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# Factors Influencing Grape Growers' Adoption of Clean Plant Materials

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## Executive Summary

**Background:**

Viruses and graft-transmissible pathogens, particularly grapevine leafroll disease viruses, pose serious threats to the U.S. grape industry, resulting in significant yield losses and economic burden. Clean plant programs, supported by the National Clean Plant Network (NCPN), produce clean, virus-tested vines that can substantially reduce these risks. Despite their benefits and economic returns, the adoption of clean vines remains lower than expected.

**Objective:**

This study investigates the barriers to adoption of clean plant materials through a grower survey, with the goal of understanding the economic and behavioral factors shaping growers' decisions.

**Methodology:**

A nationwide survey was conducted in the spring of 2024 with 59 responses from diverse commercial vineyards. The survey assessed vineyard characteristics, virus impact, and clean vine adoption behavior.

**Key Findings:**

- **Virus Impact:** On average, growers reported 32% of their vineyard acreage affected by viruses, with over 70% experiencing increased production costs ranging from under $100 to over $1,000 per acre.
- **Adoption Rate:** 76% of respondents currently use certified clean vines, yet many remain hesitant about full-scale adoption.
- **Top Barriers:**
    - 60% reported a **lack of guarantee** that vines are truly testing negative for economically relevant viruses.
    - 32% reported limited trust in nurseries.
    - 30% faced **limited availability** of clean vines.
    - Only 6% were unaware of clean vine technology, indicating that awareness is not a primary obstacle.
- **Nursery Reliability:** Half of respondents found it difficult to locate trustworthy nurseries.
- **Willingness to Pay:** Most growers were willing to pay $1–$3 more per vine, with 30% willing to pay up to $10 more.
- **Future Adoption:** 83% of growers are likely to adopt clean vines in the future, highlighting strong potential demand.

**Conclusions & Recommendations:**

Despite widespread awareness and willingness to pay for certified clean vines, growers are hindered by uncertainty about vine cleanliness, inconsistent nursery practices, and supply shortages. A **trusted national certification standard**, improved nursery transparency, and

**greater investment in clean plant infrastructure** are urgently needed. Public policies supporting cost-share programs, technical education, and expanded clean vine production can help reduce financial and logistical barriers. Strengthening industry-government collaboration is essential to ensure a reliable clean vine supply chain and promote the sustainable development of the grape and wine industry in the U.S.

## Acknowledgement

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## Introduction

Viruses and graft-transmissible pathogens present significant challenges to specialty crops like grapes, costing the industry billions of dollars annually if left unmanaged (Mannini and Digiaro, 2017). Planting certified, virus-tested vines is critical to preventing disease introduction and maintaining cost-effective production, helping the U.S. grape industry stay competitive globally (Golino et al., 2017; Arnold et al., 2019). To support this, the National Clean Plant Network (NCPN) was established under the 2008 USDA Farm Bill to produce and distribute clean, virus-tested plant material. NCPN-grapes centers comprehensively produce and maintain clean vine stocks, and use advanced diagnostics and therapies to eliminate pathogens, particularly those associated with grapevine leafroll disease (GLRD), one of the most damaging grapevine virus diseases worldwide (Naidu et al., 2014; Fust et al. 2025; Gergerich et al., 2015).

GLRD causes severe yield losses of 30–68%, delays fruit ripening, and significantly lowers fruit quality, affecting sugar content, acidity, tannins, and flavor profiles (Naidu et al., 2014; Fust et al. 2025). The disease spreads through infected planting material and insect vectors like mealybugs and soft scales (Tsai et al., 2010; Naidu et al., 2014; Fust et al. 2025). There is no chemical cure against viruses—infected vines must be removed in diseased vineyards to prevent further spread. Economic studies from New Zealand, New York, and California estimate grower losses from GLRD between $21,000 and $226,000 per hectare over a vineyard's lifespan, depending on infection timing, cultivar, and region (Walker et al., 2004; Nimmo-Bell, 2006; Atallah et al., 2012; Ricketts et al., 2015; Cheon et al., 2020). The most cost-effective vineyard management involves roguing infected vines and replacing them with clean, virus-tested replants in combination with vector control (Pietersen et al., 2017). Fuller et al. (2019) show that planting certified, virus-tested vines substantially reduces grower losses and that the benefits of clean plant programs like UC Davis' Foundation Plant Services exceed costs by at least tenfold annually. More recently, Li et al. (2022) provided strong evidence that public investments in clean plant centers generate significant economic returns, demonstrating that clean plant programs are highly cost-effective for the grape industry.

Given that NCPN centers have consistently produced and maintained clean grape materials for nurseries and growers—and that adopting clean plants yields significant industry and grower benefits (Fuller et al., 2019; Li et al., 2022), one would expect widespread adoption of clean planting materials during vineyard replanting and establishment. However, discussions with industry experts and stakeholders indicate that adoption rates in practice may fall short of expectations. This raises an important research question: what hinders growers from consistently adopting clean plant materials? Understanding the barriers to adoption and the economic or behavioral factors influencing growers' decisions is critical.

## Materials and Methods:

We conducted a survey to examine the factors influencing growers' adoption decisions regarding clean plant materials. The survey design process began in January 2024, focusing on grape growers' adoption behavior. In March, we conducted phone and in-person interviews with 5 New York vineyard growers to pretest the survey instrument and gather feedback on the clarity, relevance, and structure of the questions. Insights from these interviews informed subsequent revisions to the survey[1], which was refined and validated in April 2024 with New York growers, extension specialists, and experts to enhance its reliability and effectiveness. The finalized survey was launched in May 2024, marking the beginning of the data collection phase. This survey was approved by the Cornell University Internal Review Board. A copy of the survey is provided in the supplementary material.

To recruit participants, we utilized multiple distribution channels to maximize outreach and engagement. Specifically, the survey was disseminated through the Finger Lakes Grape Program newsletter in New York, a nursery email list, the National Grape Research Alliance newsletter, and the Foundation Plant Services Twitter account. We also developed a flyer containing the survey link and asked these partner organizations to assist with its distribution. Figure 1 displays the flyer used for survey promotion.

Figure 1: Flyers for recruiting growers

[1] Initially, we designed a discrete choice experiment (DCE) to examine whether growers value different attributes of clean planting material differently, such as price, certification, efficacy rate (the likelihood of the vine being disease-free), and neighboring vineyard adoption. Following the initial design, we conducted phone and in-person interviews with growers in March 2024 to gather feedback. Through these conversations, we learned that growers overwhelmingly identified efficacy rate as their primary concern, with other attributes perceived as significantly less important. Based on this insight, we reevaluated the suitability of the DCE approach, as the lack of meaningful trade-offs across attributes suggested it may not effectively capture growers' decision-making behavior in this context. As a result, we revised the study design and developed a survey questionnaire explicitly asking growers about their concerns and perceptions regarding clean planting materials.


The survey questionnaire was designed using Qualtrics, and the data collected were stored in Excel for analysis. The survey takes approximately five minutes to complete and begins with an introduction outlining its objectives, followed by a formal consent form. Participants could proceed with the survey only after providing their consent.

The survey consisted of three parts. The first part gathered information on vineyard characteristics and grower demographics, including vineyard size, zip code (or region), contract growing status, total land in production (acres), land allocated to red vinifera varieties (acres), average cost per vine when purchasing from nurseries, and the respondent's years of experience in vineyard management.

The second part focused on the impact of viruses on growers' vineyards. It included questions about the percentage of the vineyard affected by viruses and the estimated average financial loss due to viral diseases over the past five years (reported in dollars).

The third part assessed growers' adoption of clean vines and the factors influencing their decisions. It includes questions about whether growers currently use clean vines, their main concerns regarding adoption, the difficulty of finding reliable nurseries, their willingness to pay a premium for clean vines, the amount they are willing to pay compared to traditional vines, and their likelihood of adopting clean vines in the future.

The survey concluded with an open-ended question inviting growers to share any additional comments or concerns regarding clean planting materials and the certification program.

## Survey Results

In this section, we present the survey results corresponding to each component of the questionnaire. A total of 59 complete responses were collected. Respondents were grouped into four regions based on their zip codes. The majority (71.19%) were located in the West (e.g., California, Oregon, Washington), followed by the East (e.g., New York, New Jersey,

Pennsylvania, Maine) at 16.95%, the South (e.g., Delaware, North Carolina, Mississippi) at 8.47%, and the Midwest (e.g., Michigan, Missouri) at 3.39%.

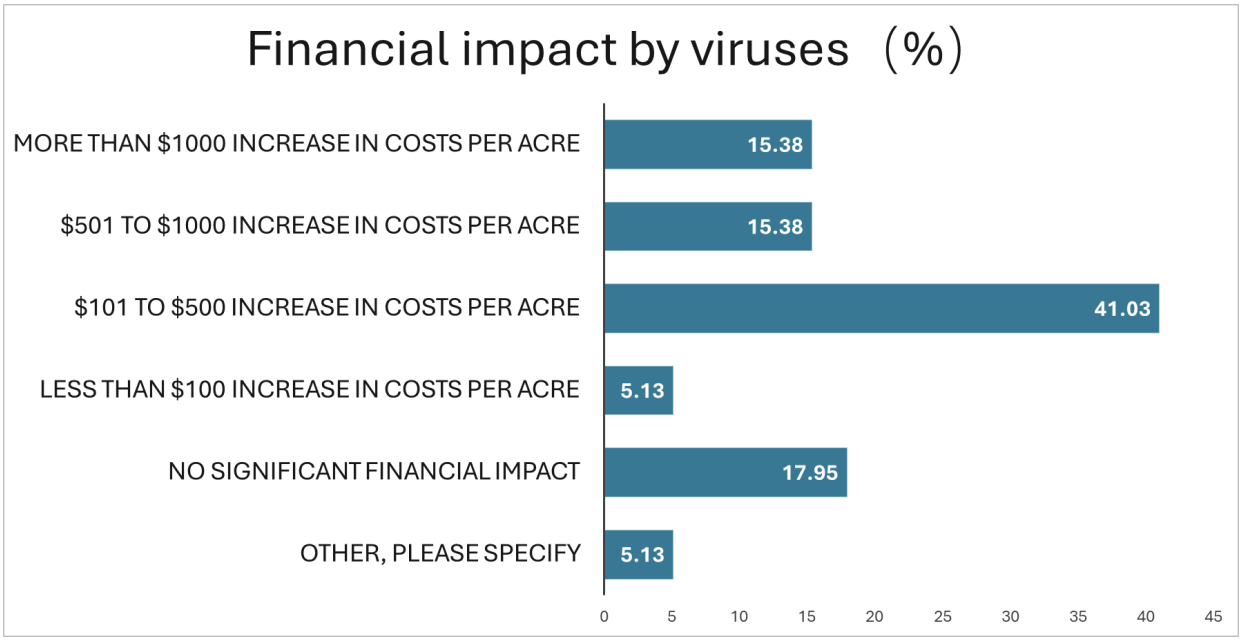
Among respondents, approximately 75% reported managing large vineyards with over 1,000 acres. An additional 15% operated vineyards ranging from 50 to 1,000 acres, while 10% managed small vineyards with less than 50 acres. On average, respondents reported 786 acres of vineyard land in production, with 491 acres dedicated specifically to red vinifera varieties. These results indicate that while the sample includes a range of vineyard sizes, it is primarily composed of large-scale commercial operations with a strong emphasis on red vinifera production.

The average reported cost per vine purchased from nurseries was $5.30, with a standard deviation of $3.30. The average price is consistent with our expectation and with industry standards. However, the wide variation indicates that some growers pay significantly more or less than the average, largely due to differences in production scale, vine quality, and grape variety. In terms of experience, respondents reported an average of 23 years managing vineyards, ranging from 1 year to 65 years, demonstrating substantial diversity in growers' experience levels.

Next, we asked participants about the impact of viruses on their vineyards. Based on responses from vineyard growers, the average reported proportion of vineyard acreage affected by the virus is 32%. However, the large standard deviation of 32.6% highlights considerable variation among growers. Some vineyards experienced minimal or no impact, while others faced severe infection rates, with over half—or even most—of their vineyard affected.

We also asked respondents to estimate the financial impact of virus infections, with results summarized in Figure 2. The data show that viruses have led to increased production costs for most vineyards. Specifically, 41.03% of respondents reported an additional $101 to $500 per acre in costs. Another 15.38% experienced increases between $501 and $1,000 per acre, while 15.38% reported costs exceeding $1,000 per acre, indicating significant financial burdens for some growers. A smaller group (5.13%) faced less than $100 per acre in additional costs, while 17.95% reported no significant financial impact. Additionally, 5.13% selected "Other," indicating unique situations or impacts not fully captured by the predefined categories. The results suggest that virus infections remain a substantial economic concern for many vineyard growers, with the majority experiencing moderate to severe financial impacts.

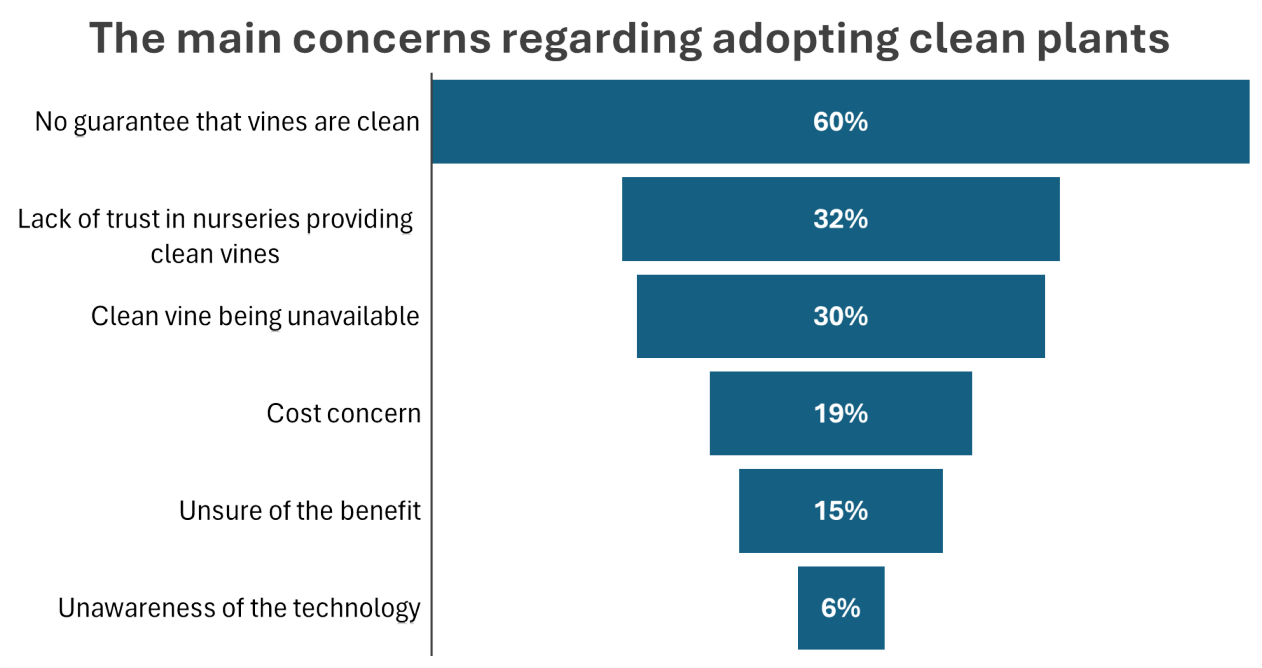
Figure 2: Financial impact by viruses over the past five years




Before asking growers about their current use of clean vines, we first provided a clear definition to ensure a consistent understanding. Clean vines were defined as: "*These are plants derived from mother vines that have been extensively tested for viruses at nurseries and found to be free of specific viruses known to impact vine health, such as leafroll and red blotch viruses*."

A natural starting point was to ask whether growers currently purchase clean vines. Surprisingly, 76% of participants reported that they use clean vines in their vineyards, suggesting that clean vine adoption is already common practice among many vineyard growers. Given that the primary objective of our survey is to understand growers' concerns regarding the adoption of clean planting materials, we asked participants to select their top two concerns from a provided list. The results are presented in Figure 3.

Figure 3: The main concerns regarding adopting clean plants



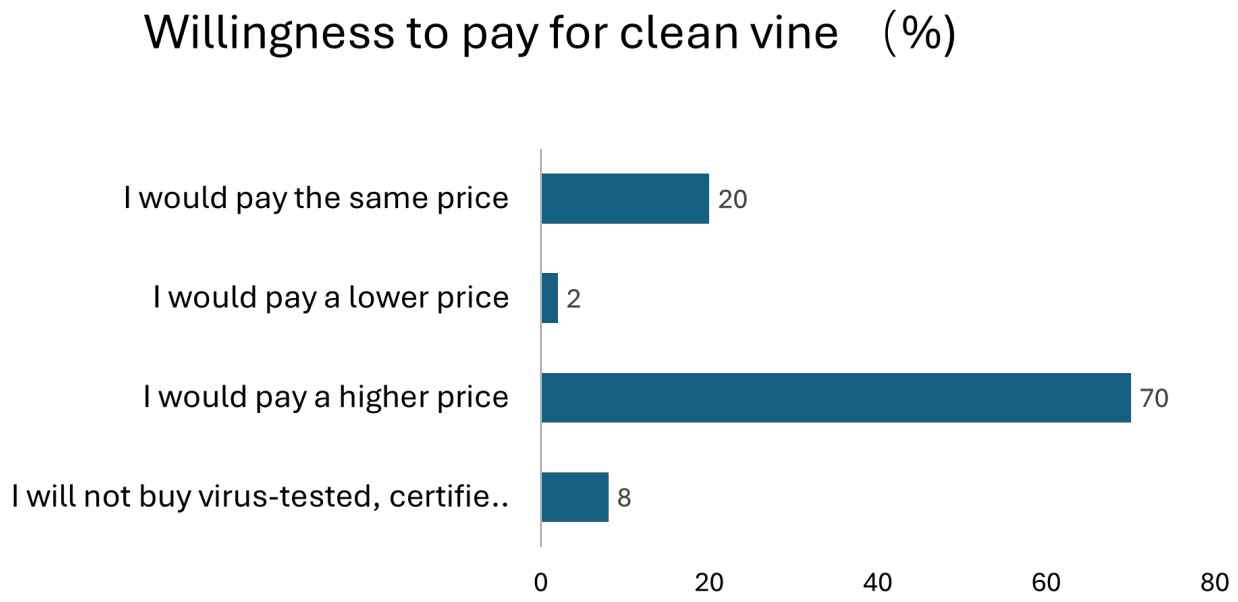

The results show the main concerns growers have about adopting clean plants. The top concern, cited by 60% of respondents, is the lack of guarantee that vines are truly clean. 32% expressed a lack of trust in nurseries providing clean vines, while 30% were concerned about the unavailability of clean vines. Cost concerns were noted by 19%, and 15% were unsure of the benefits of adopting clean plants. Lastly, 6% of respondents indicated unawareness of the technology as a barrier. Overall, the biggest challenges relate to confidence in vine cleanliness and the reliability of nurseries.

This suggests that the biggest barrier to adopting clean plants is trust and confidence—growers are primarily concerned about the lack of guaranteed vine cleanliness and trust in nurseries delivering truly clean vines. Even if growers are willing to adopt clean plants, many fear the investment may not protect them if the plants are still infected. Additionally, supply issues (clean vines being unavailable) and cost concerns further discourage adoption. The fact that only a small percentage are unaware of the technology or unsure of its benefits indicates that awareness is not the main issue—rather, growers need stronger assurances, transparency, and reliable certification systems to increase adoption.

We also asked participants to rate the difficulty of finding reliable nurseries on a Likert scale ranging from 1 (extremely easy) to 5 (extremely difficult). Overall, 50% of respondents reported experiencing some level of difficulty (somewhat difficult or extremely difficult), while 18% indicated that finding reliable nurseries was neither easy nor difficult. These results suggest that locating trustworthy nurseries remains a significant challenge for many growers, potentially contributing to hesitancy in adopting certified clean vines.

To assess growers' willingness to pay for clean vines, we presented the following scenario: "When buying grapevines from a reputable nursery, are you willing to pay a higher price for a virus-tested, certified vine compared to a non-certified vine priced at $5?" The results of this question are presented in Figure 4.

Figure 4: Growers' willingness to pay for clean vines




Most growers recognize the value of certified clean vines and are willing to pay above the market price of $5 per vine to reduce virus risks. However, a notable portion (20%) remains hesitant, depending on specific conditions, and a small group is unwilling to pay extra, likely due to cost concerns or skepticism about the added value. This highlights both demand potential and the need to address grower concerns around pricing, certification, and benefits.

As a follow-up, participants who indicated a willingness to pay a higher price for clean vines were asked how much more they would be willing to pay. The results show that among those willing to pay a premium, the majority (65%) were comfortable with a moderate price increase of $1 to $3 per vine, reflecting strong demand as long as the additional cost remains reasonable. Meanwhile, 30% of respondents were willing to pay a significantly higher premium of $3 to $10 per vine, indicating that some growers place substantial value on the assurance of vine cleanliness and are willing to invest more to reduce the risk of virus infections. Overall, these findings suggest that while price sensitivity exists, there is a segment of growers willing to make substantial investments in clean plant materials if doing so ensures better vine health and long-term productivity.

Regarding the likelihood of using clean vines in the future, the data show that the vast majority of participants (83%) are positively inclined toward future adoption, demonstrating strong potential demand for certified clean planting material. Specifically, 67% reported they are extremely likely to adopt clean vines, while another 17% indicated they are somewhat likely.

These responses suggest that most growers recognize the value of clean vines in reducing virus risks and improving vineyard health. The high percentage of growers indicating extreme likelihood further suggests that, if key barriers such as cost, availability, and trust in nurseries are addressed, adoption rates could increase significantly in the future.

Finally, to capture additional perspectives, we invited growers to share any comments or concerns regarding clean planting materials and the certification program. Based on their responses, we categorized the comments into three main groups: 35% focused on the quality of and trust in certified vines, 30% raised concerns about cost and the economic sustainability of operating a vineyard or winery, and the remaining 35% addressed virus management and disease spread. Figures 5–7 provide examples of growers' comments across these categories.

Figure 5: Growers' concern and comments regarding quality and trust in certified vines

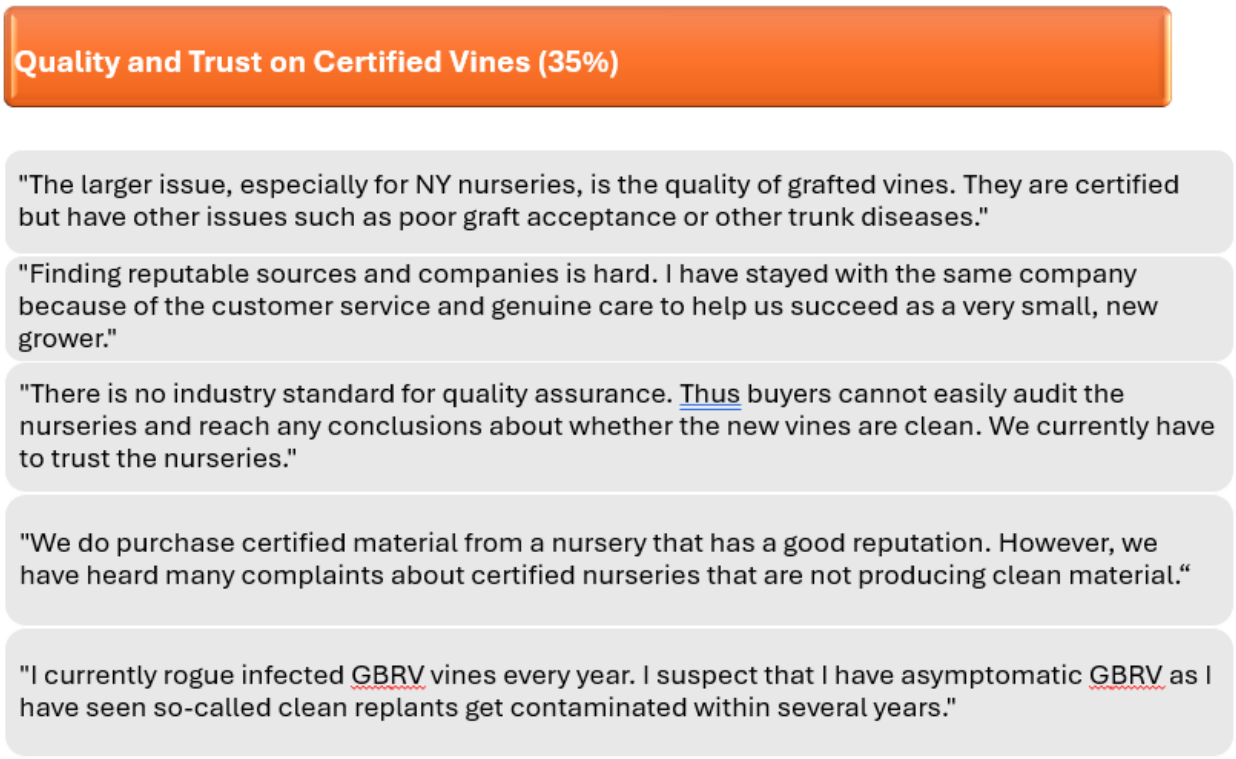


Figure 6: Growers' concern and comments regarding cost and economic sustainability

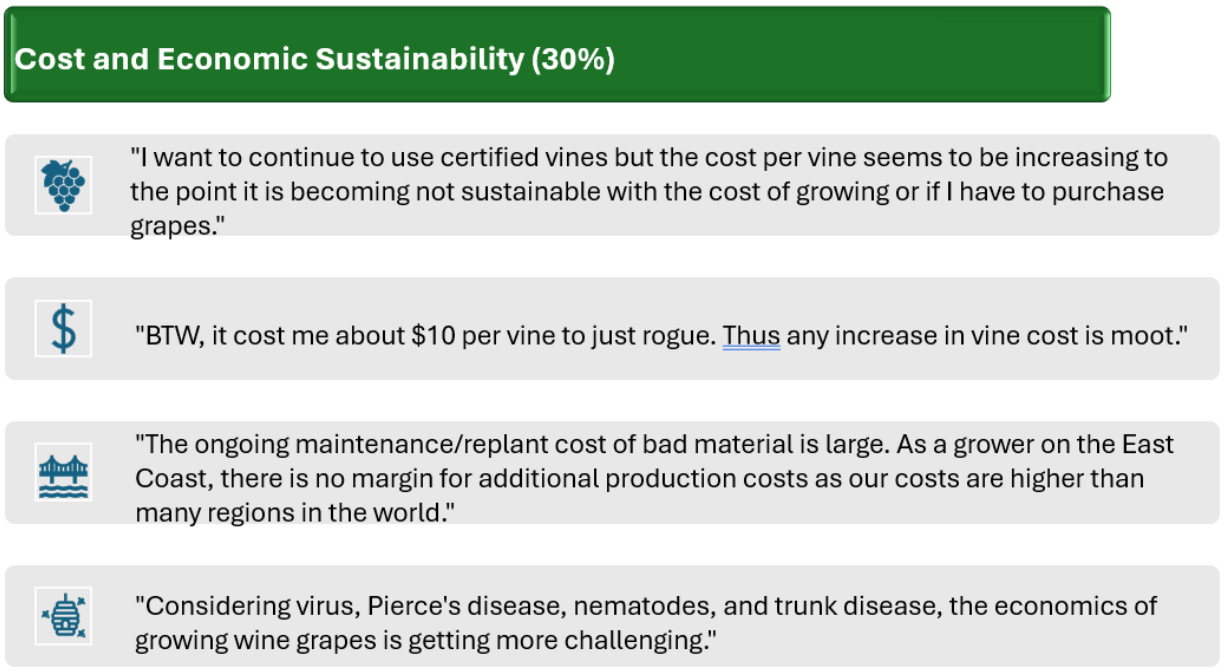
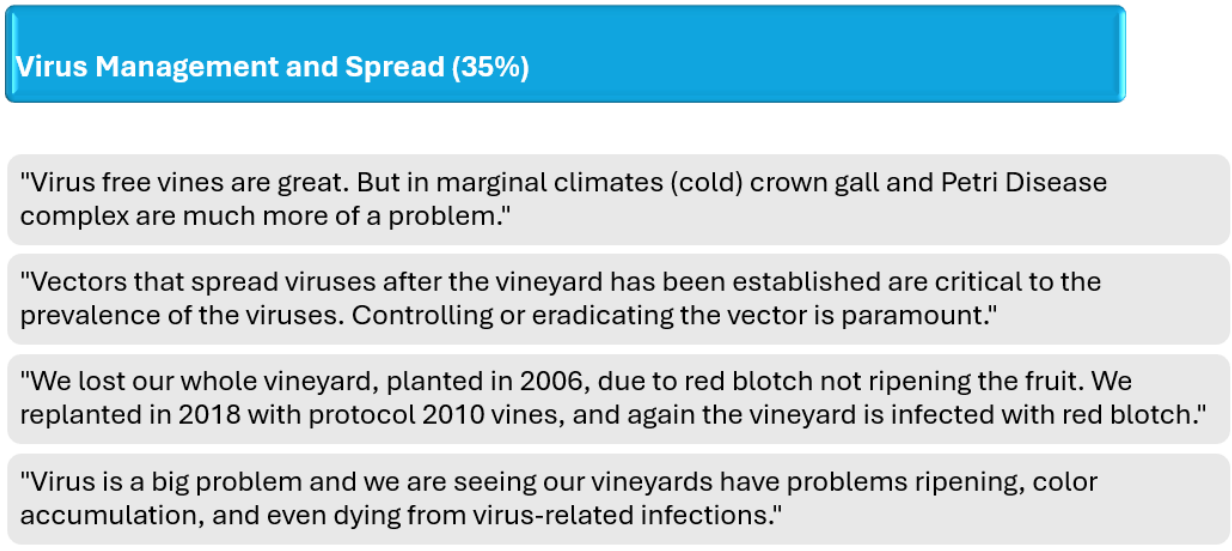



Figure 7: Growers' concern and comments regarding virus management and spread




## Conclusion and Discussion

This study aimed to understand the barriers and grower perceptions surrounding the adoption of certified clean vines in the U.S. grape industry. Using a targeted grower survey, we collected data on vineyard characteristics, virus impacts, and attitudes toward clean plant materials. The

results reveal that while most growers recognize the value of certified clean vines and are willing to pay a premium, significant barriers remain.

The main barriers to adopting clean vines are the lack of guarantees regarding vine cleanliness, limited trust in nurseries, and restricted availability of certified clean vines. While many growers are willing to pay a high premium for truly clean vines, they express serious doubts about the reliability of current sources and the actual cleanliness of the vines they purchase. These findings highlight a clear need for an industry-wide standard and a trusted certification program to ensure vine quality and build grower confidence in adopting clean planting materials.

In addition to concerns about certification and trust, growers face persistent challenges with virus management. While certified clean vines help reduce the risk of infection, they do not eliminate it entirely. Viruses like grapevine red blotch and diseases such as crown gall can still spread through vectors, soil, or neighboring vineyards, leading to reinfection and ongoing financial strain. Economic pressures are also a major concern, as the rising cost of certified vines and the continuous need for maintenance practices like roguing infected vines add significant financial burdens—particularly in high-cost production regions like the East Coast. Balancing vine health and quality with affordability remains a critical challenge for growers.

The findings highlight a clear need for the grape industry to strengthen certification systems and establish transparent, enforceable standards that guarantee vine cleanliness. Improving trust in nurseries is critical, and this can be achieved by enhancing diagnostic testing, maintaining better records, and openly communicating with growers about vine health. Additionally, the industry must work to expand the production and availability of certified clean vines to ensure that supply can meet demand, particularly during replanting cycles. Industry groups also have a role in promoting the best practices, emphasizing that certified clean vines reduce the risk of virus introduction, ongoing management, such as vector control and roguing, remains essential to minimizing reinfection and long-term losses.

For government and public programs like the National Clean Plant Network (NCPN), the results underscore the importance of continued and expanded funding to support clean plant centers, diagnostics, and advanced pathogen detection technologies. Policymakers should consider developing financial incentives or cost-share programs to help growers offset the higher upfront costs of certified clean vines and the ongoing expenses of virus management, especially in high-cost production regions. Additionally, investing in further research, economic analysis, and grower education programs can strengthen adoption by providing clearer evidence of the long-term benefits of clean vines. Lastly, stronger collaboration between industry and government is needed to develop uniform national standards for certification and nursery practices, reducing uncertainty and ensuring the reliability of the clean vine supply chain.

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NCPN Grower Survey

**Consent form** We are inviting you to participate in a research study titled "factors affecting vineyard growers' demand for clean, certified plant material". This study is being led by Dr. Jie Li and Dr. Miguel Gomez from the Dyson School of Applied Economics and Management at Cornell University. This study is being funded by a grant from the United State Department of Agriculture (USDA).

**What the study is about** The purpose of this study is to investigate vineyard growers' demand for clean, certified grape plant material. The goal of the research is to understand the key factors affecting growers' adoption decision of clean, certified planting stocks.

**What we will ask you to do** We will ask you to complete a short online survey questionnaire (**about 5 minutes**) to the best of your knowledge.

**Risks and discomforts** We anticipate that your participation in this survey presents no greater risk than your everyday use of the Internet.

**Benefits and Incentives** There are no direct benefits and incentives to this study beyond your contribution to a research project.

**Privacy/Confidentiality/Data Security** No personal identifiers other than your winery name will be collected in this study. We will do our best to keep your participation in this research study confidential to the extent permitted by law; however, it is possible that other people may need to review the research records and may find out about your participation in this study. For example, the following people/groups may check and copy records about this research:

The Office for Human Research Protections in the U. S. Department of Health and Human Services

The research study sponsor, USDA

Cornell University's Institutional Review Board and the Office for Research Integrity and Assurance

**Sharing De-identified Data Collected in this Research** De-identified data from this study may be shared with the research community at large to advance science. We will remove or code any personal information that could identify you before files are shared with other researchers to ensure that, by current scientific standards and known methods, no one will be able to identify you from the information we share. Despite these measures, we cannot guarantee anonymity of your personal data.

**Taking part is voluntary** Participation in this research study is completely voluntary. You have the right to withdraw at any time.

**If you have questions** The main researchers conducting this study are Miguel Gomez (mig7@cornell.edu) and Jie Li (jl2522@cornell.edu) from Cornell University. If you have questions about the research, you may contact them. If you have any questions or concerns regarding your rights as a subject in this study, you may contact the Institutional Review Board (IRB) for Human Participants at 607-255-6182 or access their website at https://researchservices.cornell.edu/offices/IRB. You may also report your concerns or complaints anonymously through Ethicspoint online at www.hotline.cornell.edu or by calling

toll free at 1-866-293-3077. Ethicspoint is an independent organization that serves as a liaison between the University and the person bringing the complaint so that anonymity can be ensured.

Statement of Consent

If you consent to participate in the proposed study, please click on the "Yes, I approve" box below.

☐ Yes, I approve (7)

☐ No, I do not approve (8)

*Skip To: End of Survey If Consent form We are inviting you to participate in a research study titled "factors affecting vin... = No, I do not approve*

What is the name of your winery/vineyard?

_____

What is the zipcode of your vineyard?

_____

How many years of experience do you have in growing grapes?

_____

How many acres of land do you have in production now?

_____

What grape varieties do you grow in your farm? (Select all that applies)

☐ White Vitis vinifera

☐ Red Vitis vinifera

☐ Native American

☐ Hybrid

☐ Others

Do you often grow grapes under any sort of contract?

☐ Yes (1)

☐ No, please explain (2) _____

Have any of your vines been affected by viruses like leafroll or red blotch?

☐ Yes (1)

☐ No (2)

*Display this question:*

*If Have any of your vines been affected by viruses like leafroll or red blotch? = Yes*

Which grape varieties are impacted most by the virus?

☐ Hybrid

☐ Red Vitis vinifera

☐ Others _____

*Display this question:*

*If Have any of your vines been affected by viruses like leafroll or red blotch? = Yes*

What percentage of your vineyard has been impacted by the virus?

*Display this question:*

*If Have any of your vines been affected by viruses like leafroll or red blotch? = Yes*

What has been the **financial impact** of grapevine viruses on your vineyard **per acre each year over the past five years**? The overall financial impact includes changes in yield, higher management costs, or other financial impacts.

☐ No significant financial impact

☐ Less than $100 increase in costs per acre

☐ $100 to $500 increase in costs per acre

☐ $501 to $1000 increase in costs per acre

☐ More than $1000 increase in costs per acre

☐ Other, please specify _____

Are you currently using clean, certified grape vines in your vineyard? These are plants that derive from mother vines that been extensively tested for viruses at nurseries and found to be free of specific viruses known to cause issues with vine health such as leafroll and red blotch viruses.

☐ No (1)

☐ Yes (2)

What are the main constraints or issues for you to adopt (or not adopt) clean, certified vines? (Select up to 2 reasons)

☐ Unaware of the technology

☐ Concerns about cost/affordability

☐ Unsure of the benefits

☐ Clean vine being unavailable from nurseries

☐ No trust in the nurseries who provide the clean vines

☐ No guarantee that vines are clean

☐ Other (please specify): _____

*Display this question:*

*If Are you currently using clean, certified grape vines in your vineyard? These are plants that deri... = Yes*

How would you rate your experience with finding trustworthy nurseries that sell clean, certified grape vines?

☐ Extremely difficult

☐ Somewhat difficult

☐ Neither easy nor difficult

☐ Somewhat easy

☐ Extremely easy

How much, on average, do you pay for **a vine** in a nursery?

_____

When buying grapevines from a reputable nursery, are you willing to pay for a higher price for a clean, certified vine compare to a non-certified vine that sells at $5?

☐ I would pay a lower price

☐ I would pay the same price

☐ I would pay a higher price

☐ I will not buy virus-tested, certified vine

*Display this question:*

*If When buying grapevines from a reputable nursery, are you willing to pay for a higher price for a... = I would pay a higher price*

How much more would you be willing to pay for a clean, certified vine compared to a non-certified vine?

_____

*Display this question:*

*If When buying grapevines from a reputable nursery, are you willing to pay for a higher price for a... = I would pay a lower price*

How much less would you be willing to pay for a clean, certified vine compared to a non-certified vine?

_____

We really value your input, especially when it comes to **your challenges in adopting the clean, certified grapevines**. Could you spare a moment to share your thoughts with us? To share your thoughts, you have two options: you can either **type your response** or **record your thoughts** using the audio feature. Please select your preferred method to proceed.

☐ I like to type my response (1)

☐ I like to record my response (2)

*Display this question:*

*If We really value your input, especially when it comes to your challenges in adopting the clean, ce... = I like to type my response*

Please type your response here:

_____

_____

_____

_____

_____

*Display this question:*

*If We really value your input, especially when it comes to your challenges in adopting the clean, ce... = I like to record my response*

To record your response, click the **"record audio"** button and share your thoughts on your challenges in adopting clean, certified grapevines. Please keep your recording under 10 minutes! Below are step-by-step instructions on how to record your audio.

Thank you so much for your time! This is the last question of the survey. How likely will you consider using clean, certified vines in the future?

- ☐ Extremely likely (1)
- ☐ Somewhat likely (2)
- ☐ Neither likely nor unlikely (3)
- ☐ Somewhat unlikely (4)
- ☐ Extremely unlikely (5)

# OTHER A.E.M. EXTENSION BULLETINS

| EB No | Title | Fee (if applicable) | Author(s) |
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