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# An analysis of the cost-effectiveness of solar-powered irrigation systems in Côte d'Ivoire

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## Abstract

Food insecurity, malnutrition, and poverty remain pervasive problems in Côte d'Ivoire (CI). Improving agricultural productivity through irrigation development is considered a potential solution to help address these challenges, however, this approach requires energy. Solar-powered irrigation systems (SPISs) have gained global attention as a clean energy solution for irrigation. Nonetheless, the adoption of SPISs in CI is contingent on their cost-effectiveness in comparison to conventional irrigation systems powered by traditional energy sources. This study assessed the cost-effectiveness of a small-scale SPIS relative to a comparable diesel-powered irrigation system (DPIS) for a single case in Gbandokaha, northern CI, using crop and site-specific input data for requirements under semi-arid conditions. Using a modelling approach, only the anticipated cost differences between the SPIS and the DPIS were estimated and compared. The analysis included financial life-cycle costs (LCCs) as well as environmental LCCs from carbon dioxide ($CO_2$) emissions. LCC estimates were informed by sizing the power units of both irrigation systems for groundwater pumping for dry season irrigation of eggplant crops on a 1 ha field. The analysis considered a 25-year assessment period with varying annual diesel fuel price escalation rates (0 %, 2 %, and 4 %) and a discount rate of 4.38 %. The study found that the initial capital cost of the DPIS is only 54.8 % of that of the SPIS. However, the lifetime maintenance and operation costs, as well as the total LCCs of the SPIS, are significantly lower than those of the DPIS, accounting for only 1.4–2.1 % and 13.2–19.1 %, respectively. The payback periods for the SPIS to achieve the same total LCCs as those of the DPIS were estimated to be 1.4 years. Moreover, the results showed that the primary cost component of the SPIS's total LCCs is the initial capital cost (89.8 %), while for the DPIS, it is the lifetime diesel fuel cost (84.9–89.6 %). Additionally, the study revealed that adopting the SPIS could reduce lifetime $CO_2$ emissions by 99 % compared to the DPIS. The findings of this study offer insights into promoting solar irrigation and its implications for the development of low-carbon emission irrigated agriculture in CI.

**Keywords:** Cost comparison, cost-effectiveness, Côte d'Ivoire, diesel irrigation, groundwater irrigation, photovoltaic irrigation, solar irrigation, solar-powered irrigation systems

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