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Assessing Climate Change Reporting Disclosure Indexes (CCRDI) in Malaysia Plantation Sector: Toward Sustainable of Food-Security

Ummi Junaidda [1*] **, *Matin Chowdhury*** [2]

[1] *School of Accounting, Faculty of Business & Management, University Sultan Zainal Abidin, Gong Badak Campus, Kuala Nerus 21300, Malaysia*

[2] *Department of Accounting and Finance, Faculty of Business, Curtin University Malaysia, Miri 98009, Malaysia*

ABSTRACT

Climate change is a phenomenon that will raise the number of hydrological extremes, namely floods and droughts, that will affect the plantation sector. This sector is vital to ensure the country's food security in achieving Sustainable Development Goal 2 (SDG 2) of zero hunger. Due to the phenomenon of the environment, the government focuses on both the resilience of businesses and economic sustainability. Climate-related disclosures are essential decision-useful information that enables users to understand the impact of climate-related risks and opportunities. Currently, the practice of Malaysian plantation companies shows limited focus on climate risk reporting, and the report is superficial. Thus, this study is designed to examine the current practice among plantation companies in Malaysia on climate change matters, and to propose an index of sustainability-resilience to climate change in the sustainability report. This study applies a content analysis approach that examines 41 plantation companies listed on the main market of Bursa Malaysia. The findings indicate that none of the companies in the sample achieved an 80% level on the climate change reporting disclosure indexes (CCRDI). This presents a situation of inadequate climate disclosures in one of the Association of Southeast Asian Nations (ASEAN) regions, Malaysia, indicating that ASEAN's Agri-sector hinders economic resilience, distorts investment flows, threatens food security, and sustainable growth amid growing climate and geopolitical risks.

*CORRESPONDING AUTHOR:
Ummi Junaidda, School of Accounting, Faculty of Business & Management, University Sultan Zainal Abidin, Gong Badak Campus, Kuala Nerus 21300, Malaysia; Email: junaidda@unisza.edu.my

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This specifies a need for a practical policy that should prioritise mandatory climate-related financial disclosures that align with global sustainability frameworks, and enhance capacity building in the plantation sector. Labour skills, knowledge, and resources need to improve to support sustainable practices, climate adaptation, and resilient investment.
Keywords: Malaysia Market; Climate Change Practices; Plantation Sector

1. Introduction

The plantation sector plays a crucial role in many developing economies, particularly in Southeast Asia. This includes the cultivation of crops such as oil palm, rubber, rice, sugarcane, and various tropical fruits. Diagram 1 simplifies these three phases of activities and illustrates how the three phases of activities occur and are affected by climate change. Even though climate change imposes a serious threat to global agriculture, its overall impact on global agriculture is still unclear. Global temperature is expected to rise by 2.5–4.5 ºC by the end of the 21st century. The amount of greenhouse gases (GHG), particularly CO_2, is increasing at an alarming rate and is enhancing plant photosynthesis and productivity. However, the increase in productivity is counteracted by the more negative effects of climate change on agriculture, such as increased evapotranspiration, drought, floods, changes in the amount and distribution of rainfall, higher pest infestations, and more irrigation demand. Climate change also affects the availability of nutrients and their efficiency by influencing microbial activities and populations in the soil. Therefore, adaptation in the agriculture sector to the changing climate is indispensable because of its sensitivity and size.

An interdisciplinary approach is essential to mitigate the effects of global warming, involving agronomists, soil scientists, plant physiologists, plant breeders, meteorologists, and water experts working together to develop integrated solutions. Therefore, policymakers need to provide financial support for individuals practising eco-friendly agriculture, such as climate-smart agriculture, and stay informed about the current status of global warming to make sound decisions. Additionally, government and non-government organisations, universities, and research institutions must play a key role in encouraging and assisting farmers to adopt climate-smart/eco-friendly agriculture to reduce the harmful impacts of global warming. The costs of these mitigation strategies will increase significantly if no immediate action is taken now [1].

Climate change reporting disclosure indexes (CCRDIs) are critical tools for assessing sustainability and resilience in business operations. As climate-related risks continue to pose economic and environmental threats, companies, particularly those in resource-intensive industries such as the plantation sector, are increasingly expected to integrate environmental, social, and governance (ESG) factors into their corporate reporting. In Malaysia, the plantation industry plays a significant role in the economy while simultaneously attracting scrutiny over its environmental and social impact. Thus, understanding how plantation companies disclose climate-related risks and sustainability measures is essential for assessing their long-term viability and contribution to national and global sustainability agendas. This study aims to propose CCRDIs within Malaysian plantation companies through a content analysis approach, identifying key sustainability and resilience indexes that define their climate response strategies.

Previously, climate reporting by companies, particularly in Malaysia, was limited, inconsistent, and lacked the depth and structure provided by regulatory bodies. Most disclosures were voluntary and not focused on climate risk or financial impact. In this regard, in recent years, regulatory bodies, investors, and other stakeholders have emphasised the need for transparent climate-related financial and non-financial reporting. International frameworks such as the Task Force on Climate-related Financial Disclosures (TCFD), the Global Reporting Initiative (GRI), and the Sustainability Accounting Standards Board (SASB) provide general guidelines for this disclosure, emphasising material risks, governance structures, and strategic responses to climate change. In Malaysia, regulatory bodies such as Bursa Malaysia and the Securities Commission have encouraged corporate entities to align with global disclosure standards, thereby reinforcing the importance of transparent reporting on climate risks and resilience measures.

The plantation sector, being a major contributor to Malaysia's economy and a key player in the global supply

chain for palm oil and other agricultural products, is under immense pressure to demonstrate sustainability. Companies in this sector must disclose their efforts to mitigate deforestation, reduce carbon footprints, implement sustainable land management practices, and improve labour conditions. Consequently, examining climate change disclosure in Malaysian plantation companies offers valuable insights into how sustainability and resilience indexes are integrated into their corporate strategies.

Figure 1 demonstrates the environmental impacts of agricultural production stages on climate change. This particularly occurs in large-scale plantations, which significantly contribute to climate change throughout the entire lifecycle of production. Diagram 1 categorises climate impact into three key phases: pre-planting, planting and cultivation, and post-planting [2]. The specific activities within each phase are elaborated as follows to understand the environmental consequences.

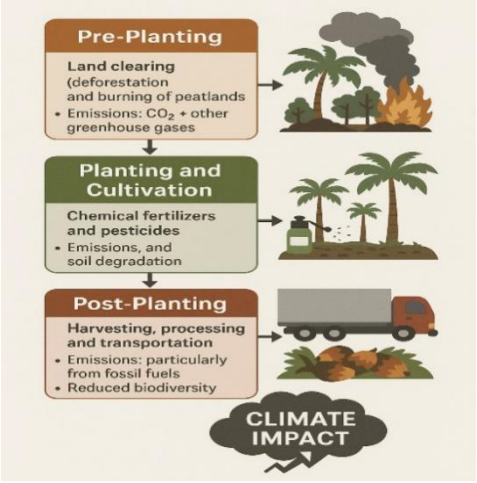

Figure 1. Environmental Impacts of Agricultural Production Phase on Climate Change.

In the pre-planting phase, land-clearing practices such as deforestation and the burning of peatlands are commonly employed to make way for new plantations. These activities release substantial amounts of carbon dioxide (CO_2) and other greenhouse gases into the atmosphere, contributing directly to global warming. Peatland burning is especially harmful, given its high carbon density and long-term ecological consequences [3].

During the planting and cultivation phase, the widespread use of chemical fertilisers and pesticides contributes further to environmental degradation. These agrochemicals emit nitrous oxide (a potent greenhouse gas), pollute nearby water bodies, and accelerate soil degradation through nutrient depletion and erosion. This phase not only impacts emissions but also affects soil health and long-term agricultural productivity.

Finally, the post-planting phase encompasses harvesting, processing, and transportation of agricultural products. These activities rely heavily on fossil fuels, contributing to carbon emissions and climate change. Moreover, large-scale monoculture plantations often lead to significant biodiversity loss, as native flora and fauna are displaced or destroyed to make room for commercial crops.

Overall, these three phases highlight the environmental impacts of agricultural practices that have affected nations. To address these threats and vulnerabilities, targeted interventions are necessary, including the adoption of sustainable land management practices, reduced chemical inputs, improved logistics efficiency, and biodiversity conservation strategies [4].

2. Literature Review

Sustainability and resilience are two interrelated concepts shaping the long-term viability of companies operating in climate-sensitive industries. Sustainability focuses on maintaining environmental integrity, social responsibility, and economic stability, while resilience refers to a company's ability to adapt and recover from climate-related disruptions. These two terms have evolved over the years whereby previous literature has identified that sustainability, typically refers to practices that mini-

mise environmental degradation, promote social welfare, and maintain economic viability [4,5], while resilience refers to the sector's ability to absorb climate impacts, economic fluctuations, or political instability and recover to maintain productive capacities [6]. In the plantation industry, sustainability indexes not only focus on GHG emission reduction, but also include responsible land use, biodiversity conservation, and water resource management. Meanwhile, resilience indexes involve risk assessment mechanisms, adaptation strategies, and financial risk management related to climate variability and regulatory changes introduced by regulatory bodies.

Legitimacy Theory highlights the disparity between the values of companies and society, known as the legitimacy gap, which can threaten companies. This gap arises from companies' insensitivity to the impacts of their activities and the community's expectations, as they focus primarily on maximising profits. Company disclosures often react to environmental, economic, social, and political pressures to legitimise their existence and behaviours. According to Legitimacy Theory, organisations build environmental legitimacy by acting responsibly towards the environment and society for their past actions. For example, such efforts include obtaining ISO 14001 certification, improving environmental performance, establishing environmental committees, and increasing foreign diversity. These initiatives assist companies in bridging the legitimacy gap. Jannah et al. [7] identified that such activities and initiatives can indirectly predict the level of carbon emission disclosure by companies.

A previous study by Salleh et al. [8] only investigated one of the greenhouse gas (GHG) emissions among Malaysian plantation sector companies and the audit committee (AC) effectiveness in influencing reporting practices. However, this study focused more on GHG reporting and discovered that the AC is vital in assisting such reporting. On the other hand, ASEAN [9] examines the implementation of GRI Standards in Plantation Sector Companies Listed on the Indonesia Stock Exchange (IDX) and found that the application of GRI Standards is still relatively low and requires special attention among the plantation companies in Indonesia. In relation to these disclosures, the latest guidelines, TCFD, a new standard of IFRS S1 and IFRS S2, has been released in association with climate change-related disclosure reporting. Hence, the current study focuses on the recent development of climate reporting, which is limited to the researcher's knowledge and needs further investigation. Nevertheless, climate change issues are considered a serious matter of global concern. Hence, this matter will be discussed further in this article.

Malaysian plantation companies are increasingly incorporating these indexes into their corporate strategies, often aligning their sustainability commitments with national policies such as the Malaysian Sustainable Palm Oil (MSPO) certification and international initiatives, including the Roundtable on Sustainable Palm Oil (RSPO). However, the effectiveness and transparency of these commitments largely depend on the quality and comprehensiveness of their CCRDIs. Thus, a systematic content analysis of these disclosures can help identify gaps, strengths, and opportunities for improvement. Despite the growing emphasis on CCRDIs, plantation companies in Malaysia face several challenges in climate-related reporting. One major obstacle is the lack of standardised reporting practices, as different firms adopt varying frameworks, making comparisons difficult. Additionally, some companies may engage in greenwashing, providing misleading or exaggerated claims about their sustainability efforts to maintain a positive public image without substantive climate action.

Moreover, financial constraints and limited technical expertise hinder smaller plantation firms from effectively implementing and reporting comprehensive CCRDIs. Unlike large multinational corporations, these smaller firms may struggle to allocate resources for climate risk assessments, sustainable technology adoption, and transparent reporting. Addressing these challenges requires stronger regulatory enforcement, capacity-building initiatives, and increased investor scrutiny to encourage best practices in climate disclosures. At the same time, emerging trends in climate disclosures indicate a shift towards more integrated and forward-looking reporting. Digitalisation and big data analytics are enhancing the accessibility and accuracy of environmental reporting, while stakeholder engagement is fostering greater accountability. Furthermore, with the rise of ESG-driven investments, companies are increasingly incentivised to improve their CCRDIs to attract ethical investors and ensure long-term financial stability.

Given the critical role of CCRDIs in shaping corpo-

rate sustainability and resilience, this study examines the extent to which the climate change resilience disclosure index within Malaysian plantation companies aligns with TCFD guidelines and IFRS S1 and IFRS S2. Further, an index of sustainability-resilience to climate change for Malaysian Plantation companies can be identified. This study contributes to the existing body of knowledge on corporate sustainability reporting by offering empirical insights into how Malaysian plantation firms communicate their climate commitments. The findings will be valuable for policymakers, corporate leaders, investors, and researchers seeking to enhance corporate climate transparency and foster resilient businesses.

With diverse economies and different institutional strengths, the ASEAN region encounters considerable challenges in forming transparent, coherent, and effective climate change reporting disclosures. Even though ESG (Environmental, Social, and Governance) practices have gained momentum and recognition globally, ASEAN economies still face structural and policy-driven challenges in executing climate change-related reporting practices [9,10]. One of the challenges is the deficiency of standardised regulatory frameworks across the region. Unlike the European Union, which has enacted comprehensive sustainability disclosure legislation such as the CSRD (Corporate Sustainability Reporting Directive), ASEAN economies present substantial disparity in their legal mandates for climate change-related reporting disclosure. For example, Both Malaysia and Singapore are showing substantial progress in executing ESG disclosure for publicly listed companies [11,12] while other economies (e.g., Cambodia, Myanmar, and Laos) lack mandatory regulatory frameworks, resulting in inconsistent and fragmented climate change related reporting practices [13].

Many ASEAN firms, especially SMEs, possess insufficient internal ability to evaluate and disclose climate change-related risks using frameworks [14,15]. The absence of robust assurance protocols and third-party verification mechanisms further diminishes data credibility and reliability [16]. In addition, firms encounter challenges in adapting global reporting systems to align with local settings [17]. This misalignment weakens the value of disclosed information for stakeholders such as investors and regulators assessing region-specific climate change risks [17,18]. Consequently, climate change-related reporting is often perceived as a compliance obligation rather than a strategic imperative, particularly in jurisdictions with slipshod or incompetently executed environmental legislation [15,19]. Thus, insufficient institutional capacity, fragmented regulatory frameworks, weak market incentives, and inadequate regional coordination hinder climate change-related reporting disclosures in the ASEAN region.

3. Underlying Theories

The significant theories of this matter commonly comprise three: legitimacy theory, stakeholder theory, and institutional theory. Dowling et al. [20] introduced the concept of organisational legitimacy, arguing that organisations must align their activities and disclosures with societal norms and values to ensure continued existence. On the other hand, Meyer et al. [21] argued that companies adopt certain practices not because they are efficient, but because they enhance legitimacy and survival.

Legitimacy theory offers an inclusive scope of discussion for exploring the climate change reporting disclosure indexes (CCRDIs) of Malaysian plantation companies. This theory posits that companies seek to align their operations and disclosures with societal norms and expectations to maintain their legitimacy and ensure continued support from the public and regulators. In the Malaysian plantation sector, deforestation, carbon emissions, and biodiversity impacts are common issues. When a company uses sustainability disclosures as a strategic tool to signal conformity to environmental norms, it appears responsible and secures its social license to operate. Legitimacy theory helps explain why plantation companies emphasise specific resilience and sustainability indexes.

Freeman [22] is the cornerstone of stakeholder theory. He argued that businesses must consider and address all stakeholders' needs, not only shareholders, to achieve long-term success. This work has profoundly influenced corporate social responsibility and sustainability disclosure research. Stakeholder theory complements this by focusing on how companies manage the expectations of various stakeholder groups, including investors, regulators, local communities, NGOs, and consumers. Companies are accountable to a diverse array of interested parties. In the

context of CCRDIs, Malaysian plantation companies may apply their climate disclosures to demonstrate responsiveness to stakeholder concerns about climate risk, supply chain sustainability, and labour rights. (e.g., reporting on emissions reduction, reforestation efforts, or social adaptation strategies depending on stakeholder priorities.

Di-Maggio et al. [23] introduced the concept of institutional isomorphism, which is how organisations become similar over time due to coercive, mimetic, and normative pressures. It is a foundational text in understanding how external pressures influence organisational behaviour, including disclosure practices. Institutional theory highlights that organisational behaviour is shaped by the rules, norms, and practices embedded in the institutional environment. Companies that engaged in plantation received regulatory pressures, industry standards, needs and requirements, and expectations set by international bodies such as the RSPO (Roundtable on Sustainable Palm Oil). Institutional theory explains the isomorphic pressures: mimetic(copying peers), coercive(complying with regulatory requirements), and normative(adhering to professional standards) that drive companies to adopt similar disclosure practices.

Fernando et al. [24,25] stress that these three theories are deeply interrelated, although each emphasises different aspects. In relation to this study, Legitimacy Theory underscores the broader societal approval of companies. At the same time, stakeholder theory narrows this down to specific influential groups. Institutional theory explains the structural pressures that institutionalise certain disclosure norms. These three theories provide a comprehensive framework on the importance of CCRDIs. The legitimacy theory drives the "why," stakeholder theory explains the "to whom," and institutional theory informs the "how" of sustainability and resilience disclosure practices in Malaysian plantation firms.

4. Methodology

To achieve the objectives of the current study, 41 plantation companies listed on Bursa Malaysia's main market have been chosen. The final sample is shown in the **Appendix A**. This study covers a two-year period from 2021 to 2022. The sample was selected for these years to examine the response and actions of the companies regarding this disclosure following the issuing of the guidelines by the TCFD during the year 2020. The current study used total population sampling, which allowed explanations and conclusions to be made about the population under study. Data were retrieved from the company's annual reports listed on Bursa Malaysia. The annual reports were downloaded from the Bursa Malaysia website (https://www.bursamalaysia.com.my) or from the respective companies' websites. Data on sustainability were manually collected by reading and screening the section on sustainability in the sustainability report or any other sections in the annual report that address climate change matters.

To achieve this study's objective, a comprehensive review of the climate change resilience disclosure index was conducted through content analysis. Content analysis is a systematic and replicable research method used to analyse text, communication artefacts, and media to derive meaningful insights. It is widely used in social sciences, business, and governance studies to examine patterns, trends, and themes within qualitative and quantitative data. Researchers employ content analysis to interpret textual information systematically by categorising it into predefined or emergent themes. The method can be conducted using two primary approaches: qualitative and quantitative. Qualitative content analysis involves an interpretive process where researchers analyse the meaning and context of the content, often using coding techniques to identify key themes and patterns (Hsieh & Shannon, 2005). This approach is particularly useful for exploring deeper meanings and subjectivity in communication. In contrast, quantitative content analysis involves counting the frequency of words, phrases, or specific themes, allowing researchers to identify trends and correlations in large datasets [26]. The integration of both approaches, known as mixed-method content analysis, provides a more comprehensive understanding of the studied phenomenon.

One of the key strengths of content analysis is its ability to handle a vast amount of textual data, making it an effective method for studying governance and corporate reporting. In the context of corporate sustainability and governance research, content analysis is often used to assess the disclosure practices of companies, examining the extent to which they report on environmental, social, and governance (ESG) factors [27]. The method is partic-

ularly useful for analysing annual reports, sustainability disclosures, and corporate communications to evaluate transparency and accountability. Furthermore, content analysis allows researchers to examine how companies align with regulatory frameworks, such as the Global Reporting Initiative (GRI) or the Task Force on Climate-related Financial Disclosures (TCFD). There are two parts to the significant data collected in this current study, namely (1) climate change practices, and (2) climate change resilience disclosure index. Hence, the data in this study were processed manually, and certain keywords were applied by the researchers, related to climate change. This required establishing content validity for climate change-related issues to ensure the data collected were correct, accurate and applied consistently. Content validity is also known as the second coder process, which verifies the data collected by the author. The second coder is an expert in climate matters and accounting disclosure.

For determining the climate change practices, and climate change resilience disclosure index, the process involved identifying each item to determine whether it was available or not in the annual report of the company. This approach was employed by Hassan et al. [28,29] where disclosure was measured by counting the number of disclosures made. For the CCRDI, the number of items was further calculated by dividing it by the total disclosure that collected in the study which were 31 items. The results were then presented as percentages rather than numerical values to show the final score and the extent of disclosure practices of the companies.

5. Findings and Discussions

The following discussions focus on climate change and are present under two parts: (1) climate change practices implemented by the companies on climate change, and (2) the climate change resilience disclosure index for the plantation sector over the past two years.

5.1. Climate Change Practices in the Plantation Sector

Companies take several actions to respond to climate change that affect their business operations. This discussion specifically focuses on mitigation and remedial actions taken by the plantation sector companies listed on Bursa Malaysia. Upon completion of the data collection process, the actions taken are summarised in **Table 1**.

Table 1. Climate Change Practices of Plantation Companies.

Climate Actions	Year 1	Year 2
1.Energy consumption	31	30
2.Greenhouse Gas Emissions	30	27
3.Bio-diversity	33	31
4.Water Consumption	35	35
5.Waste management	39	38
6.Prevention of Air Pollution	23	23
7.Prevention of Pollution of Soil & Water	31	30

Basically, the companies in the plantation sector engage in the seven practices presented in **Table 1** above. The identification of the seven items in **Table 1** is based on what the companies have reported and determined by the author from their annual report. For example, one of the companies has reported the following;

> "The agricultural sector is expected to practise sustainable agriculture to minimise carbon emissions and *reduce air pollution*, and to *protect biodiversity*, forests, *water and soil*".
>
> "Achieved a total of 25 projects in Malaysia that *saved energy*, steam and electricity."
>
> "Collaborations with relevant parties in developing and implementing various landscape approaches towards effective fire *prevention*."

In this example, it can be observed that the company is practising air pollution reduction, biodiversity production, water and soil production, and energy saving to mitigate climate change. Once those keywords are identified, it indicates that the companies are making an effort to imple-

ment salient climate change practices. The same process is repeated across the companies' annual reports to identify the relevant data and information.

Table 1 above shows that water consumption reporting remained unchanged at 35, as did the prevention of air pollution at 23. Other categories, including energy consumption, greenhouse gas emission, biodiversity, and prevention of soil and water pollution, experienced slight declines in reporting in year 2. Notably, greenhouse gas emissions reporting dropped from 30 in Year 1 to 27 in Year 2, and biodiversity reporting decreased from 33 to 31, raising concerns about corporate transparency in environmental disclosures. Waste management had the highest reporting level, with 39 in Year 1 and 38 in Year 2, indicating its importance in the climate resilience efforts of the companies.

Table 2 below presents descriptive statistics for climate change practices across two years (Year 1 and Year 2) based on a sample size of 41 (N = 41). In Year 1, the minimum number of reported climate change actions was 1, while the maximum was 7, with a mean of 5.41 and a median of 6. The standard deviation was 1.80, indicating moderate variability in reporting. In Year 2, the minimum reporting dropped to 0, while the maximum remained at 7. The mean slightly decreased to 5.22, and the median fell to 5.5, suggesting a slight decline in overall reporting. The standard deviation increased to 1.95, indicating greater variability in reporting patterns compared to Year 1.

Table 2. Descriptive Statistics for Climate Change Practices of Plantation Companies (N = 41).

Year	N	Minimum	Maximum	Mean	Median	Standard Deviation
1	41	1	7	5.41	6	1.80
2	41	0	7	5.22	5.5	1.95

There was a slight decline in the overall reporting of climate change actions from Year 1 to Year 2, as indicated by the decrease in the mean (from 5.41 to 5.22) and median (from 6 to 5.5). This suggests that, on average, companies reported fewer climate change practices in Year 2 compared to Year 1. The fact that the minimum reporting value dropped to 0 in Year 2 is particularly concerning, as it suggests that at least one company did not report any climate change actions in the second year, which was not the case in Year 1. The increase in standard deviation (from 1.80 to 1.95) indicates a wider range of reporting behaviours in Year 2, suggesting greater inconsistency among companies in disclosing their climate change practices.

The increasing standard deviation in climate change-related disclosures reflects an intensifying disparity in ASEAN economies. This variation demonstrates that although certain firms enhance disclosures, others are underperforming. Further, an increasing heterogeneity also highlights disparities in reporting resources, institutional qualities, and regulatory guidelines among firms and economies [30]. This underlines the necessity for standardised disclosure regulations to enhance reporting quality and ensure equitable conditions in ASEAN economies.

Table 3 below presents the distribution of companies (N = 41) based on the number of climate change practices they reported in Year 1 and Year 2. The table categorises companies based on how many climate change actions they disclosed, ranging from 0 (no reporting) to 7 (maximum reporting). In Year 1, no companies reported 0 actions, but in Year 2, one company did not report any climate change practices. The number of companies reporting 1 or 2 actions remained constant across both years, at 2 companies each. The number of companies reporting 3 actions increased slightly from 2 to 3 companies in Year 2. Companies reporting 4 actions declined from 4 in Year 1 to 3 in Year 2, indicating a minor decrease. Another key insight is that the majority of companies reported the highest number of climate change practices (7 actions) in both years. In Year 1, 18 companies reported 7 actions, which slightly decreased to 17 companies in Year 2. Despite this minor reduction, a significant proportion of companies still maintained a high level of climate action reporting, indicating that sustainability continues to remain a priority for many organisations.

Table 3. Frequency of Climate Change Practices of Plantation Companies (N = 41).

No. of Practices	Number of Companies Year 1	Number of Companies Year 2
0	0	1
1	2	2
2	2	2
3	2	3
4	4	3
5	10	10
6	3	3
7	18	17
Total	41	41

5.2. Climate Change Reporting Disclosure Index

The climate change reporting disclosure index is a reporting index developed based on the TCFD guidelines, with IFRS S1 and IFRS S2 used as parameters in collecting the data. Five pillars of climate change reporting disclosure index have been identified as presented in **Table 4**, with a total score of 31 items.

Table 4 provides a summary of Climate Change Reporting Disclosure Index (CCRDI) scores for plantation companies in the Malaysian market under five key pillars: Governance (G), Strategy (S), Risk Management (RM), Metrics and Targets (MT). The analysis highlights progress, stagnation, and key gaps in climate-related disclosures. Governance structures in Malaysian plantation companies show stability but limited progress. Limited training programs are provided to the board on climate matters, which require improvement. However, the board is actively involved in monitoring and slightly low in control activities on this climate change matter. Thus, indicating weak board oversight. Board roles and meetings remain unchanged, suggesting formal governance exists but lacks dynamic leadership in addressing evolving climate challenges effectively. **The Appendix B Table A1** presents the report of anonymous companies with the best and worst CCRDI scores.

The companies recognise climate risks for the strategy pillar but lack resilience planning. The risk identification and financial discussions remain strong. However, the failure to develop climate resilience strategies suggests inadequate preparation for long-term impacts. The absence of scenario-based planning highlights a major weakness that could expose firms to future environmental and regulatory vulnerabilities.

The companies' Risk management shows modest gains in risk awareness, but regulatory compliance has slightly declined, raising concerns about adherence to industry standards. Companies acknowledge climate risks but fail to enhance risk frameworks and materiality assessments. Without stronger prioritisation of climate risks, firms may struggle with long-term sustainability and risk mitigation efforts.

The fourth pillar is metrics and targets that demonstrate progress in GHG disclosures, which remain at a minimal level, without improvements in internal carbon pricing, climate risk measurement, or target setting. Showing this weak linkage between targets and risks suggests a lack of commitment to emission reductions. Companies risk falling behind in global sustainability benchmarks and reporting standards without clear tracking mechanisms. Reporting biodiversity and greenhouse gas emissions necessitates specialised data, monitoring instruments, and competent employees, which can be expensive for companies, particularly small and medium-sized enterprises or regions with embryonic ESG frameworks. The sustainability reporting frameworks within ASEAN may lack consistency owing to their voluntary nature [13]. Firms may reduce biodiversity and greenhouse gas reporting under economic uncertainty, organisational changes, or stakeholder emphasis in the absence of legal mandates or enforcement mechanisms.

The four pillars illustrate that CCRDI in Malaysian plantation companies highlights significant gaps in governance, strategy, risk management, metrics, and targets. While companies acknowledge climate risks and actively monitor them, their efforts remain largely reactive rather than proactive**.** Governance structures exist but lack strategic leadership, and risk management frameworks fail to integrate long-

term resilience strategies. Lack of financial commitment and weak tracking mechanisms indicate that these firms are not fully prepared to align with global sustainability expectations. Without substantial improvements, they risk regulatory scrutiny, reputational damage, and financial instability in the face of increasing climate-related risk.

Table 4. Summary and Score of CCRDI: Five Pillars and Each Item.

Pillars	List of Items	Score Year 1	Score Year 2
G	1.Name of the board	35	35
	2.Diagram	26	30
	3.Roles each based on diagram	30	31
	4.Meeting	27	27
	5.Training on CRI	13	18
	6.Manage the CRI	41	40
	7.Monitor the CRI	31	30
	8.Control the CRI	30	29
S	9.Short/medium/long term risk	17	17
	10.Opportunities or risk	40	40
	11.Process to identify above no. 9	40	40
	12.Impose financial impact	29	30
	13.Discussion on impact	37	37
	14.Resilience strategy. Use Climate related scenarios	2	2
RM	15.Determine the relative significance of CRR	9	12
	16.Follow regulatory requirements	26	25
	17.Use risk framework	25	25
	18.How deciding MTAC	35	32
	19.How do you prioritise climate-related risks	9	9
	20.How materiality determined	29	29
	21.Climate risk is considered a business risk	25	25
MT	22.Which metrics used	25	24
	23.Does the company measure CRO	0	0
	24.Established internal carbon price	0	0
	25.Broken down the GHG into relevant scope.	7	8
	26.Description of the value chain (scope 3) activities	2	3
	27.Method, estimation, data gaps on GHG	3	3
	28.Target used	15	15
	29.Link target to goals	14	12
	30.Link target to risks	12	11
	31.Progress overtime	14	14

Notes: CCRDI: Climate Change Reporting Disclosure Indexes; G: Governance; S: Strategy; RM: Risk Management; MT: Mitigation & Target; MTAC: mitigate, transfer, accept, or control; CRO: climate-related risks and opportunities.

Table 5 below shows the frequency of CCRDIs by plantation companies. The percentage score of the CCRDIs is based on the total of 31 items developed in **Table 4** above. For Year 2, at least one company recorded a zero CCRDI, whereas in Year 1, every company had some level of disclosure. This indicates a concerning trend where at least one company completely ceased climate-related reporting, highlighting potential weaknesses in regulatory enforcement, shifting corporate priorities, or economic constraints affecting sustainability transparency.

Table 5. Frequency of Climate Change Reporting Disclosure Index by Plantation companies (N = 41).

Percentage Score CCRDIs	Number of Companies Year 1	Number of Companies Year 2
0	0	1
1–3	0	0
4–6	1	0
7–8	0	0
9–10	0	0
11–20	2	2
21–30	4	4
31–40	6	6
41–50	8	9
51–60	10	7
61–70	6	8
71–80	3	3
81–90	1	1
91–100	0	0
Total	41	41

Another key change is the increase in companies reporting a CCRDI percentage score of 41–50 from 8 to 9, as well as in the 61–70 category from 6 to 8. This suggests that while some companies have reduced their disclosure efforts, others have improved, resulting in a mixed trend. The decline in companies within the 51–60 range from 10 to 7 further supports this shift, as some firms may have either progressed to higher disclosure levels (e.g., 61–70) or regressed to lower categories.

Interestingly, no companies reported CCRDI scores in the highest (91–100) or near-highest (81–90) ranges in both years, indicating that none of the companies in the sample has reached a comprehensive level CCRDI of 100%. This suggests a gap in full transparency and climate accountability, as even the most proactive firms have not maximised their reporting potential.

5.3. Implications of Inadequate Climate Disclosure in Plantation Sector on Agri-Food Supply Chains

The plantation sector is essential in ASEAN agri-food systems, especially in the agronomy of palm oil, cocoa, rubber, and other commodities. Based on the recent data from the current study, there is evidence of inadequate disclosure of climate information. Thus, inadequate disclosure practices critically intensify the susceptibility of the food supply chain through concealing climate-linked hazards, obscuring environmental corrosion, and hindering corresponding actions among stakeholders [31,32]. In a sector already burden by global political tensions, severe weather measures, and biodiversity loss, the absence of uniform, transparent disclosures of climate-linked issues impedes supply chain actors, investors, and policymakers from precisely estimating resilience and exposure [33]. The lack of comprehensive climate disclosure frameworks results in knowledge asymmetries, undermining policy effectiveness and market efficiency. For instance, weak disclosures from the Agri-sector might impede the appropriate assessment of climate-linked risks, investment flows distortion, and convey a misleading sense of security among trade in economies. Moreover, weak corporate disclosure transparency undermines accountability systems that promote adaptive practices essential for long-term supply chain sustainability, including carbon emission reductions and biodiversity conservation [34]. The section delves into the consequences of these disclosure gaps in three important areas: investment, trade, and regulation.

Investment Implications: From the investment viewpoint, inadequate climate change-related disclosure intensifies exposure to operational and financial risks. Investors and supply chain financiers are progressively seeking ESG transparency to estimate climate change-related vulnerabilities, encompassing transition and physical risks such as floods, droughts, or regulatory drawbacks

associated with carbon emissions-intensive processes. In the plantation sector, inadequate climate change reporting on direct emissions, energy consumption, and especially land-use effects and deforestation throughout the value chain constrains investors' capacity to assess risk and offer green finance [35]. This opacity may result in high financing costs, potential exclusion, and diminished investor confidence from climate-aligned investment portfolios and sustainability-related loans. In addition, insufficient climate change-related reporting may consequently disrupt ties with foreign customers or hinder producers from engaging in preferential trade programs.

Trade implications: The plantation sector is involved in global value chains, and inadequate climate change disclosure jeopardises market access and reputational integrity. The absence of transparent GHG emissions data, land-use change information, and biodiversity impact assessments undermines the ability of producers in Malaysia and Indonesia to comply with new traceability standards. In contrast, certification programs such as the Malaysian Sustainable Palm Oil (MSPO) and the Roundtable on Sustainable Palm Oil (RSPO) illustrate the beneficial effects of organised, transparent sustainability criteria. The Malaysian Sustainable Palm Oil (MSPO) certification serves as Malaysia's national standard for sustainable palm oil production. It guarantees sustainable, socially accountable, and commercially feasible palm oil activities. These programs have enhanced environmental monitoring; nonetheless, their climate-related disclosure elements are restricted and would benefit from linkage with global climate frameworks.

Regulatory Implications: The inconsistencies in disclosures also have ramifications for international agricultural trade discussions on the subsidies for agriculture under the WTO. Countries demonstrating limited climate transparency might validate environmentally allied subsidies under the classification of "Green Box" [36]. The variations in disclosure are present within ASEAN economies such as Malaysia and Singapore, which have implemented more sophisticated sustainability reporting requirements compared to countries like Myanmar or Laos, indicating regulatory fragmentation issues [10]. This disparity may skew regional agricultural investment and trade; firms that disclose more transparently may incur higher costs than others. Associating climate disclosure standards like NCNP 2.0 (National Climate Change Policy 2.0) and the ASEAN guidelines to promote regional climate-smart agriculture, offers a chance to improve regional food security via standardised reporting and risk management. Integrating the climate risk disclosure along with ASEAN guidelines would allow Malaysia to evaluate Agri firms based on environmental performance, pinpoint regional vulnerabilities, and formulate collective adaptation measures [9]. This will aid Malaysia and ASEAN nations in achieving their national strategic objectives on climate change under the Paris Agreement and enhance regional collaboration during climate-induced crises, such as agricultural failures or food export prohibitions.

6. Conclusions and Future Research Avenues

The climate change resilience disclosure index serves as a vital mechanism for assessing how companies navigate the challenges of climate change and sustainability transitions. In Malaysia's plantation sector, where environmental and social concerns are prominent, CCRDIs play a pivotal role in shaping industry practices and influencing stakeholder perceptions. By conducting a content analysis of these disclosures, this research sheds light on sustainability and resilience indexes that define corporate responses to climate risks in plantation companies. The level of current practice is shown at a mid-level disclosure, whereby some companies are improving, others are backsliding, and no company has achieved full disclosure, as the score out of the 31 items indicates that only one company achieved 81% in both years. The average score is only between 40% and 60%. Therefore, the findings of the study could be used and referred to by the Plantation companies in Malaysia as an index to enhance climate reporting. Ultimately, it enhances the quality and credibility of CCRDIs of more sustainable practices, regulatory compliance, and boosts investor confidence, contributing to a more resilient and responsible plantation industry in Malaysia. The decline in the action of climate change may be attributed to factors such as slow regulatory enforcement, shifting corporate sustainability priorities, or external economic pressures. The trend suggests the need for stronger governance

frameworks to ensure consistent climate action reporting in the plantation sector. Policymakers should enhance regulatory measures, and corporations should integrate more transparent reporting mechanisms to align with global sustainability commitments, such as the Paris Agreement and the Sustainable Development Goals (SDGs). The findings highlight the importance of maintaining rigorous disclosure practices to ensure the plantation sector contributes effectively to climate change mitigation.

The CCRDI provides a significant foundation of evidence to guide regulatory decisions, especially for entities such as Bursa Malaysia. By identifying disclosure deficiencies and sectoral discrepancies, CCRDI can enhance ESG regulations, direct focused enforcement, and prioritise indexes that match national climate objectives. It facilitates enhanced strategic alignment with frameworks such as the ASEAN Taxonomy and TCFD. The CCRDI could evolve into a regional benchmarking tool, which will be included in ESG rating frameworks, sustainability-issue-related financing, and cross-border reporting systems in the future. It may further include automated evaluations, sector-specific modules, and regulatory interoperability, enhancing transparency, accountability, and uniformity within ASEAN's climate change-related disclosure framework.

Despite the study's contribution, this study also comes with its limitations. The index that is provided in the current study is limited to a period of two years only. In the meantime, when climate disclosures evolve, findings from this study may become outdated as new sustainability reporting guidelines emerge. This study only employs a small sample of 41 companies in the plantation sector, which limits the generalisation to the listed companies. The method of the study that only used content analysis from the annual reports was unable to capture informal or internal sustainability practices that the companies probably do not disclose publicly and could only be discovered through face-to-face interviews. As for future research, it might incorporate a wider industry for comparisons, examine stakeholder perspectives on climate change, identify the role of technological advancements in climate reporting, and examine financial performance linkages to enhance the understanding and effectiveness of climate-related disclosures in the Malaysian market.

Author Contributions

Conceptualization, methodology, validation, formal analysis, data curation and writing original draft were carried out by U.J. Review and editing were undergone by M.C. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

All data used in this research are publicly available from the original sources cited in the references.

Conflicts of Interest

The authors declare no conflict of interest.

Appendix A. List of Plantation Companies

1	Chin Teck Plantations Berhad
2	Batu Kawan Berhad
3	Kuala Lumpur Kepong Berhad
4	PLS Plantations Berhad
5	Jaya Tiasa Holdings Bhd
6	Dutaland Berhad
7	TSH Resources Berhad
8	Kluang Rubber Company (Malaya) Berhad
9	Sungei Bagan Rubber Company (Malaya) Berhad
10	Pinehill Pacific Berhad

11 Golden Land Berhad
12 MALPAC Holdings Berhad
13 IOI Corporation Berhad
14 United Malacca Berhad
15 BLD Plantation Bhd.
16 Kim Loong Resources Berhad
17 Sime Darby Plantation Berhad
18 NPC Resources Berhad
19 Harn Len Corporation Bhd
20 Sarawak Oil Palms Berhad
21 Riverview Rubber Estates Berhad
22 Sin Heng Chan (Malaya) Berhad
23 Negri Sembilan Oil Palms Berhad
24 Boustead Plantations Berhad
25 Kretam Holdings Berhad
26 Rimbunan Sawit Berhad
27 TA ANN Holdings Berhad
28 TH Plantations Berhad
29 TDM Berhad
30 Far East Holdings Berhad
31 Gopeng Berhad
32 FGV Holdings Berhad
33 Astral Asia Berhad
34 Hap Seng Plantations Holdings Berhad
35 Inch Kenneth Kajang Rubber Public Ltd Co.
36 Sarawak Plantation Berhad
37 Innoprise Plantations Berhad
38 Cepatwawasan Group Berhad
39 MHC Plantations Bhd
40 Genting Plantations Berhad
41 United Plantations Berhad

Appendix B

Table A1. Anonymous data companies on best and worst score on CCRDI.

Pillars	List of Items	Company ABC Best Company Score Year 2	Company XYZ Worst Company Score Year 2
G	1.Name of the board	/	/
	2.Diagram	/	x
	3.Roles each based on diagram	/	x
	4.Meeting	/	x
	5.Training on CRI	/	x
	6.Manage the CRI	/	/
	7.Monitor the CRI	/	/
	8.Control the CRI	/	/
	Total	8/8	2/8
S	9.Short/medium/long term risk	/	x
	10.Opportunities or risk	/	/
	11.Process to identify above no. 9	/	/
	12.Impose financial impact	/	x
	13.Discussion on impact	/	/
	14.Resilience strategy. Use Climate related scenarios	x	x
	Total	5/6	3/6
RM	15.Determine the relative significance of CRR	/	x
	16.Follow regulatory requirements	/	x
	17.Use risk framework	/	x
	18.How deciding MTAC	/	x
	19.How do you prioritise climate-related risks	/	x
	20.How materiality determined	/	x
	21.Climate risk is considered a business risk	/	/
	Total	7/7	1/7

Table A1. *Cont.*

Pillars	List of Items	Company ABC Best Company Score Year 2	Company XYZ Worst Company Score Year 2
MT	22.Which metrics used	/	x
	23.Does the company measure CRO	x	x
	24.Established internal carbon price	x	x
	25.Broken down the GHG into relevant scope.	/	x
	26.Description of the value chain (scope 3) activities	x	x
	27.Method, estimation, data gaps on GHG	/	x
	28.Target used	/	x
	29.Link target to goals	/	x
	30.Link target to risks	/	x
	31.Progress overtime	/	x
	Total	7/10	0/10
	OVERALL SCORE (%)	**87.09**	**19.35**

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