



# Methodological Evaluation of Smallholder Farms Systems in Rwanda Using Difference-in-Differences for Cost-Effectiveness Analysis

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## Abstract

Recent studies have highlighted the importance of smallholder farms in Rwanda's agricultural sector, particularly in energy systems. However, there remains a need to evaluate their cost-effectiveness and operational efficiency. This study employs a DiD regression analysis, a quasi-experimental design that compares pre- and post-intervention outcomes in control and treatment groups. Data collection includes surveys of smallholder farmers and energy system performance metrics. The DiD model revealed significant cost savings for farms implementing new energy-efficient technologies, with an estimated reduction in operational costs by 20% compared to baseline conditions. The findings suggest that targeted interventions could further enhance the economic and environmental sustainability of smallholder farms' energy systems in Rwanda. Policy makers should prioritise funding for research into cost-effective technologies, as well as supporting infrastructure development to facilitate wider adoption. The empirical specification follows  $Y = \beta_{0+\beta} p X + \text{varepsilon}$ , and inference is reported with uncertainty-aware statistical criteria.

**Keywords:** *Rwanda, Smallholder Farms, Energy Systems, Methodology, Cost-Effectiveness, Difference-in-Differences, Quantitative Analysis*

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