Sustainability in the Dutch houseplant nursery industry: Barriers and drivers

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ABSTRACT

This research investigates the adoption of sustainable practices within the houseplant nursery industry, focusing on understanding the barriers and drivers influencing such practices. Utilizing a qualitative methodology, semi-structured interviews were conducted with key stakeholders from March 28th to May 2nd, 2024, employing purposive sampling to gather insights from sustainability managers, regulatory authorities, and general managers of houseplant nurseries. Data analysis followed three coding phases: open, axial, and selective coding, organized around, market/economic, institutional/regulatory, socio-cultural and technological factors. Financial constraints, regulatory complexities, and misinformation and fear emerged as significant challenges, exacerbated by the absence of exclusive trading relationships and a fragmented industry culture. Conversely, strong market demand, certification standards, and intrinsic motivation were identified as drivers, alongside regulatory mechanisms and collaborative initiatives. The findings align with existing literature on financial, regulatory, and socio-cultural challenges but also highlight unique industry-specific obstacles. This underscores the need for targeted strategies to overcome barriers and leverage drivers, fostering sustainability within the houseplant nursery industry. While acknowledging limitations, including sample size constraints and geographical scope, the research provides valuable insights for future endeavours aiming to promote sustainability in similar sectors.

Keywords: Sustainability, Sustainable Entrepreneurship, Barriers, Drivers, Houseplant nursery industry, SBMI.

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1 INTRODUCTION

The escalating global temperatures, as emphasized by the IPCC (2018) report urging to limit global warming to 1.5°C, place an urgent demand for sustainable practices across all industries, including the indoor plant sector. Indoor plant production has evolved into a highly specialized form of agriculture, marked by technological advancements such as heated greenhouses, artificial fertilizers, and assimilation lighting (Lazzerini et al., 2014). This specialization, coupled with intensive resource use, contributes significantly to environmental impacts, including greenhouse gas emissions and depletion of natural resources (Darras, 2020). In contrast to conventional agriculture, the indoor plant industry relies heavily on greenhouses, intensive labour, and technology, along with substantial inputs of fertilizers and pesticides (Abeliotis et al., 2016; Russo et al., 2008; Sahle and Potting, 2013). Recent studies have highlighted the Global Warming Potential (GWP) of various houseplants, accentuating the environmental consequences of container use and electricity consumption (Darras, 2020). The pressing need for sustainability in this sector is further underscored by the high energy demands of popular plants like Phalaenopsis and Fiscus (Lazzerini et al., 2014). Given these environmental impacts, sustainable entrepreneurship becomes essential in innovating and implementing practices that reduce ecological footprints. Sustainable entrepreneurship encompasses identifying, generating, assessing, and utilizing opportunities to develop future products and services aligning with sustainable development goals (Pacheco et al., 2010). It prioritizes preserving nature, supporting life, and benefiting communities while pursuing economic and non-economic gains (Shepherd & Patzelt, 2011). In the houseplant nursery industry, this entails crafting approaches to minimize environmental footprints while ensuring profitability. The sector is at a pivotal moment where sustainability requirements converge with business objectives.

The Dutch houseplant nursery industry, recognized for its vital role in societal well-being through indoor plant integration (Qin et al., 2013; Han et al., 2022), accounted for a net export value of 2.6 billion euros in 2023 (Floridata, 2024). While being a significant contributor to the country's economy the environmental impact should not be overlooked. The impact of the horticulture sector on greenhouse emissions in the Netherlands is significant. In 2022, the total greenhouse gas emissions from greenhouse horticulture amounted to 4,9 Mton[1] (Wageningen University & Research, 2023). That year, 32% of the total greenhouse emissions by agriculture in the Netherlands was caused by the use of natural gas in greenhouses (Brand, 2023). The sector faces increasing pressure to adopt sustainable practices. This pressure is driven by escalating consumer demands, NGO scrutiny, and impending regulatory frameworks like the EU Corporate Sustainability Reporting Directive (CSRD) (Haasnoot et al., 2022; Reichheld et al., 2023). The industry is gradually shifting towards sustainability, with initiatives such as the Floriculture Sustainability Initiative (FSI) mandated certification by Royal FloraHolland in 2026 (Royal Flora Holland, 2024a). This initiative reflects the sector's acknowledgment of the increasing societal demand for sustainable practices, aligning with the objectives outlined in the Covenant Energietransitie Glastuinbouw to become climate neutral by 2040 (Glastuinbouw Nederland, 2022). In addition to that, in 2024, the European Commission has endorsed the Product Environmental Footprint (PEFCR) method as the most suitable approach for measuring environmental sustainability. Which allows for an even playing field and prevents greenwashing within the floriculture sector. It not only raises awareness but also highlights areas where further sustainability improvements are needed (Royal Flora Holland, 2024b).

However, despite the notable progress, achieving full sustainability and climate neutrality in 2040 remains challenging. Pursuing sustainability can be hindered by factors like operational

[1] Mton refers to megaton, which is a unit of measurement equivalent to one million metric tons

constraints and financial considerations (Menon & Ravi, 2021). A part of the growers in floriculture believe that the industry should progress toward sustainable production practices, while others feel they already take care of the environment (Tambascio, 2008). Research on sustainability barriers and drivers has been extensive across various sectors, including agriculture & horticulture. However, it remains limited within the houseplant nursery industry. Since the specific barriers and drivers of sustainability in this sector are not yet known this research will be aimed at investigating: ***What are the barriers and drivers of sustainability in the houseplant nursery industry within the Netherlands?*** Understanding these unique challenges and motivations is essential for policymakers and growers to develop effective strategies that advance environmental responsibility. As the industry navigates towards sustainability, addressing these challenges and embracing sustainable cultivation practices are imperative for reducing its environmental footprint and ensuring long-term viability.

In the forthcoming literature review, this report will explore the environmental impact of the houseplant sector and review the concept of Sustainable Business Model Innovation (SBMI). Additionally, it will conduct a systematic analysis of the market/economic, technological, institutional/regulatory, and socio-cultural factors that act as both barriers and drivers for sustainability, SBMI and circularity within diverse industries. Subsequently, the methodology chapter will clarify the data collection process, the analysis methods employed, and the ethical considerations paramount to this research. Following this, the results section will analyse identified barriers and drivers within the houseplant sector gained from expert interviews. The discussion will compare these findings with existing literature highlighting unique industry-specific factors. In addition to that, it will discuss the implications of the study's findings for promoting sustainability in the houseplant sector, while also addressing any limitations and suggesting future research directions.

2 THEORY

The literature review is divided into sections: introducing the house plant sector and sustainability, defining SBMI and examining barriers and drivers in existing literature. It provides a structured analysis to understand SBMI's challenges, motivations, and theoretical underpinnings, essential for framing interview questions and guiding data analysis.

2.1 The houseplant segment and its environmental impact

The houseplant sector is also known as the indoor plants sector, which is part of the potted plants segment of the floriculture domain within horticulture. Potted plants are part of the ornamentals domain, which consists out of the most diversified products and fast-changing industry of horticulture (Volckaert & Gobin, 2014). They include a very big and diverse group of whole plants or parts of plants that are grown usually for decorative purposes (Yahia, 2019). Implementing indoor plants in houses and offices results in a positive effect on our health and overall happiness (Qin et al., 2013; Han et al., 2022). In contrast to conventional agriculture, horticulture and floriculture industry relies heavily on greenhouses, intensive labour, and technology, along with substantial inputs of fertilizers and pesticides (Abeliotis et al., 2016; Russo et al., 2008; Sahle and Potting, 2013). An assessment conducted by Versnellingshuis Circulaire Economie 2021, sheds light on the Dutch indoor plant segment its environmental impact. It identifies energy consumption and soil usage as key drivers, with variations observed across plant species. Importantly, energy remains a significant factor, compounded by the impact of plant materials and transportation, particularly for imported species. This is supported by Wandl and Haberl, 2017; Soode et al., 2015 which studied the emissions of ornamentals, with emissions per product for products like Orchids (4.2 kg CO_2e[2]) and Cyclamen (5.6 CO_2e). The majority of emissions, accounting for 76%, are attributed to

[2] CO_2e denotes carbon dioxide equivalent, a unit for measuring carbon footprints

greenhouse heating, followed by substrate at 7% and greenhouse infrastructure at 5%. Fuel used for soil sterilization represents 4% of emissions, while another 4% comes from the use of peat (Darras, 2020). Notably, fertilizer, pesticides, and pots are found to have minor relevance in terms of emissions, according to this study.

2.2 Sustainable business model innovation

This research focusses on the barriers and drivers of sustainability which resonates with SBMI. SBMI is a change in the way a firm operates in order to create positive impacts or to reduce negative consequences for the environment and society (Ferlito & Faraci, 2022). By providing a solution to global challenges such as climate change and poverty, SBMI can shape markets and society (Schaltegger et al, 2016). SBMI can thus be defined as innovation to create significant positive impacts, and significantly reduce negative impacts for the environment and society, through changes in the way the organization and its value-network create, deliver and capture value or change their value propositions (Bocken et al., 2014).

2.3 Barriers and drivers of sustainability

The transition towards sustainability in the indoor plant sector is influenced by a complex varietyof barriers and drivers, necessitating a systematic approach to understand and address these factors. This section follows a categorical framework to dissect these elements, drawing on insights from Grafström and Aasma (2021), Paletta et al. (2019), McCarthy and Schurmann, (2014)’s work on circularity and horticulture. The framework is divided into four key categories: market/economic, institutional/regulatory, socio-cultural and technological barriers and drivers, each encompassing specific challenges and motivations that impact the adoption and implementation of sustainable practices within the indoor plant segment. While research directly addressing this context is limited, insights from related fields such as circularity, SBMI,

agriculture, and horticulture are drawn upon to provides a comprehensive understanding. The inclusion of literature from circularity, SBMI, agriculture, and horticulture is justified by the shared themes and challenges in sustainability practices across these fields, each offering valuable perspectives on sustainability adoption relevant to the houseplant industry. Circularity literature informs sustainable resource utilization and waste reduction, while SBMI literature offers insights into integrating sustainability principles into business models. Additionally, agriculture and horticulture literature provide context-specific challenges and opportunities for sustainable practices applicable to the houseplant industry. Through this exploration, this literature review aims to clarify the current state of knowledge surrounding sustainability in the houseplants industry and to lay the groundwork for comparative analysis with empirical findings. The following section will provide a deeper exploration of the subcategories of barriers and drivers.

First, market barriers and drivers explore the economic dynamics, consumer demand, and competitive landscape that shape the industry's move towards sustainability. Grafström & Aasma (2021) identified significant market barriers such as high upfront investment, poor access to finance, lack of a well-established market, and inconsistent policies across countries. These factors are critical in the houseplant nursery industry, where high costs of technology, infrastructure investment, and compliance costs add to the financial burden. McCarthy & Schurmann (2014) emphasize the lack of profitability due to high technology costs, expensive organic inputs, and labour costs, compounded by a low consumer willingness to pay premium prices for sustainable products.

The niche market for organic and sustainable products presents a challenge as consumers often resist paying higher prices (McCarthy & Schurmann, 2014). Additionally, growers in the horticulture sector face low farm gate prices and lack power within the supply chain, being

price-takers rather than price-makers. This situation is exacerbated by the economic barriers highlighted by Long et al. (2015), who noted that high costs and long return on investment (ROI) periods deter sustainable innovation. Hall et al. (2009) found that the odds of a grower with an operation between 1 and 5 acres adopting sustainable practices are 28.81 times greater than those of a grower with over 10 acres. However, Moons et al. (2022) argue that growers with fewer acres and less financial power perceive these economic barriers as significant obstacles to innovation.

According to Massoud et al. (2009), drivers include meeting customer demand, using sustainability for marketing, following industry trends, and enhancing company image. By responding to consumer preferences, leveraging sustainability in marketing efforts, staying updated on industry trends, and showcasing environmental commitment, businesses can gain competitive advantages and bolster their brand reputation. However, an alternative perspective by Hall et al. (2009) suggests that market demand may not be a significant factor in the adoption of sustainable practices in floriculture, indicating variability in the impact of market dynamics across different contexts.

Second, institutional/legislative barriers and drivers address the regulatory and policy-related challenges and enablers for sustainability, as well as the role of institutions in facilitating or hindering cooperation throughout the supply chain. In the horticulture sector, institutional and legislative barriers can be significant. Long et al. (2015) highlighted issues such as inconsistencies between national and EU-level policies, lack of clear carbon pricing, and policies that do not align with farmers' needs. McCarthy and Schurmann (2014) further noted the lack of government support as a major barrier. Grafström & Aasma (2021) pointed out poor institutions for cooperation throughout the supply chain as a commonly cited institutional

barrier. However, Hall et al. (2009) argued that environmental regulations may not significantly affect the adoption of sustainable practices, suggesting some variability in their impact. General barriers in this category include inconsistent policies across countries, externalities not internalized through taxes or subsidies, and poor institutional frameworks (Grafström & Aasma 2021). Massoud et al. (2009) found that supportive sustainability policies can act as a driver, a finding supported by Tura et al. (2019).

Fourth, technological barriers and drivers focus on the advancements and limitations in technology that facilitate or obstruct sustainable practices. This includes the availability and adoption of sustainable growing techniques, energy-efficient systems, and innovations that reduce environmental impact. A significant technological barrier is the lack of verification of the impact of new technologies. Potential users often require assurances over the impacts of technologies before investing, but climate smart agriculture technologies, being new, often lack a track record and supporting impact studies (Long et al., 2015). Additionally, R&D and policies frequently do not match the 'on-the-ground' realities faced by growers. Technologies and policies developed away from the nursery often neglect day-to-day practicalities, meaning they do not align with the actual needs of the growers (Long et al., 2015). Grafström & Aasma (2021) also noted that technological barriers often stem from the initial costs and the required transition from traditional methods, which can be mitigated by advances in technology and increased research and development. Which is supported by Björklund (2018), who, further highlights the barriers with limited access to advanced agricultural technologies. Technological drivers where not explicitly mentioned in the existing literature. However, in their study, McCarthy and Schurmann (2014) highlight the pivotal role of effective extension services, focusing on economic advantages, in supporting floriculture growers. These services serve as guiding lights, equipping growers with essential tools and knowledge to navigate the

complexities of sustainable practices. Additionally, Tura et al. (2019) assert that enhanced information sharing and management technologies support the creation of new services, increase transparency, and enable more efficient processes, thereby serving as a driver for sustainability.

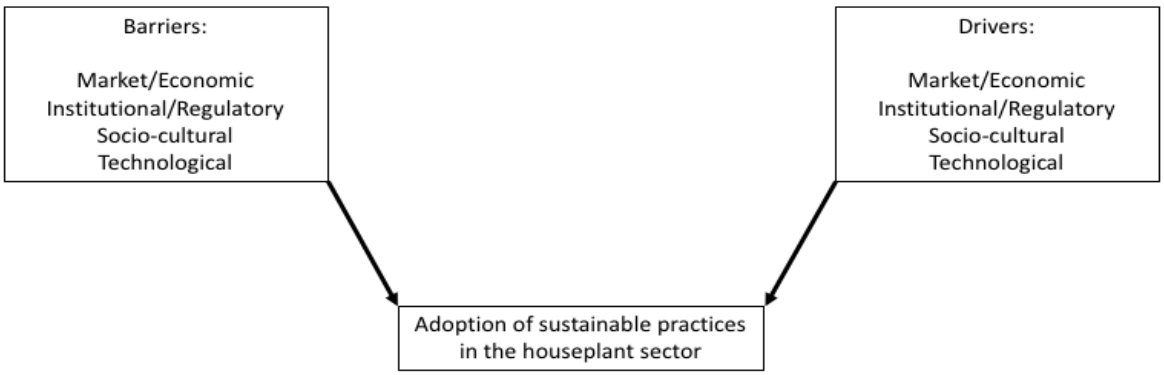
Fourth, socio-cultural barriers and drivers in the indoor plant sector encompass a wide variety of societal and cultural influences impacting sustainability. These include industry norms, stakeholder attitudes, regulatory frameworks, and the overarching cultural shift towards sustainability. Grafström and Aasma (2021) highlighted resistance from management and mid-level personnel, low consumer awareness and interest, confidentiality about production, and weak cooperation as significant barriers. Paletta et al. (2019) further emphasized resistance from managers, lack of engagement, low consumer awareness, and lack of collaboration across supply chains as additional barriers. Additionally, Massoud et al. (2010) identified low levels of environmental knowledge and awareness among respondents, misconceptions between hygienic practices and environmental management practices, and a lack of customer demand for environmental certification in the national market as notable barriers. However, amidst these challenges, positive attitudes and long-term environmental goals have been identified as drivers (McCarthy & Schurmann, 2014; Hall et al., 2009). Additionally, Tura et al. (2019) revealed that increased external demand for sustainability, rising awareness of sustainability needs, and industry roadmaps can serve as drivers.

Based on relevant literature, notably the works of Grafström & Aasma (2021) and Paletta (2019), a conceptual model has been developed to elucidate factors influencing the adoption of sustainable practices within the houseplant sector. Existing research underscores the diverse and sector-specific nature of these factors, which encompass aspects of sustainability, SBMI,

and circularity. However, the comprehensive framework proposed by Grafström & Aasma (2021) and Paletta et al. (2019) categorizes these factors into four main groups: market/economic, institutional/regulatory, socio-cultural, and technological barriers and drivers.

Further investigation into this framework is essential to derive context-specific insights and provide a comprehensive understanding of the factors influencing sustainability in the houseplant industry. By exploring these key groups in depth, research can gain valuable insights into the nuanced barriers and drivers that shape the adoption of sustainable practices within the Dutch houseplant nursery industry. In conclusion, Figure 1 below provides a visual representation of the conceptual model synthesized from the literature review, illustrating the various factors influencing the adoption of sustainable practices in the houseplant sector.

Figure 1: Conceptual framework



Adapted from: Grafström & Aasma (2021); Palletta et al. (2019)

3 METHODOLOGY

This research aims to investigate the adoption of sustainable practices within the houseplant nursery industry, with a focus on understanding the barriers and drivers influencing such practices. Given the complex and multifaceted nature of sustainability initiatives, a qualitative research methodology is chosen for its ability to provide rich insights into the nuanced perspectives, motivations, and challenges surrounding sustainability practices (Edmondson & McManus, 2007; Graebner et al., 2012).

3.1 Data collection

The data for this research was collected through semi-structured interviews conducted between March 28th and May 2nd, 2024. The interviews aimed to gather insights from key stakeholders involved in sustainability practices within the houseplant nursery industry, which is why a purposive sampling technique was selected. Expert sampling, which is seen as a positive tool to use when investigating new areas of research, to determine whether or not further study would be worth the effort (Etikan, 2022). The participants selected for interviews represented various key roles and organizations within the houseplant nursery industry, all involved in sustainability practices.

Among them were three sustainability managers at trading companies (I1,I2,I9). These individuals played pivotal roles within trading companies engaged in the sale of houseplants. As sustainability managers, they were tasked with developing and implementing sustainability initiatives throughout the supply chain, from sourcing to retail operations. Notably, one of the interviewees held the position of Sustainability Manager at Royal Flora Holland. the largest flower auction company globally and was recognized as the first initiator of footprint calculation methods within the industry, contributing to the advancement of sustainability measurement and reporting practices.

Additionally, three commercial and project managers at sustainability regulatory authorities (I3,I4,I6), including a representative from the FSI and Milieu Programma Sierteelt (MPS), who were instrumental in shaping sustainability standards and policies within the houseplant nursery industry were interviewed. Serving as commercial and project managers, their responsibilities included overseeing the development and enforcement of sustainability regulations and leading initiatives to promote sustainable practices among industry stakeholders.

Furthermore, three general managers of houseplant nurseries (I5,I7,I8), who held leadership positions within houseplant nurseries, overseeing the overall management and operations of their facilities were interviewed. As general managers, they played a direct role in decision-making processes related to sustainability practices, encompassing resource management, production methods, and environmental stewardship. Table 1 in Appendix A provides an overview of the interviews conducted for this research.

The interviews were conducted in a semi-structured format, allowing for flexibility while ensuring key topics related to sustainability practices were covered. Audio recording was utilized during the interviews to capture participants' responses accurately. Subsequently, the interviews were transcribed, facilitating detailed analysis of the data.

3.2 Data Analysis

In the data analysis phase, three rounds of coding were conducted: open, axial, and selective coding. These coding rounds were facilitated using Excel, allowing for systematic organization and analysis of the data. The predetermined categories provided by Grafström & Aasma (2021)

and Paletta (2019), namely market/economic, institutional/regulatory, sociocultural, and technological, served as a framework for coding, ensuring consistency and alignment with existing literature. During the open coding phase, the data was carefully examined to assign initial codes capturing key concepts and themes within each category. This process enabled the identification of patterns and emerging sub-categories.

Subsequently, in the axial coding phase, initial codes were refined and grouped into broader categories corresponding to Market/Economic, Institutional/Regulatory, Sociocultural, and Technological factors. This facilitated exploration of connections and relationships between different codes within each category. Finally, in the selective coding phase, core categories were identified, refined further, and synthesized to offer comprehensive insights into the multifaceted nature of sustainability practices within the industry. By systematically applying these coding techniques and utilizing the predetermined categories, the data analysis process was rigorous and thorough, resulting in a rich and nuanced understanding of the complexities surrounding sustainability practices within the houseplant nursery industry.

3.3 Ethical considerations

As this research involved human participants, it was conducted in accordance with the RUG guidelines for ethical research and the Netherlands Code of Conduct for Research Integrity (Netherlands Organisation for Scientific Research [NWO], 2018). Informed consent was obtained from each interviewee through a consent form, which included detailed information about the topic and purpose of the research. To ensure confidentiality, all collected data was anonymized. The audio recordings were deleted after transcription, and the transcripts were securely stored in a Google Drive folder accessible exclusively to the assessors of this research paper.

4 RESULTS

Based on the interviews with nine industry experts, several critical barriers and drivers influencing sustainability within the houseplant sector were identified. These factors are categorized into market/economic, institutional/regulatory, sociocultural, and technological domains, each presenting unique challenges that hinder progress as well as opportunities that facilitate the adoption of sustainable practices.

4.1 Barriers

While the houseplant industry holds promise for sustainability, it is not without its challenges. In this context, exploring the barriers faced by the industry is essential to understanding the complexities and limitations that hinder the widespread adoption of sustainable practices.

4.1.1 Market/economic barriers

The most commonly mentioned barrier within the market/economic category is financial constraints, highlighted by 6 out of 9 (I1,I3,I4,I5,I6,I7) interviewees. These financial barriers stem from the high costs of initial investments and the uncertainty surrounding the return on investment (ROI). Unlike the fruit and vegetable sector, where trade companies maintain fixed supplier relationships, the indoor plant sector lacks such exclusivity. This absence of guaranteed linkage to a single trading company complicates sustainability efforts by leading to a divided demand and affecting grower's certainty. Consequently, this fragmentation makes it challenging to establish long-term or financially sustainable agreements. With interviewee 1 stating: *" It leads to significant fragmentation in demand, as well as uncertainty for the grower, such as multi-year agreements or the earning model agreements with the market, which are crucial for investing in sustainability" (I1).*

Additionally, the cost of implementing sustainable alternatives is a significant concern. The financial burden associated with transitioning to sustainable practices is substantial, further exacerbating the challenge for growers. One interviewee highlighted the difficulty of recovering these investments, stating: *"The investments, they're often substantial investments that aren't always recovered within five or six years. And actually, we should say, an investment should always be fairly well recovered in the short term, because it's a constantly changing world, you never know"* (I7). Another interviewee succinctly captured this sentiment, stating: *"So there must be a financial gain for people, or it will go very slowly"* (I1).

Contradicting this perspective, Interviewee 8 expressed optimism about the availability of funding for sustainability projects and highlighted positive developments in technology: *"Fortunately, there are quite a few investors who are willing to invest in such sustainability projects. I don't immediately see the barriers, no"* (I8).

Compounding these issues are unrealistic expectations from retailers, who demand higher sustainability standards while simultaneously expecting lower prices. Five interviews (I1,I4,I5,I8,I9) revealed a cost implementation gap for sustainable houseplants. While the market and customers demand sustainable products, they are not willing to pay more for them. As one interviewee observed, *"Everyone wants it, but it becomes more of a big prerequisite, a hygiene factor, rather than an added value. That seems to be the case"* (I5).

The market and economic barriers identified through expert interviews underscore significant challenges in promoting sustainability within the houseplant sector. Financial constraints, market fragmentation, and unrealistic retailer expectations collectively hinder the adoption of sustainable practices. Addressing these barriers requires coordinated efforts from industry

stakeholders, policymakers, and consumers to create a supportive environment for sustainability. Financial incentives, consumer education, and realistic retailer demands are crucial to overcoming these obstacles and fostering a more sustainable houseplant sector.

4.1.2 Regulatory/institutional barriers

Among the barriers faced in the regulatory and institutional domain, regulatory complexity stands out as a significant impediment, highlighted four (I1, I5, I8, I9) times across interviews. Interviewee 9 expressed concerns about government policies affecting investment decisions in sustainability projects, highlighting the need for consistent and stable policies over time:

"Yes, but you see, the drawback of that is always, of course, that we have an unmanageable government. For example, with the SDGs or with that energy, we have ODE, we have taxes and so on. then I understand that as an entrepreneur you want to invest somewhere, but then you want to have continuous policy for a number of years." (I9)

The regulatory landscape introduces hurdles, particularly concerning crop protection products. Processes become complex, requiring extensive approvals for alternatives. In niche markets where few suppliers are willing to invest in compliance, obtaining approval becomes even more challenging. Interviewee 8 underscored regulation as one of the most significant barriers, emphasizing its tendency to cause delays*:*

"Sometimes, regulations can make things a bit more complex. This can be the case with crop protection products, even when there are excellent alternatives available, but then there's still a whole process to go through. And if it's just for a small, what we call a niche market, which is where we operate, there are few suppliers who really bother to get those products right. And when it comes to sustainability, you have to deal with all sorts of permit processes" (I8).

As mentioned in another part of the interview, *"That sometimes causes delays"* (I8). This suggests that the regulatory environment not only complicates processes but also slows down the implementation of initiatives, potentially hindering the timely execution of sustainability projects or the adoption of innovative practices. Acquiring permits for projects like solar parks is cited as a notable challenge, adding to the overall regulatory burden (I8, I9).

In summary, regulatory complexity, particularly the unpredictability of government policies, constitutes a significant barrier within the houseplant nursery sector, as highlighted by interview findings. The intricate approval processes for crop protection products and sustainability projects, coupled with fluctuating regulatory standards, create formidable barriers for businesses in this field. These barriers not only complicate operational procedures but also impede the timely implementation of sustainability initiatives, hindering progress towards environmentally conscious practices. Streamlining regulatory frameworks and establishing clear, consistent policies are imperative to overcome these barriers and empower house plant nurseries to embrace sustainable innovations, thereby driving industry-wide progress.

4.1.3 Socio- cultural barriers

Within the socio-cultural domain, numerous challenges hinder progress towards sustainability in the houseplant industry. Including collaboration challenges, misinformation and fear, as well as cultural and organizational factors.

Collaboration challenges are pervasive, resonating across four interviewees (I1,I2,I5,I7). The industry's fragmented structure hampers unified efforts among stakeholders, depicting a landscape of division rather than cohesion. As noted by one interviewee:

"I think one of the most challenging things for indoor plant producers is that we have quite a divided sector. So, our sector isn't... If you look at the business model, it's a bit divide and conquer in our sector. That's both among growers, as it is among retail, as it is among trade. We're not very good in our sector at being cooperative." (I1)

Misinformation and fear compound these challenges, as highlighted by Interviewees 1,3 and 6. Growers' reluctance to share information stems from a pervasive climate of apprehension, fuelled by the fear of scrutiny and criticism. With interviewee 3 stating*:*

"They are afraid to share information about what they are working on. There is really a dark cloud hanging over us. We receive a lot of criticism, of course. And I think that makes growers a bit hesitant to say, 'Well, I'm going to be transparent about how I do it"(I3).

This culture of secrecy impedes transparency and stifles innovation within the industry.

Moreover, cultural and organizational factors exacerbate the socio-cultural challenges. As elucidated by five interviewees (I1,I2,I3,I5,I9), the conservative ethos prevailing within the sector acts as a barrier to change, hindering the widespread adoption of sustainable practices. Interviewee 5 brought attention to the resistance to change regarding packaging materials, plastic covers, plastic containers, and similar items within the supply chain, by stating:

"It's a bit difficult to say where that motivation comes from, but for example, those packaging materials, plastic wraps, plastic crates, all those kinds of things, yeah, there are quite a few parties in the chain who aren't really keen on that change. And whether that indeed has to do with costs, it's more just about ease of work and those kinds of things" (I5).

Revealing that parties in the industry are not yet receptive to embracing sustainability initiatives in these areas, indicating entrenched attitudes that hinder progress.

In summary, socio-cultural barriers present significant challenges to sustainability in the houseplant industry. Collaboration issues, fuelled by misinformation and fear, along with entrenched cultural and organizational factors, hinder progress. The fragmented industry structure and reluctance to share information impede cooperation and innovation. Overcoming these obstacles will require promoting transparency, sharing knowledge, and fostering a more open and flexible culture within the sector.

4.1.4 Technological barriers

While technological barriers were not extensively mentioned, several key points emerged from the interviews. Including, lack of knowledge and guidance among growers, the industry becoming a niche market for technology investment, and the readiness of sustainable alternatives.

A technological barrier is the lack of knowledge and guidance among growers, as emphasized by Interviewee 3:

"When you take the grower by the hand and really explain, 'Hey, you need to do this now, you need to do that now, and it won't take much time and we are going to help you,' it makes a big difference. Especially for those growers who are just starting with certification, this can be an enormous help. Some growers experience uncertainty and a bit of fear about what they should do and where they should go. I think that also plays a role as a barrier." (I3).

The absence of comprehensive support systems and education initiatives hinders growers' ability to embrace sustainable practices. Addressing this gap through targeted training and guidance can significantly alleviate this barrier and facilitate the adoption of sustainable technologies.

Furthermore, some sustainable alternatives are not yet fully developed or readily available. Interviewee 4 highlighted that alternatives to peat are not yet prepared for widespread adoption, while Interviewee 9 mentioned that certain sustainable alternatives are still experiencing teething problems. These technological limitations underscore the need for further research and development to overcome these challenges and ensure the availability of viable sustainable solutions. Unfortunately, two interviewees (I8, I9) noted that the houseplants industry is becoming a niche market in terms of investment in new technology. With interviewee noting:

"You see this now as well, that the ornamental plant market, for which there is a separate approval, is so small worldwide compared to mega crops like potatoes or corn, that companies think, 'Yes, it's becoming such a niche market, I won't invest in it anymore" (I9).

This niche market dynamic may contribute to slower adoption rates of innovative solutions.

In summary, while technological barriers were not prominently featured in the interviews, key challenges such as the lack of knowledge and guidance among growers, industry reluctance to invest in new technology, especially in of a niche market, and the readiness of sustainable alternatives highlight areas where targeted interventions and innovation are needed to advance sustainability within the houseplant industry.

4.2 Drivers

The houseplant industry, despite experiencing numerous barriers, also benefits from several drivers that facilitate the adoption of sustainable practices. These drivers highlight the potential

for positive change and the opportunities available for stakeholders in their pursuit of sustainability within the houseplant sector.

4.2.1 Market/economic drivers

All interviewees mentioned market demand and the pressure exerted by retailers and consumers for more sustainable products. This demand serves as a significant driver for the industry. One interviewee emphasized this by stating, *"For us, the most crucial aspect, as I mentioned earlier, is that our license to produce really depends on whether or not we embrace this sustainable shift. Because eventually, consumers simply won't want our product anymore otherwise"* (I5). Additionally, three interviewees (I4, I6, I7) noted that consumers are becoming more critical about the sustainability of products. This increasing scrutiny from consumers further motivates companies to adopt sustainable practices to meet market expectations and maintain their market position. The combined pressure from both retailers and consumers underscores the growing expectation for sustainability, compelling producers to adapt accordingly.

Three interviewees (I4, I6, I7) highlighted the marketing benefits associated with sustainability. These benefits include the potential to enhance the company's unique selling point, improve the product's image, and create future partnerships. For instance, one expert noted, ‘‘*From a marketing perspective, take company X for example, they're really known as a sustainable company. They supply IKEA, and IKEA highly values that. So, your relationship with your customer also strengthens by truly demonstrating that you're doing sustainable things*" (I6). This statement illustrates how demonstrating sustainability can strengthen customer relationships and provide a competitive edge.

In summary, the market and economic drivers identified through expert interviews reveal significant opportunities for promoting sustainability within the houseplant sector. The strong market demand and pressure from retailers and consumers, combined with the marketing benefits of sustainability, create a compelling case for stakeholders to adopt sustainable practices. Leveraging these drivers can help overcome the barriers and foster a more sustainable houseplant industry.

4.2.2 Regulatory/institutional drivers

All interviewees mentioned certification and industry standards as the main drivers for sustainability. Certifications, such as those provided by MPS and footprint calculations, along with standards set by Royal Flora Holland and the FSI, play a critical role in promoting sustainable practices. Interviewee 2 emphasized this by stating:

"FSI had an ambition to start getting growers certified according to a certain standard. And that was the FSI standard, the Basket of Standards, in which a number of global certificates were benchmarked, according to the Global Gap principle, so to speak. ... That has given a really good boost to our sector, especially to the plant nursery side, to indeed start with certification" (I2).

Additionally, standards and goals outlined in the covenant of the sector were highlighted as essential components driving sustainability efforts (I5).

Regulatory policies were mentioned by 6 out of 9 (I1,I4,I5,I6,I7,I9) interviewees as key drivers. These policies include clear goals set by the government, energy taxes, and the implementation of CSRD. One interviewee noted:

"But I think the biggest push in the last few years has been the EU legislation changes, actually. So, the standards have helped bring the sector together to push sustainability as a topic, to understand what needs to be done that sort of make it more mainstream and understood. And that's across all of the broader flower and houseplant sector" (I4).

Energy taxes and costs were frequently mentioned as significant drivers, with one interviewee stating, *"Energy taxes and costs have moved the sector forward for sure"* (I5). The implementation of CSRD and emission taxes were also noted as crucial regulatory measures driving sustainability efforts (I6).

The regulatory and institutional drivers identified through expert interviews reveal significant support mechanisms for promoting sustainability within the houseplant sector. Certification and industry standards, along with clear regulatory policies, provide a robust framework that encourages sustainable practices and helps align industry efforts towards common sustainability goals.

4.2.3 Socio-cultural drivers

Six out of nine (I1,I2,I3,I5,I8,I9) interviewees mentioned collaboration and sector-wide initiatives as major drivers. The importance of working together within the industry was emphasized, with one interviewee noting:

"Sustainability is where we have a common goal. And then it doesn't matter for a moment if you're each other's competitors. I always know a very nice example. You have Orchidee

Nederland. And all Orchid growers are connected there. I find such initiatives amazing. Because then you can start taking steps together" (I3).

Additionally, the significance of these collaborations for future partnerships was highlighted, described as *"partnerships for the future"* (I1, I6). This sentiment was echoed by other experts, who emphasized the sharing of data (I2), collaboration with retailers (I6), and cooperation across the supply chain (I9). These collaborative efforts are seen as essential for driving sustainable practices across the industry.

Intrinsic motivation was mentioned by five out of nine (I1,I3,I5,I8,I9) interviewees as another key driver. This motivation includes factors such as entrepreneurial vision (I1), the motivation of owners (I1), and the personal and generational responsibility felt by those within the industry (I3). One interviewee captured this sentiment by saying:

"I think there is a lot of intrinsic motivation among growers because they are inherently quite green. Ultimately, they have a green product, which is what they live from, and they all have that green heart. So, intrinsically, I think there is quite good motivation" (I1).

This intrinsic drive is reinforced by the motivation of companies and their employees (I8), as well as the commitment embedded within the company's DNA (I5).

In summary, the sociocultural drivers identified through expert interviews reveal substantial opportunities for promoting sustainability within the houseplant sector. The emphasis on collaboration and sector-wide initiatives, coupled with strong intrinsic motivation, creates a

solid foundation for sustainable practices. Leveraging these drivers can help overcome the barriers and foster a more sustainable houseplant industry.

4.2.4 Technological drivers

Two out of nine interviewees identified data-driven approaches and footprint calculations as significant technological drivers. One expert emphasized the importance of data-driven approaches, stating, *"The ability to calculate the footprint can act as a driver*" (I1). Another interviewee reinforced this view, highlighting the potential of data to enhance sustainability efforts: *"Data-driven approaches are crucial for understanding and improving our environmental impact"* (I9).

In summary, while technological drivers were not extensively discussed, the identified focus on data-driven approaches and footprint calculations underscores the importance of leveraging technology to support sustainable practices in the houseplant industry. By harnessing these technological tools, stakeholders can gain valuable insights into their environmental impact and make informed decisions to promote sustainability.

5 DISCUSSION

The discussion delves into the nuanced findings of the study on sustainability within the houseplant industry. By aligning the findings with existing literature while also uncovering unique industry-specific insights, the discussion aims to offer valuable recommendations and avenues for future research to enhance sustainability efforts in the houseplant industry.

5.1 Conclusions

The results of this study highlight both similarities and differences with existing literature on the barriers and drivers of sustainability in diverse sectors and revealed context specific factors. This comparison offers critical insights and nuances specific to the houseplant industry, providing a deeper understanding of the unique challenges and opportunities within this sector. Financial constraints are a well-documented barrier in the literature, with studies emphasizing high upfront investment costs, limited access to finance, and the absence of a well-established market as significant challenges. These studies also note the high costs of technology and the low willingness of consumers to pay premium prices for sustainable products. The financial barriers identified in this study align closely with these points, highlighting high initial investment costs and uncertain returns on investment (ROI). However, a unique finding is the lack of exclusive trading relationships in the houseplant sector, which complicates long-term financial planning and sustainability efforts. Additionally, unrealistic expectations from retailers regarding higher sustainability standards at lower prices further exacerbate financial constraints. This nuance emphasizes the fragmented nature of the houseplant sector, which may not be as pronounced in other horticultural domains.

Regulatory and institutional barriers are also highlighted in the literature, with inconsistencies in policies, a lack of government support, and poor institutional frameworks identified as

significant obstacles. The findings from this study corroborate these points, with regulatory complexity being a significant barrier. Specific issues include complex approval processes for crop protection products and permits for sustainability projects like solar parks. This study also points out the lack of reliability from the government, adding another layer to the regulatory challenges that may not be as explicitly covered in the literature.

Socio-cultural barriers in the literature often focus on low consumer awareness and resistance from managers as key factors. This study identifies collaboration challenges, misinformation, fear, and conservative attitudes within the industry as significant socio-cultural barriers. The fragmented structure of the sector and reluctance to share information due to fear of scrutiny and criticism are notable findings. These barriers underscore the importance of fostering a cooperative culture and transparency, which are essential for overcoming socio-cultural challenges in the houseplant sector.

Technological barriers, according to the literature, include the lack of verified impacts of new technologies, high initial costs, and the misalignment of research and development (R&D) and policies with growers' needs. The study aligns with the literature by identifying the lack of knowledge and guidance among growers and the readiness of sustainable alternatives as key technological barriers. Additionally, the industry's niche market status for technology investment further complicates the adoption of innovative solutions. This aspect is particularly critical as it highlights the need for targeted interventions and support systems to bridge the knowledge gap.

Despite these barriers, the houseplant industry also benefits from several drivers that facilitate the adoption of sustainable practices. The literature identifies meeting customer demand, using

sustainability for marketing, and enhancing company image as primary drivers. The study confirms these drivers, with all interviewees mentioning market demand and retailer pressure as significant motivators. The marketing benefits associated with sustainability, such as enhancing the company's unique selling point and strengthening customer relationships, were also emphasized. These findings are consistent with the literature, indicating strong market and economic drivers for sustainability in the houseplant sector.

The role of clear regulatory policies and industry standards as drivers is also highlighted in the literature. This study reinforces the importance of certification and industry standards, such as those from MPS and the FSI, as significant drivers. The role of regulatory policies, including energy taxes and CSRD, is also underscored. These findings align well with the literature, highlighting the critical role of regulatory frameworks in promoting sustainability.

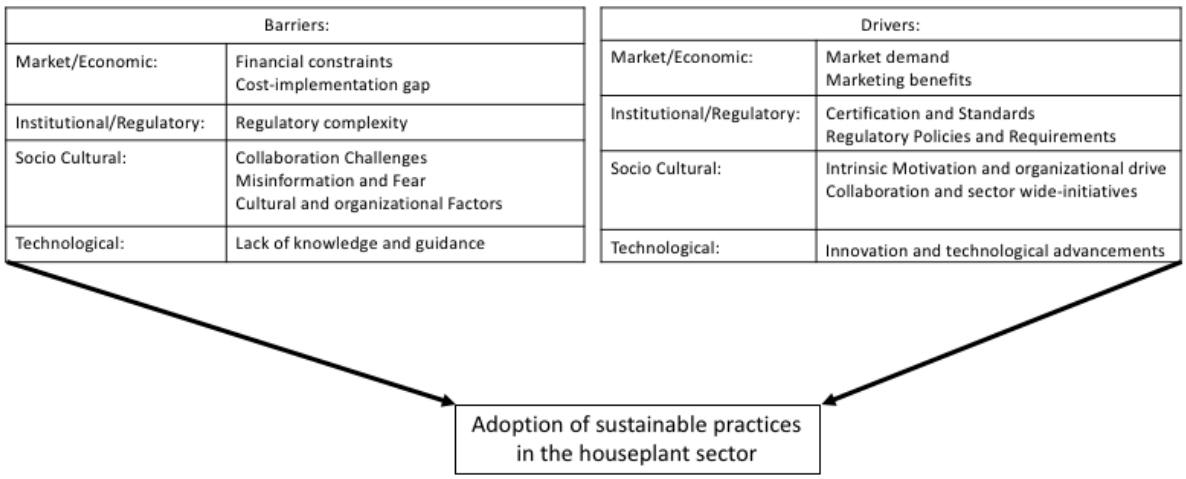
Socio-cultural drivers, including intrinsic motivation and collaborative initiatives, are noted in the literature. The study echoes these findings, with collaboration and sector-wide initiatives being major drivers. The emphasis on intrinsic motivation, such as entrepreneurial vision and personal responsibility, further supports the literature. This alignment underscores the importance of fostering a collaborative culture and leveraging intrinsic motivation to drive sustainability efforts.

Technological drivers are less frequently discussed in the literature, but the potential of data-driven approaches and technological innovations to drive sustainability is noted. Consistent with the literature, this study identifies data-driven approaches and footprint calculations as significant technological drivers. Although not extensively discussed, the emphasis on data

underscores its critical role in enhancing sustainability efforts through informed decision-making.

In summary, this study provides a comprehensive examination of the barriers and drivers of sustainability in the house plant sector. The findings reveal significant alignment with existing literature, particularly regarding financial constraints, regulatory complexity, and socio-cultural challenges as major barriers. However, the research also uncovers unique challenges specific to the houseplant industry, such as the lack of exclusive trading relationships and the fragmented structure of the sector, which complicate sustainability efforts. On the positive side, market demand, certification standards, and intrinsic motivation are identified as strong drivers that align with and support the adoption of sustainable practices. These insights underscore the importance of targeted strategies and collaborative efforts to overcome the identified barriers and leverage the drivers, promoting sustainability within the houseplant industry. The conceptual model presented below illustrates the main barriers and drivers affecting the adoption of sustainable practices in the houseplant sector. These factors are grouped into four key domains: market/economic, institutional/regulatory, socio-Cultural, and technological.

Figure 2: Conceptual model based on empirical evidence



5.2 Recommendations

To make the houseplant sector more sustainable, it is important to pay attention to the findings of this study. Understanding the obstacles, like financial challenges and regulatory issues, can help develop specific plans to tackle the industry's unique problems. On other hand, embracing the positive factors revealed in this research, such as consumer demand and certification standards, can guide the way toward sustainable practices. For instance, addressing financial barriers could involve exploring avenues for cost-sharing initiatives among stakeholders or advocating for financial incentives to support sustainable practices. Similarly, streamlining regulatory processes and fostering a culture of collaboration within the industry can help overcome institutional hurdles.

Moreover, capitalizing on market demand and certification standards presents tangible pathways for driving sustainability efforts forward. By aligning product offerings with consumer preferences and adhering to recognized sustainability certifications, businesses can not only meet market expectations but also enhance their brand reputation. Additionally, leveraging intrinsic motivations among industry players and fostering collaborative initiatives can amplify the momentum towards sustainability.

In essence, by strategically navigating the identified barriers and actively leveraging the drivers elucidated in this study, stakeholders can pave the way for a more sustainable houseplant industry. This entails a concerted effort to integrate sustainability considerations into business strategies, engage in knowledge-sharing networks, and advocate for supportive policy frameworks. Ultimately, embracing these insights can catalyse transformative change, fostering an industry that is both environmentally conscious and economically viable.

5.3 Limitations

Despite its contributions, this study has several limitations. First, the sample size of nine interviewees, while providing valuable insights, may not fully capture the diversity of perspectives within the industry. A larger sample could provide a more comprehensive understanding of the barriers and drivers. Second, the study is geographically limited to the Dutch indoor plant sector, which may limit the generalizability of the findings to other regions with different regulatory and market conditions. Third, the study primarily relies on qualitative data from interviews, which may be subject to respondent bias and may not capture all quantitative aspects of the barriers and drivers.

5.4 Future research

Future research in the field of sustainability within the houseplant sector could explore several avenues to build upon the findings of this study and address its limitations. Firstly, conducting a larger-scale study with a more extensive sample size could offer a more comprehensive understanding of the barriers and drivers influencing sustainability practices in the industry. This could involve surveying a broader range of stakeholders, including growers, retailers, policymakers, and consumers, to capture diverse perspectives and experiences. Secondly, expanding the geographical scope of research beyond the Dutch indoor plant sector could provide valuable insights into how regulatory and market conditions vary across different regions and cultures. Comparative studies across multiple countries or regions could help identify common challenges and best practices, facilitating cross-border collaboration and knowledge sharing. Thirdly, future research could adopt a mixed-methods approach, combining qualitative data from interviews with quantitative data from surveys or experimental studies. This would allow for a more comprehensive analysis of the factors influencing sustainability adoption, including both subjective perceptions and objective measurements.

Furthermore, investigating technological barriers and drivers in more depth would be beneficial, given their importance in shaping sustainability practices. Research could focus on exploring innovative technologies and practices that enhance resource efficiency, reduce environmental impact, and improve the overall sustainability of the houseplant industry. Lastly, longitudinal studies tracking the implementation of sustainability initiatives over time could provide valuable insights into the long-term impacts and effectiveness of different strategies. This would help assess the sustainability trajectory of the houseplant sector and identify opportunities for continuous improvement and adaptation. Overall, future research endeavours should aim to address the identified limitations of this study while furthering our understanding of sustainability in the houseplant industry and informing evidence-based policies and practices.

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APPENDIX

Appendix A: List of interviewees

Table 1: List of interviews

Interview	**Company type**	**Job description**	**Location**	**Date**	**Duration**
Interviewee 1	Trading	Sustainability manager	Online	28/03/2024	49:59
Interviewee 2	Trading	Sustainability manager	Online	10/04/2024	32:10
Interviewee 3	Sustainability Regulatory Authority	Regional Manager	Online	10/04/2024	28:38
Interviewee 4	Sustainability Regulatory Authority	Project Manager	Online	12/04/2024	28:40
Interviewee 5	Grower	General Manager	Online	16/04/2024	33:53
Interviewee 6	Sustainability Regulatory Authority	General Manager	Online	23/04/2024	40:43
Interviewee 7	Grower	General Manager	Online	25/04/2024	18:25
Interviewee 8	Grower	General Manager	Offline	26/04/2024	19:50
Interviewee 9	Trading	Sustainability manager	Online	02/05/2024	35:35

Appendix B: Overview of existing literature

Group	Study Background	Technological	Market/Economic	Institutional/Regulatory	Socio-Cultural
SBMI & Agriculture	**Björklund, J. (2018).** Barriers to Sustainable Business Model Innovation in Swedish Agriculture.	**Barriers:** Lack of technological adoption hindering innovation and efficiency. Limited access to advanced agricultural technologies.	**Barriers:** Resistance or lack of support from consumers. Challenges from changing consumer preferences and price sensitivity. Market pressures from large cooperatives affecting pricing and competitiveness.	**Barriers:** Difficult and complicated government regulations and legislation. Administrative burdens consuming time and resources. Lack of relevant support and advisory services from governmental organizations. Limited access to knowledge and skills for strategic business management and innovation.	**Barriers:** View of farming as a lifestyle rather than a professional business. Reluctance to embrace professional management practices. Influence of cultural values and norms, such as the Law of Jante, on business behavior. Concerns about societal perceptions and reputation within the community.
Circularity	**Tura, N., Hanski, J., Ahola, T., Ståhle, M., Piiparinen, S., & Valkokari, P. (2019).** Unlocking circular business: A framework of barriers and drivers. Journal of Cleaner Production, 212, 90-98. https://doi.org/10.1016/j.jclepro.2018.11.202	**Barriers:** Increased technical difficulty in handling CE material flows (lower homogeneity of raw material). Lack of compatible technologies and high technological uncertainty. Lack of practices and systems for collecting, sharing and utilizing CE information	**Barriers:** High initial costs. Potential to create value from waste and production side streams. Potential for new service business development	**Barries:** Region-specific laws and regulations against CE solutions. Conflicts of interest and fluctuations in taxes and governmental subsidies - high future uncertainty	**Barriers**: Region-specific and (local) cultures hamper the implementation of new solutions. Conservativeness in business practices (e.g. waste management industry). Lacking or uncertain customer needs
		Drivers: Emerging process technologies support CE business. Enhanced information sharing and management technologies support the creation of new services, increase transparency and enable more efficient processes	**Drivers:** Cost savings. Potential to ceate value from waste. Potential new services development	**Drivers:** Directing laws and EU regulations create a demand for new solutions. ISO - standard development for solid recovered fuels. Societal development projects e.g. industry roadmaps supporting sustainable development	**Drivers:** Increased external demand for sustainability. Increasing awareness of sustainability needs. Societal development projects e.g. industry roadmaps supporting sustainable development
Circularity	**Grafström, J., & Aasma, S. (2021).** Breaking circular economy barriers.	**Barriers:** Lack of product design. Lack of know-how. Insufficient systems.	**Barriers:** quality standards, supply uncertainties, and perception issues. High up-front investment costs,poor access to finance..	**Barriers:** Heterogeneity in policies between countries. Complex legislations and high administrative costs. Poor implementation of existing. policies and lack of support. Unintended policy effects.	**Bariers:** Resistance from management and mid-level personnel. Low consumer awareness and interest . Confidentiality about production. Weak cooperation.
Circularity	**Paletta, A., Leal Filho, W., Balogun, A.-L., Foschi, E., & Bonoli, A. (2019).** Barriers and challenges to plastics valorisation in the context of a circular economy: Case studies from Italy.	**Barriers:** Lack of incentives for recycling due to low virgin material prices. High up-front investment costs for circular economy practices. Uncertainty in recycled material markets.	**Barriers:** Lack of incentives for recycling due to low virgin material prices. High up-front investment costs for circular economy practices. Uncertainty in recycled material markets.	**Barriers:** Inconsistent policies across countries. High administrative costs and complex waste legislation. Lack of support for research and development.	**Barriers:** Resistance from managers and lack of engagement. Low consumer awareness. Lack of collaboration across supply chains.
Agriculture	**Long, T. B., Blok, V., & Coninx, I. (2015).** Barriers to the adoption and diffusion of technological innovations for climate-smart agriculture in Europe: Evidence from The Netherlands, France, Switzerland and Italy.	**Barriers:** Difficulty in proving value and demonstrating impact. Lack of verified impact of technologies. High costs and long ROI periods.	**Barriers:** Lack of knowledge of, and access to capital/investment. Products too expensive/ROI periods overly long. Access to, and reaching customers.	**Barriers:** Unsympathetic regulatory landscape. Regulatory and policy issues. R&D and policies do not match on-the-ground reality.	**Barriers:** Low awareness of CSA/inaccessible language. Low consumer demand. Unequal distribution of costs/benefits across supply chains.
Floriculture	**Hall, T. J., Dennis, J. H., Lopez, R. G., & Marshall, M. I. (2009).** Factors affecting growers' willingness to adopt sustainable floriculture practices.	**Barriers:** Lack of knowledge of sustainable floriculture practices Concerns about ease of implementation Perceived production risks	**Barriers:** Insignificant customer value Need to demonstrate sustainability benefits to improve customer value	**Barrier:s** Insignificant effect of environmental regulations Need for educational support to reduce risks	
					Drivers: Positive attitudes towards sustainability improve adoption rates Smaller growers with 1 to 5 acres more likely to adopt
Horticulture	**McCarthy, B., & Schurmann, A. (2014).** Sustainable horticulture: understanding barriers to the adoption of innovation.	**Barriers:** High costs of new technologies and precision agriculture. High cost of certified organic inputs. Issues with learning and implementing new farming practices. Lack of extension services and support from accreditation bodies.	**Barriers:** Lack of profitability and high upfront costs. Loss of income during the conversion period to certified organic farming. Compliance costs including certification fees, labeling, and paperwork. High labor costs. Niche market for organic products. Consumers unwilling to pay premium prices. Large gap between farm gate prices and wholesale/retail prices. Competition against large multinational growers engaging in predatory pricing practices. Low farm gate prices and being price-takers in the supply chain.	**Barriers:** Lack of support from the government and inflexible local certifying bodies. Compliance costs and bureaucratic hurdles for certification.	**Barriers:** Negative image and perceptions of organic farming (e.g., seen as "hippy" or lifestyle farming). Lack of trust in new methods and questioning the efficacy of organic standards. Hard work and physical labor associated with organic farming. Market-driven practices conflicting with long-term sustainability goals. Cultural reliance on chemical usage for quick results and insurance.
		Driver: Effective extension services focusing on economic advantages.			**Drivers:** Positive attitudes toward improving soil health and long-term environmental goals among organic growers.
Horticulture	**Massoud, M., Fayad, R., El-Fadel, M., & Kamleh, R. (2010).** Drivers, barriers and incentives to implementing environmental management systems in the food industry: A case of Lebanon.	**Barriers:** Perceived difficulty in acquiring ISO 14001 certification	**Barriers:** Perception that ISO 14001 certification does not add value to competitiveness in the national market. High cost of acquiring ISO 14001 certification. Low perceived financial benefits from adopting an EMS. High operational costs in the Lebanese food sector.	**Barriers:** Lack of government support and incentives for adopting EMS. National regulations do not support or motivate the adoption of a voluntary EMS. Certification not required legally for export. Current national regulations perceived as insufficient in promoting EMS adoption.	**Barries:** Low level of environmental knowledge and awareness among respondents. Misconception between hygienic practices and environmental management practices. Lack of customer demand for environmental certification in the national market.
			Drives: Reducing operational costs. Facilitating export to international markets. Achieving access to international markets.Enhancing company image. Enhancing competitiveness in international markts	**Drivers:** Supportive poicies	**Drivers:** Following international food industry trends.

Appendix C: Interview Framework

Interview Framework

Estimated Time 30-60 minutes

Introduction:

Thank the participant for their involvement and reassure them about confidentiality.
Provide a brief overview of the research goals and emphasize the importance of their insights.

Background Information:

1. Could you please introduce yourself and describe your role within the houseplant nursery industry?
2. How long have you been involved in sustainability initiatives within the industry, and what motivated your interest in this area?

Understanding Barriers:

3. From your experience, what are the primary challenges and obstacles that houseplant nurseries encounter when trying to adopt sustainable practices?
4. Can you provide examples of specific operational, financial, or technological constraints that hinder the implementation of sustainability initiatives?
5. How do regulatory policies, standards, or certification requirements impact the adoption of sustainable practices within houseplant nurseries?
6. In your opinion, what cultural or organizational factors within nurseries contribute to resistance or reluctance towards embracing sustainability?

Exploring Drivers:

7. What factors do you believe motivate houseplant nurseries to pursue sustainability initiatives?
8. Have you observed any shifts in consumer preferences or market trends that encourage nurseries to prioritize sustainability efforts?
9. How do you perceive the role of government incentives, grants, or subsidies in promoting the adoption of sustainable practices within the industry?
10. Are there any internal motivations within nurseries, such as corporate values, brand reputation, or employee engagement, that drive sustainability efforts?
11. Can you discuss the influence of collaborations or partnerships with other stakeholders (e.g., suppliers, retailers) on the adoption of sustainable practices?

12. Is there any additional information or perspectives you would like to share regarding the adoption of sustainable practices in houseplant nurseries?

Thank the participant for their time and valuable contributions to the research.

Appendix D: Link to consent forms, interview transcripts and coding tree

Consent forms
Interview transcripts
Coding Tree