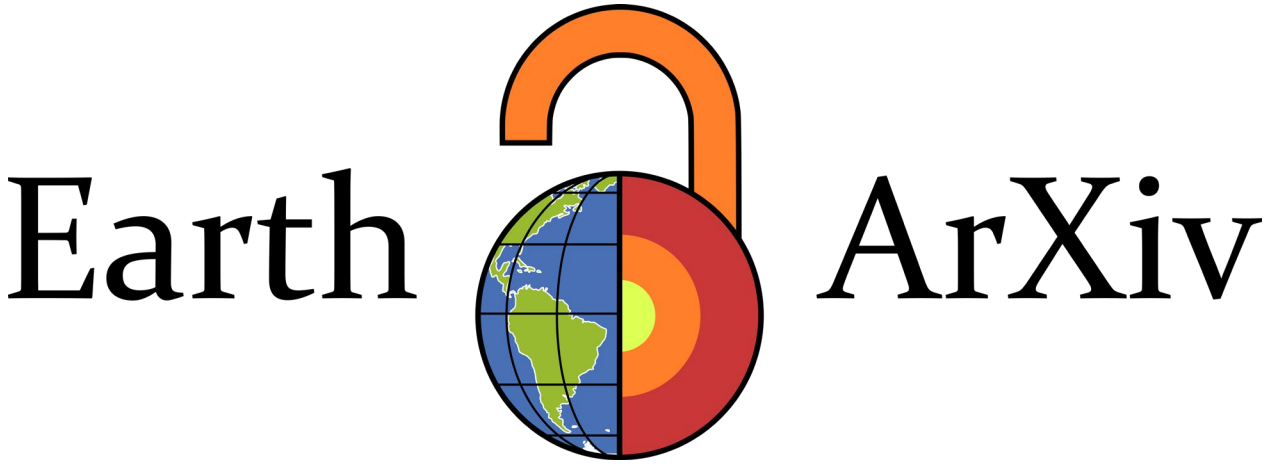

Title: Methodological Concerns Regarding RSPO Certification and Plantation Efficiency in Malaysia. A Commentary on Sustainable Palm Oil Certification Inadvertently Affects Production Efficiency in Malaysia (Zachlod et al. 2025):

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Methodological Concerns Regarding RSPO Certification and Plantation Efficiency in Malaysia. A commentary on "Sustainable Palm Oil Certification Inadvertently Affects Production Efficiency in Malaysia" by Zachlod et al. (2025).

Abstract

This commentary is in response to the recent article by Zachlod et al. (2025) in *Communications Earth & Environment*, which concludes that Roundtable on Sustainable Palm Oil (RSPO) certification leads to reduced plantation efficiency in Malaysia. While the study raises an important discussion on the unintended consequences of certification, its findings are undermined by substantial methodological and analytical limitations. We identify four critical areas of concern. First, the study suffers from omitted variable bias failing to control for well documented drivers of yield variation including climatic anomalies (El Niño/La Niña events), aging plantations, replanting cycles, COVID-19 related labor shortages and land-use policy constraints which are not adequately accounted for, despite their well-documented effects on palm oil yields.

Secondly, the interpretation of correlation as causation overstates the evidence based solely on temporal correlation; rigorous econometric strategies were not employed to establish any causal links. Third, reliance on a pseudonymous company using tree coverage as a proxy for efficiency, rather than actual metrics like yield, and limited economic controls further weaken the analysis. Finally, the heavy reliance on remote sensing without adequate field validation risks misclassification of normal plantation dynamics as certification effects. We conclude that robust, multidisciplinary methods are needed before drawing policy-relevant conclusions about RSPO's impact on productivity.

Significance Statement

This commentary highlights the importance of methodological rigor when evaluating the impact of sustainability certifications such as RSPO. By clarifying key sources of omitted variable bias and misinterpretation in Zachlod et al. (2025), we caution against drawing unsupported conclusions that RSPO certification reduces plantation efficiency. Our analysis underscores the need for multidisciplinary approaches that integrate agronomy, economics, and climate science to ensure policy debates on palm oil sustainability are grounded in robust evidence.

Keywords: RSPO certification; palm oil; plantation efficiency; sustainability standards; methodological critique; causal inference; commentary; peer response; Malaysia

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Introduction

This commentary critically evaluates the recent study by Zachlod et al. (2025), questioning the claim that RSPO certification negatively impacts plantation efficiency in Malaysia. The study raises an important discussion on the unintended consequences of the Roundtable on Sustainable Palm Oil (RSPO) certification, it suffers from significant methodological limitations and analytical gaps that call into question the validity of its conclusions. These issues suggest that critical external factors may have been overlooked during the peer review process. Meemken et al. (2021) emphasize the evaluation of sustainability standards requires robust methodology that accounts for the complex interactions between certification and other environmental, economic, and social factors.

1. Omitted Variable Bias & Inadequate Controls

The study attributes the decline in palm oil plantation efficiency to RSPO certification without adequately controlling for key external factors. While the authors use NDVI (Normalized Difference Vegetation Index), NDMI (Normalized Difference Moisture Index), and BSI (Bare Soil Index), these satellite-derived indices primarily capture vegetation greenness, canopy moisture, and soil exposure, respectively. However, they do not sufficiently capture the range of climatic, economic, and operational influences, affecting plantation efficiency in Sabah during the study period (2017–2023). Ferraro and Hanauer (2014) have highlighted the importance of accounting for multiple confounding variables when measuring the impacts of environmental programs to avoid misleading conclusions about program effectiveness. Key Missing Variables include:

i. Climatic Factors

Externals stresses have a direct relationship with the yield especially in the case of oil palm yields. The yield is influenced by yield-defining factors such as solar radiation, temperature, and ambient CO_2 levels; yield-limiting factors including water availability and nutrient supply and yield-reducing factors like pest and diseases infestations (Woittiez et al., 2017). The study period (2017-2023) encompassed severe El Niño (2018-2019) and La Niña (2020-2022) events that caused droughts, excessive rainfall, and flooding across Sabah. For example, insufficient rainfall induces water stress in fruit development stages, while excessive rainfall produces waterlogging that inhibits root respiration (Omar & Kamil, 2017). These climatic shocks, together with catastrophic floods of 2021–2022 in Malaysia, disrupted soil conditions, transportation, and harvesting, further impacting productivity (Ahmad et al., 2025) along with both plantation ecology and harvesting operations. However, these weather anomalies were not accounted for.

Correlation coefficients (r) between climatic variables and palm oil yields typically range from 0.6 to 0.8, suggesting that climate explains 36% to 64% of yield variance, far more than the ~24% explained by the authors' models. That is, the majority of yield variation is not captured by the Zachlod et. al. analysis.

ii. Aging Palm Plantations & Replanting Cycles

A second omitted factor concerns the aging profile of Malaysia's oil palm plantations. Trees older than 25 years naturally experience yield declines regardless of management practices (Rival & Levang, 2014). During replanting cycles, yields also decrease, as newly established palms typically require three to four years to reach maturity and produce fresh fruit bunches (Woittiez et al., 2017). In 2023, Sabah achieved a significant milestone by replanting 61,421 hectares, an annual rate of 4% and 69% higher than the 36,218 hectares replanted in 2022 (The Edge Malaysia, 2024). This accelerated replanting may have been designed to deal with increase in pandemic-related labor shortages, when harvesting activities were already constrained, making it an opportune time to replace older stands. However, the study does not account for these replanting dynamics and instead conflates natural yield declines with the effects of RSPO certification."

iii. COVID-19 Labor Shortages (2020–2022)

Third, COVID-19 labor shortages between 2020 and 2022 directly disrupted harvesting in Malaysia's oil palm sector, which relies heavily on foreign workers. Strict border closures worsened the shortage, reducing harvesting efficiency. In 2021, the industry employed more than 391,000 workers, of whom about 74% were foreign laborers, mainly from Indonesia (Hamzah & Hashim, 2024). With borders closed, many plantations especially those near national boundaries were unable to bring in the workers needed to collect fresh fruit bunches (FFB). As a result, large volumes of fruit went unharvested, lowering overall production (Hamzah & Hashim, 2024). The study fails to control for this disruption, despite its clear impact on plantation productivity."

iv. Policy Factors & Land Use Constraints:

In 2019, Malaysia proposed to cap the total oil palm expansion at 6.5 million hectares by 2023 (Wan Mohd Jaafar et al., 2020), limiting producers from offsetting yield declines with new plantings. This is due to the rapid expansion of the palm oil industry which has raised significant land use and land cover (LULC) concerns, particularly regarding deforestation. Currently, only an estimated 300,000 hectares of land remain potentially available for expansion, and this is further constrained by increasing government-imposed restrictions for environmental reasons (Murphy et al., 2021).

RSPO's 2018 sustainability criteria mandated conservation set-asides, banning forest and peatland clearing. These policies while environmentally beneficial reduced the productive land area (Bicknell et al., 2023), yet the study fails to distinguish efficiency losses due to land-use restrictions from those due to certification. Carlson et al. (2013) document how policy changes regarding land use can significantly impact palm oil production patterns and land conversion decisions. An example that illustrates this is while many plantations in Sabah, which had been planting illegally on riparian buffers outside their own boundaries, were forced to stop due to RSPO implementation (Bicknell et al., 2023). Now, they operate within legal boundaries. This

distinction between legal and illegal yield losses is crucial, yet overlooked in the paper. Collectively, these missing controls misattribute the efficiency declines to certification effects.

2. Misinterpretation of Correlation as Causation

Zachlod et al. (2025) explicitly claim that "obtainment of the RSPO certification resulted in decreased plantation efficiency," yet provide no credible evidence for this causal relationship. However, this conclusion is based purely on a chronological relationship, rather than rigorous causal inference techniques.

The authors could use difference-in-differences analysis (Hajar et al., 2024), instrumental variable approaches (Kubitza & Krishna, 2020), or other robust econometric methods that could establish a causal link. Their argument relies on ruling out only a few confounding factors (e.g., palm oil price, NDVI), ignoring many others (e.g., plantation age, labor constraints, economic downturns).

In the original paper Zachlod et al. (2025) state that their results indicate that obtainment of the RSPO certification resulted in decreased plantation efficiency. However, this causality is stated without sufficient statistical proof. The observed efficiency decline could be due to external shocks rather than certification effects.

3. Methodological & Data Limitations

i. Inappropriate Efficiency Proxy

The study uses palm tree coverage as a proxy for plantation efficiency, which represents a fundamental misunderstanding of agricultural productivity. Relying solely on tree coverage to assess plantation efficiency can be misleading, as it reflects only the snapshot of the land used, and not the actual productivity of the oil palm trees. According to Woittiez et al. (2017), oil yield is determined by multiple factors including the number of harvested fruit bunches, average bunch weight, and oil content. Rival and Levang (2014) demonstrate that productivity in oil palm is most accurately measured through fruit yield and oil extraction rates rather than simple tree coverage. Tree coverage merely indicates land occupation and can be misleading during normal replanting cycles or land-use transitions, creating unrealistic seasonality in efficiency measures and failing to capture actual productivity events.

ii. Limited Economic Controls

The economic variable considered in this study is the annual palm oil price on December 31 of each year. This ignores price fluctuations throughout the year, fertilizer and input cost variations, labor costs and availability. Economic factors play a major role in efficiency, and they are accounted for minimally

For instance, during periods of lower crude palm oil (CPO) prices in 2018, many companies and smallholders experienced reduced profitability, prompting cost-cutting measures. Notably, the usage of fertilizer inputs was significantly reduced in 2019 as it contributes to approximately 35% of total production costs (Lubis et al., 2024). Such decisions adversely impacted fresh fruit bunch (FFB) yields with a lag in subsequent years (2021–2022), as the developmental cycle of oil palm inflorescences spans two to three years from initiation to flowering (Lubis et al., 2024).

Additionally, labour shortages for harvesting particularly in Malaysia have been an ongoing key constraint. Harvesting for oil palm needs to be three times a month to minimize fruit loss. The lack of labour has resulted in extended harvesting intervals, leading to lower oil extraction rates, increased fruit losses, and unharvested bunches. Malaysian plantations have reported labour shortage of 20 to 30%, translating to yield reductions of up to 15% (Woittiez et al., 2017). These factors exacerbated by covid need to be accounted for.

iii. Limitations of Remote Sensing Data

The study relies on European Space Agency multispectral satellite imagery. Frequent cloud cover in Sabah, particularly during the peak season from December to March, likely introduces bias in vegetation indices such as NDVI and NDMI. This persistent cloudiness can obscure satellite observations and reduce data quality (Perbet et al., 2019). The authors do not provide an assessment of data completeness or quality controls for these known limitations.

Remote sensing cannot distinguish between efficiency losses and normal plantation operations such as replanting, harvesting schedules, or management practices. Replanting cycles could be misclassified as efficiency loss, when in reality, they are part of normal plantation renewal. When oil palms reach the end of their productive lifespan and yields decline, replanting is necessary to maintain sustainable long-term management of plantations. The replanting process involves clearing mature palms and establishing new ones, which requires time to reach full productivity (Woittiez et al., 2017). During this period, a temporary reduction in production occurs, which can be mistakenly attributed to a loss in plantation efficiency.

Remote sensing offers advantages including broad spatial coverage and regular monitoring, challenges remain. These include gaps in coverage and the lack of sufficient ground-truth validation data, especially in remote and difficult-to-access regions (Abdelmajeed & Juszczak, 2024). Harvesting frequency and labor availability cannot be observed via remote sensing. Koh and Wilcove (2008) discuss the limitations of remote sensing in accurately assessing plantation productivity, noting that satellite imagery alone cannot capture many critical management practices that influence yields. Consequently, ground-based validation and location-specific assessments are essential to enhance the accuracy and reliability of satellite-derived information in such contexts. Without adequate field verification, satellite data may not fully capture local variations or subtle changes in plantation conditions (Abdelmajeed & Juszczak, 2024).

iv. Transparency and Representativeness

While study cites publicly available data, it is based on palm oil producer with a pseudonym, preventing independent verification of findings. Without any discussion or transparency of this firm's characteristics, operational scale, management practices, or representativeness relative to other RSPO-certified operations, it is not possible to evaluate the broader and general applicability of these findings if any. Meijaard et al. (2018) note the significant variation in management practices and outcomes across different types of palm oil producers, emphasizing the importance of transparency and representativeness in study design.

Conclusion

Meemken et al. (2021) argue, the evaluation of sustainability standards requires methodological rigor to ensure that their true impacts, both intended and unintended, are accurately assessed. The missing controls and weak correlations lead to many of these conclusions that are contrary to established understanding of plantation management systems, and the general conclusion that RSPO certification reduces efficiency is misleading. Given the study's policy implications for sustainability certifications, ensuring that scientific conclusions are based on comprehensive, unbiased analyses is crucial.

We look forward to more rigorous analyses of the impacts of sustainability certification on agricultural productivity from studies that employ appropriate causal inference methods and comprehensive controls. These kinds of studies are critical to our understanding of sustainable agriculture and the effectiveness of certification schemes during the modern era of climate change and increasing environmental awareness. Agricultural economists, sustainability scientists, and policymakers are looking to the scientific community to provide actionable information based on rigorously tested methodologies. Given the importance of this research for sustainability policy, future efforts to increase understanding of certification impacts and carefully reassess the conclusions of Zachlod et. al. (2025) will be needed.

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