cultivation

helps control weeds and manage pests, significantly reducing or even eliminating the use of herbicides.

Johannes Kruetten from CLEMENS emphasized a recent study revealing that under-vine cultivation can influence the aroma compounds in wine. This underscores the importance of considering wine quality and style when implementing vineyard management practices. Recognizing the variability of soil conditions across vineyards, CLEMENS offers multiple solutions to adapt effectively to these differences.

One of their flagship products, the RADIUS SL, is a robust and environmentally friendly tool that meets the needs of modern viticulture. It allows for rapid coverage, operating at speeds of up to 10 km/h, while reducing fuel consumption and minimizing water stress through shallow cultivation techniques. For example, in vineyards with a typical row spacing of 2.3 meters (common in Japan), the RADIUS SL can cover 1 hectare in approximately 26 minutes. Even at half the speed (5 km/h), it completes the task in about 52 minutes (excluding turning time on hilly terrain).

By comparison, according to the Hokkaido Council, manual under-vine weed management requires 10.5 hours per hectare per person. This means the RADIUS SL can replace the labor of at least 10 workers, significantly enhancing efficiency and cost-effectiveness in vineyard operations.

Canopy Management

In addition to soil management, CLEMENS offers tools that optimize canopy management, a critical aspect of vine health, yield, and quality. Equipment like topplers, leaf removers, and pre-pruners plays a vital role in improving sunlight exposure, air circulation, and disease prevention within the canopy, contributing to consistent vine growth and high-quality yields.

Canopy management is not only essential for maintaining vine health but also for influencing grape yield and quality. Leaf removal, while traditionally labor-intensive and not always prioritized, is a key practice for enhancing wine quality. It directly affects factors such as aroma compounds, anthocyanin levels, and ripening timing, while also improving the microclimate around grape clusters and reducing disease risks.

Timing is critical in canopy management, as precision is necessary to achieve desired outcomes. Mechanization provides a practical solution, enabling growers to perform tasks like leaf removal efficiently and at optimal times. This ensures consistent grape quality while reducing labor demand, aligning with the goals of modern, sustainable viticulture.

Adaptability for Hokkaido

In Hokkaido, where vines are trained at a 45-degree angle rather than growing straight up as in traditional vineyards, there was concern about whether machine sensors designed to avoid trunk damage would function properly. However, these sensors can be adjusted to accommodate this training method. As a result, CLEMENS machines with sensor technology can be adapted effectively for use in Hokkaido, making them a viable solution for vineyard mechanization in the region.

4.1.2 Weingut Cantsheim



Figure 7 Weingut Cantzheim – Traditional Building Featuring Tasting Rooms, Guesthouses, and a Beautiful



Figure 8 Steep Single Vineyard 'Fuchs' in Saarburg, Mosel, Germany

During my time in the Mosel, I had the privilege of gaining work experience at Cantsheim, a winery located in the Saar region, about 30 minutes from Luxembourg. The Saar is a renowned cool-climate wine region celebrated for its steep slate vineyards, which have

historically produced world-class wines. The region is home to iconic producers like Egon Müller, whose legacy highlights the premium quality associated with Saar wines.

Cantsheim is a relatively new venture, founded in 2016 by Anna and Stephan Reimann. The couple, who are both warm and welcoming, took excellent care of me during the 2023 vintage. With backgrounds in horticulture and a shared passion for wine, Anna and Stephan embarked on their winemaking journey after gaining extensive experience in the industry, both nationally and internationally.

The couple purchased and renovated an old monastery, transforming it into a stunning guesthouse and tasting room. Surrounded by a picturesque garden, this facility also hosts events such as weddings and concerts, showcasing their diverse and dynamic business model.

Stephan Reimann, who also works as a Product Manager for Certis Belchim, brings a unique dual perspective as both a viticulturist and scientist. During my time at Cantsheim, Stephan generously shared his extensive knowledge, providing invaluable insights into both the practical and technical aspects of winemaking and vineyard management.

Grape Varieties and Wine Styles

At Cantsheim, the primary grape variety is Riesling, which is crafted into a broad spectrum of styles, ranging from dry to sweet wines, and including single-vineyard premium selections and sparkling wines. The winery also focuses on Pinot Noir, producing red, rosé, and sparkling wines, further demonstrating the versatility of their production.

Advantages of the Saar Region

The cooler climate of the Saar, compared to regions like Pfalz, delays the harvest by 1-2 weeks. This extended ripening period allows for meticulous selection of grapes at varying levels of ripeness, enabling the production of a diverse range of wine styles. The longer harvest period also provides greater flexibility in winemaking, enhancing both the complexity and quality of the wines.

Labour and Mechanisation

Mechanisation is considered the way forward for long-term efficiency, as modern machinery provides consistent and accurate results. However, training human laborers remains essential, as producers must invest in skilled workers. Contractors, although in high demand, often lack flexibility and struggle to meet precise timings.

For premium wine production, where vineyards are often on steep, inaccessible terrain, manual labor remains indispensable. Human input in these sites adds value to the final product. To strike a balance, Cantsheim is working on optimizing the ratio between steep and flat vineyards to improve overall efficiency.

Challenges with Frost and Climate Change

In 2024, Cantsheim faced a 30% loss in yield due to frost. Stephan explained that frost management poses significant challenges, with limited options for mitigation. While changing grape varieties is a potential solution, Riesling remains the iconic identity of the Saar and Mosel regions. The goal is to preserve the classic Mosel characteristics for as long as possible, given that 90% of their vineyards are dedicated to Riesling.

Additionally, the region is experiencing heavier summer rains and rising temperatures. Stephan emphasized the importance of canopy management and yield control to address

these changes, while also focusing on disease pressure, sunburn prevention, and maintaining aromatic quality.

4.2 What I Learned from Central Otago, New Zealand

1.Sustainable Practices

Central Otago has prioritized sustainability, with over 90% of its vineyards certified by Sustainable Winegrowing New Zealand (SWNZ) (SWNZ, 2023). Practices such as cover cropping, minimal tillage, and organic farming reduce environmental impact and build long-term vineyard resilience. These strategies illustrate how environmentally friendly practices can coexist with high-quality wine production.

2.Labour Management

Effective labour management is a cornerstone of Central Otago's wine industry, driven by the seasonal nature of its operations. The region's workforce expands significantly during peak periods, relying on a diverse mix of workers supported by specialized visa programs and international mobility frameworks. This strategic approach underscores the critical role of adaptive workforce planning in maintaining the vitality and sustainability of a dynamic wine region.

3.Climate Risk Management

Central Otago employs advanced strategies to mitigate climate risks, safeguarding its vineyards against the region's environmental challenges. Key measures include:

- **Irrigation Systems:** Ensuring consistent water supply during dry periods to maintain vine health.
- **Frost Mitigation:** Utilizing large fans to protect crops from frost damage, particularly during critical growth phases.
- **Netting for Birds:** Implementing protective netting to prevent bird damage, preserving grape quality and yield.

About NZ wine industry

New Zealand's wine industry has experienced remarkable growth since its beginnings in 1819, when the first grapevines were planted in Northland (*New Zealand Winegrowers, n.d.*). By the 1970s, Marlborough emerged as a leading wine region, gaining global recognition for its distinctive Sauvignon Blanc. Advances in winemaking techniques, a focus on sustainability, and strategic international marketing in the 1980s brought international acclaim, particularly in markets like the UK and USA. Today, the industry boasts 744 wineries and over 41,000 hectares of vineyards, earning NZ\$1.9 billion annually and celebrated for its high-quality, unique wines (*New Zealand Winegrowers, n.d.*).

In contrast, Central Otago's winemaking journey followed a different trajectory. In 1895, Italian viticulture expert Romeo Bragato identified its potential for Burgundy-style grapes, boldly declaring, "There was no country on the face of the earth which could produce better" (*Central Otago NZ, n.d.*). Despite this early recognition, commercial winemaking in Central Otago didn't begin until the 1980s and 1990s. The region faced significant challenges,

including frost, water scarcity, and harsh southerly winds, but these obstacles were overcome through determination and innovation. Today, Central Otago is celebrated as a world-class wine region, particularly renowned for its exceptional Pinot Noir (*Central Otago NZ, n.d.*).

4.2.1 Terra sancta

In the 2023/2024 season, I had the privilege of working at Terra Sancta Winery in Bannockburn, Central Otago, as a tractor driver. Founded in 2011, Terra Sancta—Latin for "Sacred Earth"—is deeply rooted in the unique terroir and history of Bannockburn, one of New Zealand's most renowned wine regions. Owned by Mark Weldon and Sarah Elliott, the winery has earned a stellar reputation in the industry, consistently receiving high praise from renowned wine critic Bob Campbell for its premium Pinot Noir and other varietals. Terra Sancta is more than just a producer; it is a steward of the land, practicing regenerative viticulture to promote long-term environmental health and biodiversity.

The winery's history is intertwined with Bannockburn's viticultural evolution, building upon the legacy of vineyards established in the early 1990s. Its estate on Felton Road, containing some of the oldest vines in the region, serves as a cornerstone of its success. Terra Sancta's commitment to quality and sustainability has solidified its place as a leader in Central Otago's winemaking tradition.

Innovative Practices at Terra Sancta



Figure 9 Undervine Weed and Sucker Management Using Clemens Mulch Cleaner Without Tillage

Regenerative viticulture at Terra Sancta focuses on building healthy soils, fostering biodiversity, and reducing chemical inputs. One key innovation enabling their no-till viticulture approach is the use of the Cremens Multi-Cleaner. This machine, capable of operating at speeds of up to 4 km/h, allows efficient weed management, covering 1 hectare in

approximately 90 minutes while preserving the soil structure. The owner, Mark, has expressed great satisfaction with the machine, which has become an essential tool on the farm.

In comparison, current weed management methods in Hokkaido, as reported by the local government, take up to 15 hours per hectare. This highlights the significant time and labour-saving advantages of the Cremens Multi-Cleaner, which not only reduces operational costs but also makes sustainable practices more feasible for large-scale adoption. Additionally, Terra Sancta uses grazing Doll sheep to manage weeds naturally while enriching the soil with organic matter, further enhancing vineyard fertility. These practices exemplify the winery's commitment to sustainability and innovation.



Figure 10 Grazing Doll Sheep in the Vineyard

Labor Dynamics and Challenges

Terra Sancta's workforce primarily consists of employees from non-New Zealand backgrounds, leveraging the country's strong working schemes for international labour. Typical vineyard workers include Pacific Islanders, South Asians, and working holiday holders. At this winery, working holiday holders were employed temporarily during peak labour periods, such as wire lifting, sucker removal, and harvesting.

Until last year, the winery relied on local contractors for harvesting, who predominantly employed experienced workers from Vanuatu. These contractors were efficient due to the workers' skill levels but came with higher costs due to intermediary fees. This vintage, the winery opted to employ working holiday holders, who were less experienced but offered reduced labour costs. This trade-off between cost and efficiency reflects broader challenges in vineyard labour management.

Bannockburn's dry climate, with only 340 mm of annual precipitation, mitigates some of these challenges by reducing the risk of rain during harvesting and allowing for a longer harvesting period. However, in regions like Hokkaido, where harvesting often coincides with higher rainfall risk, labour inefficiency could have a more significant impact. Grapes must be harvested quickly to minimize risks of botrytis and bursting, making experienced and efficient labour essential.

Hand Picking vs. Machine Harvesting

At Terra Sancta, hand-picking is typically performed for the premium vineyards to maintain the highest quality of grapes. However, for non-organic vineyards located further from the winery, machine harvesting is utilized. Interestingly, in 2023, the machine-harvested grapes achieved the highest score for red Pinot Noir, demonstrating that premium wines can be crafted from machine-harvested fruit if the grapes are grown under optimal conditions and handled with care throughout the growing and harvesting process.

This outcome challenges the traditional perception that only hand-picked grapes can produce premium wines. It highlights the importance of vineyard management practices from the beginning of the season to the end, ensuring that grape quality is preserved, regardless of the harvesting method. Terra Sancta's experience shows that machine harvesting, when used effectively, can contribute to the production of exceptional wines while offering greater efficiency and cost savings.

Against Frost and Bird

Central Otago, known for its dry and warm summers, traditionally faces the challenge of early frosts, which pose a significant threat to vineyards. To combat this, the region employs numerous anti-frost fans. At Terra Sancta, a modern system is in place, connected online, enabling the vineyard manager to receive alerts when temperatures approach frost damage thresholds. This system also allows for real-time monitoring and management, ensuring timely responses to frost risks.

From Challenges to Potential: The Evolution of Hokkaido's Viticulture: Crafting a Sustainable Future for Japan's Northern Vineyards

Another major challenge in Central Otago is the threat posed by birds as grapes mature. Birds can cause yield losses and quality degradation by damaging the fruit, leading to rot. To mitigate this, the region uses bird-scare devices and protective netting over the vines.

These risks—frost and bird damage—could potentially become more prominent in Hokkaido's future as similar challenges have started to emerge there. Adopting these mitigation methods in Hokkaido could help protect vineyards against such risks, ensuring



Figure 11 Vineyard and anti frost fans
sustainable and high-quality wine production in the region.



Figure 12 Bird nets covering vines

Opportunities for new labour resource in Hokkaido

Hokkaido's wine regions, such as Yoichi, could potentially benefit from lessons learned at Terra Sancta. Yoichi is located only 40 minutes from the international ski resort of Niseko, which attracts working holiday holders from around the world. Many of these workers may seek additional employment opportunities after the ski season ends, offering a potential labour pool for Hokkaido's vineyards. Personally, I have encountered individuals interested in working on farms during the summer to gain more exposure to Japan, which suggests a strong potential for seasonal labour.

However, a significant barrier in Hokkaido remains the language mismatch between farmers or winemakers and working holiday holders, as many local producers lack English proficiency. Addressing this gap through training or intermediary services could enable better utilization of seasonal workers. Given that many of these workers already gain experience in food and beverage industries, there is a strong case for integrating them into Hokkaido's wine regions.

In the future, these seasonal workers could indeed serve as a valuable labour resource for Hokkaido's vineyards. However, lessons from my time in New Zealand highlight several critical factors that must be considered. At Terra Sancta, the balance between experienced contractor crews and less experienced working holiday holders underscored the importance of matching the right workforce to the task at hand. While working holiday holders offered cost savings, their lack of vineyard experience sometimes led to inefficiencies, particularly during labour-intensive periods like harvesting.

Hokkaido's climatic challenges, such as higher rainfall during harvest and the risk of botrytis, make efficient harvesting even more critical. Leveraging lessons from Terra Sancta, Hokkaido's wine industry can better prepare for these challenges by implementing robust training programs for seasonal workers, improving communication between workers and producers, and prioritizing labour efficiency during critical periods. These steps would ensure that Hokkaido's vineyards can grow sustainably while meeting the quality standards necessary for producing premium wines.

4.2.2 Grape vision LTD

In Bannockburn, Grape Vision Ltd stands as a vital contractor and consultancy company supporting local grape producers, including Terra Sancta. Established in 1996 by Robin Dicey, the company was founded to assist aspiring vineyard owners who lacked the time or expertise to manage their ventures. Since 2010, under the leadership of James Dicey, Grape Vision has become a cornerstone of Bannockburn's viticultural industry, offering specialized services in vineyard development, management, and consultancy.

Vineyard Development Expertise

Grape Vision provides comprehensive vineyard development services, managing every step from site identification to planting and infrastructure installation. Their expertise ensures optimal site selection, soil and water testing, and cultivar choice. They handle land preparation, drainage, irrigation, and frost protection with precision, employing advanced tools like GPS mapping and remote weather stations. This meticulous approach forms the foundation for successful vineyard operations, tailored to the unique needs of Bannockburn's grape producers.

Management and Contracting Services

For both absentee and local vineyard owners, Grape Vision offers full vineyard management, including young vine training, canopy management, pest control, and compliance with standards like SWNZ and BioGro. Their skilled team employs specialized equipment to ensure efficient operations, maintaining both conventional and organic vineyards to the highest standards. The company's focus is on maximizing grape quality and yield while ensuring smooth vineyard operations.

Grape Vision has also provided critical support to Terra Sancta by managing activities such as bird netting, spraying, harvesting, and overall viticultural management for select vineyards. These tailored services have contributed significantly to the vineyard's operational efficiency and premium wine production.

Consultancy for Success

With extensive experience across Central Otago, South Africa, and California, Grape Vision offers consultancy on site evaluation, viticultural systems, and business planning. They provide tailored advice on climate assessment, pest management, and staff training, empowering vineyard owners to optimize their operations and achieve their goals.

By supporting renowned producers like Terra Sancta and fostering growth across the industry, Grape Vision Ltd continues to enhance Bannockburn's reputation as a premier wine-producing region. Their commitment to quality, innovation, and sustainability ensures their ongoing role as leaders in the viticultural landscape.

4.3 What I learned in France

Traditional vs. Future Approaches

France has long been a global leader in the wine industry, achieving unparalleled success through its deep respect for terroir and centuries of winemaking expertise. However, the negative impacts of climate change—rising temperatures, unpredictable weather, and droughts—pose significant challenges to this legacy.

Drawing on their extensive experience, French winemakers are now at a critical turning point, fighting to preserve traditional grape varieties while adapting to changing conditions. Through innovative solutions such as introducing heat-resistant grape varieties, optimizing vineyard practices, and leveraging precision viticulture technologies, they are working to safeguard their traditions and maintain their reputation for excellence in the wine world.

4.3.1 Burgundy's Changing Climate: Insights for Hokkaido's Emerging Pinot Noir Scene

A visit to Burgundy in 2023 highlighted the profound challenges and adaptive strategies necessitated by climate change. This historic winemaking region, steeped in tradition, is confronting the growing impacts of a warming planet. For Hokkaido, a region gradually building its reputation as a Pinot Noir producer, Burgundy's experiences offer critical lessons and a roadmap for innovation in a shifting climate.

In the past, Burgundy winemakers often faced difficulties ripening grapes in their cooler climate. Rain during the autumn frequently required early harvests, resulting in underdeveloped grapes and lighter wines. Early-maturing varieties like Chardonnay thrived under these conditions, often delivering superior results. Meanwhile, Pinot Noir, which demands more heat to mature fully, struggled, leading to successful vintages only occasionally.

By the 2010s, rising temperatures brought new opportunities. Warmer conditions allowed for earlier harvests and consistently ripe grapes, boosting Burgundy's global standing. Noteworthy vintages, such as 2014 for Chardonnay and 2015, 2016, and 2018 for Pinot Noir, demonstrated the potential for well-balanced, flavourful wines in a warmer climate (Jefford, 2024). Cooler clay-based regions like Pommard and Aloxe-Corton began producing richer, more complete wines, reflecting the benefits of these environmental changes.

The 2020s, however, have introduced more complex challenges. Grapes now ripen faster than before, often reaching maturity in just 90 days instead of the usual 100 (Morrhall, 2020). This



Figure 13 Vineyard in Meursault, Burgundy

rapid development elevates sugar levels, leading to higher alcohol content while simultaneously diminishing aromatic complexity and slowing tannin formation. This dynamic jeopardizes the balance that defines Burgundy wines. Additionally, spring frosts, worsened by earlier budbreak, have become a recurring threat. In 2021, an unexpected frost damaged much of the crop, with Meursault losing up to 70% of its Chardonnay yield. Even in 2022, frost damage, while less severe, underscored the region's increasing vulnerability (Morrhall,2020).

To address the challenges posed by climate change, Burgundy winemakers are employing a range of innovative strategies:

1. **Late Pruning**
 - Delays budbreak to reduce the risk of frost damage.
2. **Pre-Pruning**
 - Removes most old wood during winter, with final adjustments in spring, helping to manage frost risk effectively.
3. **Increasing Vine Density**
 - Helps counteract higher temperatures and preserves acidity and balance in the wines.
4. **Frost Prevention Tools**
 - **Bougies (Wax Candles):** Provide localized heat to protect vines from frost.
 - **Heated Wires:** Raise vineyard temperatures to mitigate frost damage.
 - **Wood-Pellet Stoves with Fans:** Distribute warm air across larger areas to prevent frost formation.
5. **Introduction of Later-Ripening Clones**
 - Helps extend the ripening period and adapt to quicker maturation caused by higher temperatures.
6. **Utilization of Heat-Tolerant Rootstocks**
 - Supports vine health in hotter, drier conditions. (Morrhall,2020)

While these challenges persist, some producers are already looking beyond Burgundy for innovative solutions. Etienne de Montille, who runs Domaine de Montille in Volnay, has turned his focus to the New World and Japan as potential regions for cultivating Burgundy varieties. Recognizing the future climate challenges for Burgundy, Montille proactively explored opportunities for winemaking outside France.

In collaboration with scientists from Dijon University, Montille conducted research across various locations in Japan. Their studies identified Hakodate, situated in the southwest of Hokkaido, as having exceptional potential for growing Burgundy varieties like Pinot Noir and Chardonnay. This forward-thinking approach combines scientific insight with international collaboration, aiming to adapt Burgundy's legacy to emerging climates.

4.3.2 Vinitech, Bordeaux

To stay updated on the latest technological advancements, I visited Vinitech, the world's leading trade fair for equipment and services for the wine, fruit, and vegetable industries, held in Bordeaux. In the vineyard technology section, several advanced innovations caught my attention, including:

- **Automatic Robotic Vineyard Machines:** These robots are designed to perform tasks such as weeding, spraying, pruning, topping autonomously, reducing labour demands while maintaining precision and efficiency.
- **Analytical Tools Using Drones:** Equipped with IT systems, these drones collect and analyse real-time data on vine health, soil conditions, and pest management, providing actionable insights to optimize vineyard management.
- **UV Pest Control Systems:** Utilizing ultraviolet light, these systems offer an eco-friendly and chemical-free solution to pest management, reducing disease pressure and improving sustainability in viticulture.

Ted

The Ted robot, developed by Naïo Technologies, is an autonomous, 100% electric straddling



Figure 14 Demonstration of 'Ted' Autonomous Vineyard Robot by Naïo Technologies
tool designed specifically for vineyard maintenance. Its primary function is to perform precise mechanical weeding between vine rows, offering an eco-friendly alternative to herbicides and promoting sustainable viticulture practices.

Key Features of Ted:

- **Precision:** Guided by RTK GPS, lidar, and camera systems, Ted navigates vineyards with high accuracy, ensuring effective weeding without damaging vines.

- **Versatility:** Equipped with a universal mounting frame, Ted can accommodate a variety of cultivations, making it adaptable to different vineyard maintenance needs.
- **Efficiency:** With a working speed of up to 4.5 km/h and an autonomy of up to 8 hours, Ted can cover up to 5 hectares per day, significantly reducing the labour required for vineyard upkeep.
- **Eco-Friendly Operation:** Ted's electric propulsion minimizes soil compaction and eliminates greenhouse gas emissions, aligning with environmentally sustainable farming practices.

Since its introduction, Ted has been adopted by numerous vineyards seeking to enhance efficiency and reduce reliance on chemical inputs. Its ability to operate autonomously allows vineyard managers to allocate labour resources to tasks with higher added value, improving overall productivity.

Surprisingly, the Ted robot is compact and lightweight, making it easy to transport between vineyard sites. Its price is also relatively affordable, especially when compared to tractors, which can often cost significantly more. Additionally, it operates autonomously, requiring no operator.

The weight of the robot varies depending on its configuration and battery options, ranging from approximately 1,800 kg to 2,230 kg. This relatively low weight is intentional, designed to minimize soil compaction—a crucial factor in vineyard management

Scanopy

In modern viticulture, precision and efficiency are essential for maintaining high-quality vineyards while addressing environmental challenges. Canopy Drone Analysis is an innovative service that leverages advanced drone technology to optimize vineyard management through detailed data collection and analysis. By utilizing high-resolution cameras and sensors, these drones provide vineyard managers with critical insights into canopy health, vigor, and growth patterns.

Key features of the Canopy Drone Analysis Service include:

- **Real-Time Data Collection:** The drones capture precise information on vine health, soil conditions, and potential stress factors, allowing timely and informed decision-making.
- **Comprehensive Mapping:** The service generates detailed, visual maps of the vineyard, highlighting variations in vigor and identifying areas requiring specific interventions.
- **Disease and Pest Monitoring:** Early detection of diseases and pest infestations enables proactive management, reducing potential yield losses and improving overall vineyard health.
- **Resource Optimization:** By pinpointing areas in need of irrigation, nutrients, or canopy management, the service helps to reduce input costs and minimize environmental impact.



Figure 15 Scanopy Booth Showcasing Agricultural Drone Technology for Vineyard Monitoring

However, despite its potential, the adoption of this technology remains limited in the wine industry compared to broader agricultural sectors. Many producers hold strong philosophical beliefs about their winemaking processes and terroir, and some feel that relying on advanced technology like drones may detract from the authenticity or traditional essence of their wines. This reflects the unique mindset within viticulture, where preserving the connection between nature, land, and wine often takes precedence over adopting new technologies.

UV Boosting

UV Boosting technology is an innovative solution designed to enhance vine health and disease resistance using specific UV wavelengths. This technology stimulates the plant's natural defense mechanisms, offering significant benefits for disease control, overall plant health, and reduced dependence on chemicals and sprayers. Its effectiveness is backed by over 100 independent trials conducted over the past decade by regional Chambres d'Agriculture in collaboration with renowned research institutions.

Key Features and Benefits:

- **Disease Resistance:** Stimulates natural defenses, reducing susceptibility to diseases such as powdery and downy mildew.
- **Frost Protection:** A single pass two days before a frost event lowers the freezing temperature of buds, reducing frost damage.
- **Cost Efficiency:** Higher yields can be achieved from the first year of use, making it a cost-effective solution for vineyard management.
- **Chemical Reduction:** Allows up to a 50% reduction in fungicide use, making it compatible with organic and conventional farming systems.
- **Environmentally Friendly:** No negative impact on surrounding flora, fauna, or the vines.



Figure 16 Appearance of UV Boosting Machine

The technology uses UV lamps mounted on a tractor-driven frame, operating at speeds of 2–4 km/h with three to seven passes per year. With over 50 machines currently in operation since the prototype's development in 2017, UV Boosting has proven its value in sustainable vineyard management.

Chapter 5: Conclusion

Hokkaido's viticulture is at a pivotal moment, poised between immense potential and notable challenges. The region's cool climate and unique terroir have already positioned it as a promising player in the global wine landscape. However, its future success will depend on how it addresses critical issues such as climate change, labour shortages, and the adoption of innovative practices. Unlike established wine regions in Europe, where centuries of tradition have shaped practices and defined terroirs, Hokkaido is still in the process of discovering the grape varieties and techniques that best suit its environment. This period of exploration presents both an opportunity and a responsibility to chart a sustainable and innovative path forward.

Climate change has introduced both opportunities and uncertainties. While warmer temperatures have enabled the cultivation of new grape varieties, they have also brought challenges, including unpredictable weather patterns, shifts in grape growth timing, and increased pressure from pests and diseases. These factors underscore the need for Hokkaido's viticulture to adopt adaptive strategies that prioritize efficiency and resilience.

There are four key solutions to address these challenges:

- 1. Mechanisation:** The introduction of mechanisation represents a critical step forward for Hokkaido's vineyards. Mechanised tools, such as pruning machines, harvesters, and canopy management equipment, can significantly reduce the reliance on manual labour while improving consistency in vineyard operations. These technologies have been widely adopted in established wine regions, demonstrating their potential to enhance productivity and reduce operational costs. However, the development of winemaking is a long process, and inflation combined with Japan's weak currency makes it difficult for producers and contractors to obtain new technologies. This financial barrier highlights the need for government support to boost rapid growth in the sector. Subsidies or grants could encourage the adoption of essential mechanisation tools, paving the way for greater efficiency. Over time, as familiarity and confidence in mechanisation grow, the region could also explore advanced tools such as vineyard robots and autonomous tractors. These innovations, while currently viewed as future potential, could further revolutionise vineyard management by automating labour-intensive tasks and addressing persistent workforce challenges.
- 2. Contractor Systems:** Implementing a contractor model is another pivotal solution. In leading wine regions around the world, contractors manage labour-intensive tasks such as pruning, harvesting, and canopy management. These professionals often bring their own specialised equipment, reducing the financial and logistical burden on individual growers. A similar system in Hokkaido could alleviate labour shortages, improve operational efficiency, and promote standardisation of best practices across vineyards. By streamlining resource use and enhancing collaboration, contractors can elevate the quality and competitiveness of the region's viticulture.
- 3. Skilled Labour Schemes:** Developing targeted schemes to attract and retain skilled labour can address the persistent workforce shortages in Hokkaido's vineyards.

Programs that focus on training and upskilling local workers, as well as seasonal labour initiatives, can create a reliable and capable workforce. Introducing specialized visas for vineyard workers, particularly for international labourers with expertise in viticulture, could further help secure the required skills. Learning from successful models in other wine regions, Hokkaido can create a structured approach to managing its labour needs while ensuring fair and sustainable employment practices.

- 4. Education on Viticultural Practices to Adapt to Climate Change:** Climate change has created new challenges for viticulture, requiring growers to adapt their practices to ensure quality and sustainability. Providing education on climate-resilient techniques, such as managing water use, adjusting canopy practices, and selecting grape varieties suited to evolving conditions, is essential for the region's success. Workshops, training sessions, and knowledge-sharing platforms could help growers stay ahead of climate-driven challenges. These educational initiatives can empower growers to implement strategies that mitigate risks, optimize production, and maintain the unique characteristics of Hokkaido's terroir.

While this study has focused on mechanisation, contractor systems, skilled labour schemes, and education as key solutions, it is important to acknowledge other pressing issues, such as the shortage of seedlings and limited access to global knowledge resources, etc. Addressing these challenges will require continued investment in infrastructure and international partnerships to ensure that Hokkaido's growers are equipped with the tools and information they need to succeed.

Globally, the wine industry faces significant challenges, including declining alcohol consumption and economic instability. However, Hokkaido's unique attributes—its cool climate, emerging terroir, and commitment to quality—provide a strong foundation for growth. By embracing innovative practices and developing a unified regional strategy, the region can overcome its obstacles and establish itself as a leader in cool-climate viticulture. The journey ahead will demand resilience, adaptability, and visionary leadership, but the rewards promise to be transformative for Hokkaido's viticultural future.

References

- Central Otago NZ. (n.d.). *The Central Otago Wine Story*. Retrieved from <https://centralotagonz.com/discover/our-stories/central-otago-wine-story-2/>
- Grape Vision Ltd. (n.d.). About Us. Retrieved from <https://www.grapevision.co.nz/about>
- Hokkaido University. (2022). *Growing Hokkaido Into a True Wine-Making Region*. Retrieved from <https://www.global.hokudai.ac.jp/blog/growing-hokkaido-into-a-true-wine-making-region/>
- Japan Meteorological Agency. (n.d.). *Iwamizawa (Sorachi Region) - Normal Values (Annual and Monthly Averages) - Main Elements*. Retrieved from https://www.data.jma.go.jp/obd/stats/etrn/view/nml_sfc_ym.php?prec_no=15&block_no=47413&year=&month=&day=&view=
- Japan Meteorological Agency. (n.d.). *Otaru (Shiribeshi Region) - Normal Values (Annual and Monthly Averages) - Main Elements*. Retrieved from https://www.data.jma.go.jp/obd/stats/etrn/view/nml_sfc_ym.php?prec_no=16&block_no=47411&year=&month=&day=&elm=normal&view=
- Japan Meteorological Agency. (n.d.). *Yoichi (Shiribeshi Region) - Normal Values (Annual and Monthly Averages) - Details (Precipitation)*. Retrieved from https://www.data.jma.go.jp/stats/etrn/view/nml_amd_ym.php?prec_no=16&block_no=0052&year=&month=&day=&view=a1
- Japan Wine.jp. (2021). *Basic knowledge you should know! A thorough explanation of the history of winemaking in Japan!* Retrieved from <https://nihonwine.jp/enjoy-nihon-wine/the-definitive-edition-of-japanese-wine-history/>
- Jefford, A. (2024). *Bourgogne Vintage Chart & Ratings*. Retrieved from <https://www.winescholarguild.com/vintage-charts/french-wine-vintage-chart/bourgogne-vintage-chart>
- Mercer, C. (2024). *Decanter World Wine Awards 2024 Platinum Winners: 97-Point Wines*. Retrieved from <https://www.decanter.com/decanter-world-wine-awards/decanter-world-wine-awards-2024-platinum-winners-97-point-wines-532909/>
- Ministry of Agriculture, Forestry, and Fisheries of Japan. (2024). *Efforts to Adapt to Climate Change in the Agriculture, Forestry, and Fisheries Sectors*. Retrieved from https://www.maff.go.jp/j/kanbo/kankyo/seisaku/kikohendo_tekio_all.pdf
- Morrhall, T. (2020). *The Effect of Global Warming on Burgundy*. Retrieved from <https://www.thewinesociety.com/discover/explore/expertise/the-effect-of-global-warming-on-burgundy/>
- National Research Institute of Brewing. (2019). *The Story of Japan Wine*. Retrieved from https://www.nrib.go.jp/sake/story/pdf/WineNo02_en.pdf
- New Zealand Immigration. (2024). *Work Visa Programs for Seasonal Workers*. Retrieved from <https://www.immigration.govt.nz>
- New Zealand Winegrowers. (2024). *New Zealand Winegrowers Annual Report*. Retrieved from <https://www.nzwine.com/en/media/statistics-reports/nzw-annual-report/>
- New Zealand Winegrowers. (n.d.). *History of New Zealand Winemaking*. Retrieved from <https://www.nzwine.com/en/media/story/history-of-nz-winemaking/>

- Osamura, T. (2024). *Introduction to Hokkaido Wine Industrial History*. Retrieved from https://www.jstage.jst.go.jp/article/ckg/17/1/17_219/_pdf/-char/ja
- Schrieck, P. (2016). Viticulture in terraced steep slopes. *Landinfo (in German)*, 1, 11–15.
- Shizuku Japan. (2024). *A Comprehensive Guide to 150 Years of Japanese Wine History: Charm, Global Recognition, and Easy-to-Drink Wines*. Retrieved from https://shizukujapan.jp/media/news/japanese_wine_history/
- Strub, L., & Loose, S. M. (2016). Steep slope viticulture: An inventory of the area under vines in Germany. *Der Deutsche Weinbau (in German)*, 25-26, 14–18.
- Strub, L., Loose, S. M., & Kurth, A. (2021). The effects of viticultural mechanization on working time requirements and production costs.
- Yoichi Town Municipal Employees' Labor Union. (n.d.). *History of Yoichi and Wine*. Retrieved from https://www.jichiro.gr.jp/jichiken_kako/report/rep_miyagi36/05/0502_jre/index.htm