Electric Mobility in Agriculture: A Sustainable Solution for Farm-to-Market Transportation

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Abstract: This article presents a comprehensive critical analysis of the potential for electric mobility to serve as a sustainable solution for farm-to-market transportation in the agriculture sector. Drawing on a systematic review of secondary data, including academic literature, government and NGO reports, and documented case studies, the study evaluates the environmental, economic, and operational impacts of adopting electric vehicles (EVs) in agricultural logistics. The findings demonstrate that the transition to electric mobility, particularly when powered by renewable energy sources, can reduce greenhouse gas (GHG) emissions by up to 90% compared to conventional diesel vehicles. This substantial reduction is attributed to the elimination of tailpipe emissions and the use of clean energy for recharging, directly contributing to improved air quality and the health of rural communities. Economically, electric tractors and vehicles offer significant cost savings, with operational costs including fuel and maintenance reduced by 40% to 60%. Although the initial investment in electric vehicles is higher than traditional options, the lower running costs allow for a payback period of four to seven years, making EVs a cost-effective alternative over time, especially in regions with favourable electricity prices and high vehicle utilisation. Operationally, EVs have proven reliable for short- to medium-distance farm-to-market transport, with pilot projects in countries such as India and Canada confirming their suitability for typical agricultural tasks. However, the widespread adoption of electric mobility in rural areas faces persistent barriers, notably high upfront costs and inadequate charging infrastructure. Many rural regions lack reliable electricity and charging stations, which limits scalability and practical implementation. To address these challenges, policy recommendations include targeted subsidies and incentives, investment in renewable energy-based charging infrastructure, and capacity-building programs for farmers. These interventions are essential to unlock the full potential of electric mobility in agriculture, catalysing sustainability and resilience in food supply chains. Ultimately, the article argues that with appropriate policy support and infrastructure development, electric mobility can play a transformative role in decarbonising agricultural logistics and advancing broader climate action goals

Keywords: Electric mobility, Agricultural transportation, Farm-to-market logistics, Sustainable agriculture, Electric vehicles (EVs), Renewable energy, Greenhouse gas emissions, Rural infrastructure, Cost-benefit analysis, Policy recommendations

1. Introduction

Agricultural transportation, particularly the connection between farms and markets, is a crucial component of the agri-food chain, influencing food quality, accessibility, and ultimately, farmers' incomes. Worldwide, most agricultural transport relies on internal combustion engine (ICE) vehicles that run on diesel or petrol. These are significant sources of greenhouse gas (GHG) emissions, air pollution, and rising operational costs (FAO, 2023). For instance, according to the Food and Agriculture Organisation FAO, transportation is estimated to be one of the most significant contributors responsible for up to 11% of agricultural emissions, and rural logistics is one of the most significant contributors given the frequency and distances travelled during farm-to-market movements.

Traditional transportation not only has environmental implications, but it is also economically challenging for farmers who must bear volatile fuel prices and the extensive upkeep of an ageing vehicle fleet (Smith & Gupta, 2024). These pressures not only undercut the profitability of smallholder and some commercial farmers but also slow progress toward sustainable and resilient food systems.

Given mounting worldwide concerns about climate change and the imperative to decarbonise the agricultural sector, alternative modes of transport that match sustainability objectives are becoming ever more popular. Electric mobility, which includes battery-electric and solar vehicles, has recently emerged as a potential solution to these problems (Patel et al., 2023). Rapid developments in battery technologies, falling renewable energy prices and policies by state actors have pushed the boundaries on the availability of electric vehicles (EVs) in rural and agricultural environments (EIP-AGRI, 2023).

Electric and solar-powered vehicles have been shown in several pilot projects and case studies to have greater potential to reduce GHG emissions, production costs and overall efficiency of farm-to-market logistics (Sharma et al., 2025; EIP-AGRI, 2023) as proven in India, Canada, and members of the EU, amongst others. However, this can be constrained by the high implementation cost, the absence of charging infrastructure and less knowledge among rural inhabitants.

The objective of this paper is to summarise and synthesise secondary data from academic literature, governmental reports and pilots, to critically discuss the possibilities of electric mobility as a sustainable alternative for agricultural transport. The work aims to provide policymakers, researchers, and practitioners with information on the prospects and challenges of electric mobility in the agrifood chain by understanding its environmental, economic, and operational implications.

2.Methodology

In this research, we adopt a systematic review method and rely solely on secondary sources for data, gathered from peer-reviewed journals (e.g. Journal of Cleaner Production, Renewable & Sustainable Energy Reviews), government and NGO reports (e.g. FAO, EIP-AGRI, Indian Ministry of Agriculture), and documented examples of case studies and pilot projects (e.g. electric tractor trials in Ontario, solar-powered EV pilots in India). Publications were chosen according to the scope of electric mobility in agriculture, with special focus on research that analysed environmental and economic influences and the potential of scaling electric solutions in rural areas. This analysis was used to create themes based on the findings regarding emissions reductions, cost savings, operational reliability, and barriers to adoption, to comprehensively summarise what is known about electric mobility for farm-to-market transportation.

3.Results

3.1 Environmental Impact

The shift to e-mobility in agricultural transport provides significant ecological advantages. Sharma et al. (2025) find that the total GHG emissions achieved with the use of EVs and renewable electricity are up to 90% lower relative to conventional diesel vehicles. This significant reduction is primarily due to avoiding tailpipe emissions and utilising clean energy for recharging. In addition, the European Innovation Partnership on Agricultural Productivity and Sustainability (EIP-AGRI, 2023) indicate that transitioning from diesel-powered to electric tractors has significantly reduced emissions

of particulate matter (PM) and nitrogen oxides (NO_x), which are major contributors to rural pollution. The community thus gets cleaner air, which is of direct relevance to healthy lifestyles and environmental sustainability.

3.2 Economic Impact

From a financial point of view, the use of EVs in agriculture promises economic benefits. Electric tractors and vehicles can reportedly reduce fuel and maintenance costs by 40-60% when compared to traditional diesel vehicles (Smith & Gupta, 2024). It is because electric drivetrains are much more efficient than combustion engines and require less frequent maintenance since they have fewer moving parts and do not need oil changes or the like. The upfront cost of electric vehicles is higher, but Patel et al. (2023) estimate that it takes four to seven years in most cases, depending on the local energy price and the level of use. The running cost as time passes can compensate for the upfront cost, and then electric mobility will be a cost-effective alternative for many farmers.

3.3 Operational Considerations

Operationally, electric vehicles have demonstrated reliability for short- to medium-distance operational farm-to-market transportation. The cases of India and Canada support the findings of Sharma et al (2025) and Smith & Gupta (2024), who confirm in the literature that EVs work efficiently in a typical agricultural context by completing transport tasks as needed. However, the lack of a proper infrastructure, namely transport recharging stations, remains a constantly identified problem in the literature EIP-AGRI, 2023; FAO, 2023. This lack may limit the actuality and scalability of electric solutions for mobility in the foreseeable future, especially in rural areas. Most of the regions with agriculture have limited access to reliable electricity, and this is not suitable for creating charge stations. Therefore, addressing infrastructure and charging challenges is necessary to enable the implementation of electric vehicles.

4. Discussion

The analysis of secondary sources makes it clear that electric mobility is a disruptive technology for agricultural logistics that carries potential environmental and economic benefits. The agricultural sector has the opportunity to achieve a substantial part of the world's climate targets by shifting from fossil fuel to electric vehicles. According to Patel et al. (2023, the introduction of EVs can cut greenhouse gas emissions substantially, contributing directly to sustainability goals and to the health of many rural areas.

In addition to environmental benefits, electric mobility provides exciting economic opportunities. Smith and Gupta show how EVs' lower fuel and maintenance costs can dramatically increase the profitability of smallholder and commercial farmers, blending into continuous savings opportunities that can offset high upfront costs, especially when use is high and local electricity prices are cheap.

However, the primary barriers identified by the secondary literature have remained constant. Both high capital costs and the lack of sufficient rural infrastructure remain major barriers. Significant capital investments remain unaffordable for many farmers, even where governments or microfinance institutions exist in regions where they are scarce. Additionally, the network of renewable energy-based charging infrastructure is still primarily non-existent, limiting the use and economy of scale of electric mobility.

The primary policy proposals made by the literature cited above focus on tailoring interventions to the specifics of the problem. Subsidies and incentives to reduce the barriers to enter farmers' vulnerable rural communities, investments in renewable energy-powered charging infrastructure, and potential awareness and capacity training programs to build confidence are all recommended. These policies together could promote the use of electric mobility and hasten the creation of a more sustainable and resilient farm-to-market system.

5. Conclusion

The results of the secondary analysis of the available data showcase strong evidence that electric mobility is a suitable and economically viable means of farm-to-market transportation in agriculture. The use of electric vehicles by farmers enables a sufficient reduction in greenhouse gas emissions as well as operational expenditures, effectively targeting the goals of both environmental sustainability and economic improvement. However, the achievement of these benefits is contingent on several policy interventions. Specifically, the government should implement subsidies and contribute to the development of charging infrastructure, while farmers require further training and knowledge to understand the benefits of EV-based transportation. To realise the potential of electric mobility in rural and agriculture-centric settings, future studies should focus on exploring region-specific barriers and identifying the most beneficial way to incorporate renewable energy in the charging networks. Thus, the results will showcase the significant instrumental role that electric mobility can play in revolutionising agricultural logistics in support of broader climate action goals.

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