

Title: 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**Suggested Citation**

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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 RSPO certification. However, it suffers from significant methodological limitations and analytical gaps that undermine its conclusions. These issues suggest that critical external factors may have been overlooked during the peer review process. Meemken et al. (2021) emphasize that evaluating sustainability standards requires robust methodology that accounts for complex interactions between certification and environmental, economic, and social factors.

1. Omitted Variable Bias & Inadequate Controls

Malaysia's oil palm sector has experienced a downward trend in fresh fruit bunch (FFB) yields over the past decade. Between 1990 and 2014, the national yields averaged ~19 t/ha, but subsequently declined to ~17.2 t/ha during 2015–2019, attributable to aging trees, delayed replanting, and climate variability such as extreme heat and reduced rainfall (Khor et al., 2023). Yields fell further to ~16 t/ha in 2020–2022, as pandemic-related labor shortages disrupted harvesting activities (Khor et al., 2023). The study by Zachlod et al. (2025) 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) to capture vegetation greenness, canopy moisture, and soil exposure, they fail to reflect climatic, economic, and operational influences affecting plantation efficiency in Sabah during the study period (2017–2023). Ferraro and Hanauer (2014) highlight the importance of accounting for multiple confounding variables to avoid misleading conclusions about program effectiveness. Key missing variables include:

i. Climatic Factors

Oil palm yields are influenced by yield-defining factors (solar radiation, temperature, ambient CO₂ level), yield-limiting factors (water availability, nutrient supply) and yield-reducing factors (pest and disease) (Woittiez et al., 2017). The study period encompassed severe El Niño (2018–2019), La Niña (2020–2022) and catastrophic floods (2021–2022) in Malaysia that disrupted soil conditions, transportation, and harvesting (Ahmad et al., 2025). However, these climatic variables, explaining ~36–64% of yield variance, were not accounted for, despite exceeding the ~24% explained by Zachlod et al. (2025).

ii. Aging Palm Plantations & Replanting Cycles

Malaysia's oil palm plantations have an aging profile. 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 (FFB) (Woittiez et al., 2017). In 2023, Sabah replanted 61,421 hectares, 69% more than in 2022 (The Edge Malaysia, 2024).

This accelerated replanting may have been a strategic response to pandemic-related labor shortages, when constrained harvesting created an opportune time to replace older stands. However, the study overlooks this, conflating natural declines with certification impacts.

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

Between 2020 and 2022, Malaysia's oil palm sector, reliant on foreign workers, was severely affected by border closures. Of 391,000 workers in 2021, 74% were foreign (Hamzah & Hashim, 2024). Many plantations lacked harvesters, leaving large volumes of FFB uncollected. Despite its clear impact on productivity, this disruption was ignored.

iv. Policy Factors & Land Use Constraints:

Malaysia capped its oil palm expansion at 6.5 million hectares by 2023, leaving only ~300,000 hectares available due to environmental reasons (Wan Mohd Jaafar et al., 2020). RSPO's 2018 sustainability criteria also mandated conservation set-asides, reducing the productive land area (Bicknell et al., 2023). Policy changes significantly impact palm oil production patterns and land conversion decisions. Plantations previously cultivating illegally on riparian buffers had to cease operations due to RSPO implementation, now operating strictly within legal limits (Bicknell et al., 2023). This overlooked distinction between legal and illegal yield losses leads to misattribution of efficiency declines to certification effects.

2. Misinterpretation of Correlation as Causation

Zachlod et al. (2025) claim that RSPO certification decreased plantation efficiency, yet provide no credible evidence for this causal relationship. Their conclusion rests on chronological relationships, rather than rigorous causal inference techniques such as difference-in-differences or instrumental variables (Kubitza & Krishna, 2020). 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). 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. Tree coverage only reflects land use and cannot capture oil palm yields, which depend on harvested FFB, bunch weight, and oil content (Woittiez et al., 2017). Rival and Levang (2014) demonstrate that fruit yield and oil extraction rates, not coverage, best measure productivity. Tree coverage also misrepresents 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 study's economic variable is the palm oil price at year-end, ignoring price fluctuations throughout the year, fertilizer and input cost variations, labor costs and availability. Crude palm

oil price drops in 2018 reduced profitability, prompting fertilizer cutbacks in 2019 as it contributes to ~35% of production costs (Lubis et al., 2024). Such decisions decreased FFB yields in subsequent years (2021–2022), as the developmental cycle of oil palm inflorescences spans two to three years (Lubis et al., 2024). Labor shortages, exacerbated by COVID-19, further constrained harvesting. Malaysian plantations have reported labor shortage of 20-30%, reducing yield by up to 15% (Woittiez et al., 2017).

iii. Limitations of Remote Sensing Data

The study relies on European Space Agency multispectral satellite imagery, but Sabah's persistent cloud cover, especially from December to March, likely biases vegetation indices (Perbet et al., 2019). The authors do not provide an assessment of data completeness or quality controls for these known limitations. Moreover, remote sensing cannot distinguish between efficiency losses and normal plantation operations such as replanting, harvesting, or management practices. Replanting reduces yields temporarily as new palms require years to mature (Woittiez et al., 2017), yet such declines may be wrongly attributed to inefficiency. Other management practices, including harvesting schedules and labor inputs cannot be observed via satellite imagery (Koh & Wilcove, 2008). Although remote sensing offers broad spatial coverage, limitations in ground-truth validation remain, particularly in remote areas (Abdelmajeed & Juszczak, 2024). Without field verification, satellite data may misrepresent local variations or plantation conditions.

iv. Transparency and Representativeness

While the study cites publicly available data, it is based on a palm oil producer with a pseudonym, preventing independent verification. Without transparency on this firm's characteristics, operational scale or management practices, it is not possible to evaluate the broader and general applicability of these findings. 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) stress that evaluating sustainability standards requires methodological rigor to assess both intended and unintended impacts. The missing controls and weak correlations in Zachlod et al. (2025) lead to misleading claims that RSPO certification reduces efficiency. Given the policy implications, scientific conclusions must rest on comprehensive, unbiased analyses.

We urge more rigorous analyses on certification impacts using appropriate causal inference methods and comprehensive controls. Such research is essential for understanding sustainable agriculture and certification effectiveness in the era of climate change. Agricultural economists, sustainability scientists, and policymakers are looking to the scientific community for actionable information based on rigorously tested methodologies. Future work must reassess Zachlod et al.'s conclusions to ensure sustainability policy is informed by sound evidence.

References

- Abdelmajeed, A. Y., & Juszczak, R. (2024). Challenges and Limitations of Remote Sensing Applications in Northern Peatlands: Present and Future Prospects. *Remote Sensing*, 16(3).
- Ahmad, N., Ng, C. P., Ismai, N., Wong, M. M. R., Abbas, F., Law, T. H., Bahari, A. N. Z., & Rofia, M. F. M. A. (2025). Review of Major Flood Events in Malaysia Between 1970-2024. *Jurnal Kejuruteraan*, 37, 909–921. [https://doi.org/doi:10.17576/jkukm-2025-37\(2\)-28](https://doi.org/doi:10.17576/jkukm-2025-37(2)-28)
- Bicknell, J., O'Hanley, J., Armsworth, P., Slade, E., Deere, N., Mitchell, S., Hemprich-Bennett, D., Kemp, V., Rossiter, S., Lewis, O., Coomes, D., Agama, A., Reynolds, G., Struebig, M., & Davies, Z. (2023). Enhancing the ecological value of oil palm agriculture through set-asides. *Nature Sustainability*, 6, 1–13. <https://doi.org/10.1038/s41893-022-01049-6>
- Ferraro, P., & Hanauer, M. (2014). Advances in Measuring the Environmental and Social Impacts of Environmental Programs. *Annual Review of Environment and Resources*, 39, 495–517. <https://doi.org/10.1146/annurev-environ-101813-013230>
- Hamzah, N., & Hashim, M. (2024). Impact of COVID-19 on labour usage and the production of oil palm yield. *IOP Conference Series: Earth and Environmental Science*, 1397, 012001. <https://doi.org/10.1088/1755-1315/1397/1/012001>
- Khor, J. F., Ling, L., Yusop, Z., Chin, R. J., Lai, S., Kwan, B., & Ng, D. (2023). Impact Comparison of El Niño and Ageing Crops on Malaysian Oil Palm Yield. *Plants*, 12, 424. <https://doi.org/10.3390/plants12030424>
- Koh, L. P., & Wilcove, D. S. (2008). Is oil palm agriculture really destroying tropical biodiversity? *Conservation Letters*, 1(2), 60–64. <https://doi.org/https://doi.org/10.1111/j.1755-263X.2008.00011.x>
- Kubitza, C., & Krishna, V. V. (2020). Instrumental variables and the claim of causality: Evidence from impact studies in maize systems. *Global Food Security*, 26, 100383. <https://doi.org/https://doi.org/10.1016/j.gfs.2020.100383>
- Lubis, M., Abror, M., & Djujhana, J. (2024). Effect of fertilizer discount on fresh fruit bunches production and Nutrients in North Sumatra Indonesia. *IOP Conference Series: Earth and Environmental Science*, 1308, 012004. <https://doi.org/10.1088/1755-1315/1308/1/012004>
- Meemken, E.-M., Barrett, C. B., Michelson, H. C., Qaim, M., Reardon, T., & Sellare, J. (2021). Sustainability standards in global agrifood supply chains. *Nature Food*, 2(10), 758–765. <https://doi.org/10.1038/s43016-021-00360-3>
- Meijaard, E., Garcia-Ulloa, J., Sheil, D., Wich, S., Carlson, K., Juffe-Bignoli, D., & Brooks, T. (2018). *Oil palm and biodiversity : a situation analysis by the IUCN Oil Palm Task Force*. <https://doi.org/10.2305/IUCN.CH.2018.11.en>
- Perbet, P., Fortin, M., Ville, A., & Béland, M. (2019). Near real-time deforestation detection in Malaysia and Indonesia using change vector analysis with three sensors. *International Journal of Remote Sensing*, 40, 1–20. <https://doi.org/10.1080/01431161.2019.1579390>
- Rival, A., & Levang, P. (2014). *Palms of controversies: Oil palm and development challenges*. <https://doi.org/10.17528/cifor/004860>
- The Edge Malaysia. (2024). Ageing oil palm trees: MPOA calls for govt incentives to speed up replanting. <https://theedgemalaysia.com/node/709604>
- Wan Mohd Jaafar, W. S., Said, N. F., Abdul Maulud, K. N., Uning, R., Latif, M. T., Muhmad Kamarulzaman, A. M., Mohan, M., Pradhan, B., Saad, S. N., Broadbent, E. N., Cardil, A., Silva, C. A., & Takriff, M. S. (2020). Carbon Emissions from Oil Palm Induced Forest and Peatland Conversion in Sabah and Sarawak, Malaysia. *Forests*, 11(12).

- Woittiez, L. S., van Wijk, M. T., Slingerland, M., van Noordwijk, M., & Giller, K. E. (2017). Yield gaps in oil palm: A quantitative review of contributing factors. *European Journal of Agronomy*, 83, 57–77. <https://doi.org/10.1016/j.eja.2016.11.002>
- Zachlod, N., Hudecheck, M., Sirén, C., & George, G. (2025). Sustainable palm oil certification inadvertently affects production efficiency in Malaysia. *Communications Earth & Environment*, 6(1), 200. <https://doi.org/10.1038/s43247-025-02150-2>