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Environmental Heterogeneity and Technical Efficiency in Malaysian Oil Palm Smallholder Production

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Volume: 63 Issue: 1 Page: 27-48
DOI: 10.22452/MJES.vol63no1.2

Published JUN 2026

Indexed 2026-07-09

Document Type Article

Abstract Independent smallholders are crucial to Malaysia's oil palm sector, yet their productivity remains below potential due to

technical inefficiency and diverse production environments. This study examines the technical efficiency and production determinants of independent oil palm smallholders using a stochastic frontier analysis (SFA) framework. Primary survey data were analysed with a Cobb-Douglas stochastic frontier production function estimated under half-normal and truncated-normal distributions, with models specified both with and without environmental variables. The truncated-normal model provided the best fit, and the mean technical efficiency was about 0.63, indicating that smallholders produce only 63% of their potential output, with substantial variation across farms. Including environmental variables - such as rainfall, temperature, soil type, land type, humidity, sunlight and climate-related shocks - improved model fit and altered several input elasticities. Fertiliser use showed a negative association with output, while irrigation, labour, pest control, sunlight and temperature contributed positively to productivity. Accounting for environmental heterogeneity reduced unexplained variance, revealing that part of the observed inefficiency reflects environmental constraints rather than managerial shortcomings. These findings highlight the need for site-specific strategies tailored to local agroecological conditions to enhance smallholder productivity.

Keywords

Author Keywords: [Environmental production conditions](#); [Malaysia](#); [oil palm smallholders](#); [productivity](#); [stochastic frontier analysis](#); [technical efficiency](#)

Keywords Plus: [BASAL STEM ROT](#); [PROFIT EFFICIENCY](#); [TAMIL-NADU](#); [FRONTIER](#); [FARMERS](#)

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ISSN 1511-4554

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