SYNTHESIS REPORT

Promoting Electric Tractor for Developing a Sustainable Agriculture Ecosystem in Rajasthan

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Synthesis Report

Promoting Electric Tractor for Developing a Sustainable Agriculture Ecosystem in Rajasthan

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Overview

Addressing the environmental concerns associated with conventional tractors is crucial for reducing emissions from the agriculture sector. Electric tractors (e-tractors) present a viable alternative, enhancing energy security while aligning with India's net-zero goals. Additionally, e-tractors promote the adoption of renewable energy within rural and agricultural communities, cultivating a sustainable agricultural ecosystem and driving the growth of the rural economy.

However, the adoption of e-tractors faces several challenges, including high upfront costs, limited awareness, insufficient policy support, inadequate charging infrastructure, and a lack of EV-supporting facilities, among others.

Building on the aforementioned background and context, this initiative seeks to address these challenges through research-driven advocacy and strategic collaboration with stakeholders. The goal is to facilitate necessary reforms that will promote the adoption and growth of e-tractors in the Indian market, a critical step toward establishing a sustainable agricultural ecosystem. These efforts are intended to ensure an effective and timely transition from diesel-powered tractors to e-tractors.

Introduction

According to the European Commission's Joint Research Centre (JRC) 2024 report, India's greenhouse gas (GHG) emissions rose from 3,270.4 Mt CO2eq/year in 2014 to 4,133.6 Mt CO2eq/year in 2023. The agricultural sector remains a major contributor to these emissions, largely due to the extensive use of diesel-powered internal combustion engines in agricultural machinery.

While non-road (land-based) mobile sources, such as tractors, have received relatively limited attention, it is important to recognise that the majority of these vehicles rely on diesel fuel. Although substantial progress has been achieved in regulating emissions from on-road vehicles—particularly with the adoption of BSVI norms—emission control measures for non-road vehicles, including tractors, remain comparatively less stringent.

Due to weaker regulations and enforcement, non-road vehicles often emit significantly higher levels of pollutants per unit compared to on-road vehicles. This raises concerns about their potential emissions, particularly fine particulate matter (PM2.5) and nitrogen oxides (NOx), which pose serious environmental and health risks (Shao, 2016).

Agricultural tractors are widely used in rural areas, often extending beyond their primary agricultural purpose to serve as alternative transport for both passengers and goods. The agricultural sector is a major consumer of diesel in India, accounting for around 13 percent of total diesel consumption. Within this sector, diesel usage is distributed as follows: tractors (7.4 percent), pump sets (2.9 percent), and agricultural implements (2.7 percent).

Tractors exhibit a higher rate of diesel consumption, largely due to their use in non-agricultural activities such as transporting construction materials (e.g., bricks, stones, and mined sand) and providing transportation for individuals in rural areas. Interestingly, while tractors consume nearly as much diesel as buses (9.6 percent), they are not subject to the same emission regulations (Shao, 2016; Shao and Anup, 2022).

A study by the International Council on Clean Transportation (ICCT) indicates that emissions from on-road vehicles, such as buses and cars, are expected to decrease. However, emissions from agricultural tractors and construction equipment are projected to rise in the coming years.

As the urgency surrounding environmental sustainability and climate change intensifies, the agricultural sector is increasingly turning to innovative technologies to reduce its carbon footprint. In India, the transition to cleaner energy alternatives is gaining traction, with electric tractors emerging as a promising solution. These e-tractors offer significant potential in reducing emissions and promoting a greener agricultural ecosystem.

However, the adoption of electric tractors faces several challenges. High upfront costs, limited commercial availability, and a notable gap between consumer interest and product access are key obstacles. The small number of brands in the market contributes to the steep initial price, making e-tractors accessible only to a select portion of the population. This has constrained the consumer base and hindered broader market growth, limiting the full potential of electric tractors in transforming the agricultural sector.

This Synthesis report will outline the necessary interventions for state agencies to develop a market for e-tractors, focusing on the introduction of policy and regulatory reforms within the agriculture sector.

About The Study

A study was conducted to assess the economic benefits of e-tractors compared to diesel tractors over their lifetime, along with analysing tractor utilisation patterns in the non-farm sector to evaluate the potential of e-tractors in the Indian market. This was followed by an exhibition of e-tractors and electric farm machinery, designed to address key consumer concerns such as cost, performance, and durability, while also highlighting the socio-economic and environmental benefits of adopting zero-emission technologies in agriculture.

Rationale Behind Selecting the Study Area

The districts of Jaipur, Bharatpur, Chittorgarh, Bhilwara, and Jodhpur were selected for the study based on tractor data retrieved from the Ministry of Road Transport & Highways' Vahan Dashboard.

Table 1: Distribution of Tractors in Jaipur, Bharatpur, Chittorgarh, Bhilwara and Jodhpur

Area	Agriculture Tractor	Commercial Tractor	Tractor Trolley (Commercial)	Total
Rajasthan	**14,68,850**	**740**	**23,280**	**14,92,670**
Bharatpur	36,945	1	158	37,104
Bhilwara	38,432	117	1,231	39,780
Chittorgarh	52,082	122	792	52,996
Jaipur	59,505	NA	465	59,970
Jodhpur	98,101	94	220	98,415

Based on tractor sales data, the distribution of farm and non-farm surveys across the five districts was determined.

Table 2: Distribution of Farm and Non-Farm Survey in Various Districts

Area	Farm Survey	Non-Farm Survey	Total
Bharatpur	13	10	23
Bhilwara	13	25	38
Chittorgarh	18	15	33
Jaipur	21	10	31
Jodhpur	35	10	45
Total	**100**	**70**	**170**

Figure 1: Fram Survey Distribution Across Five Districts of Rajasthan

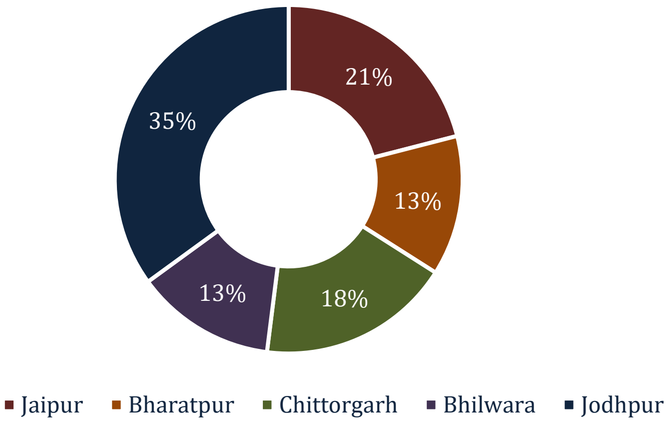
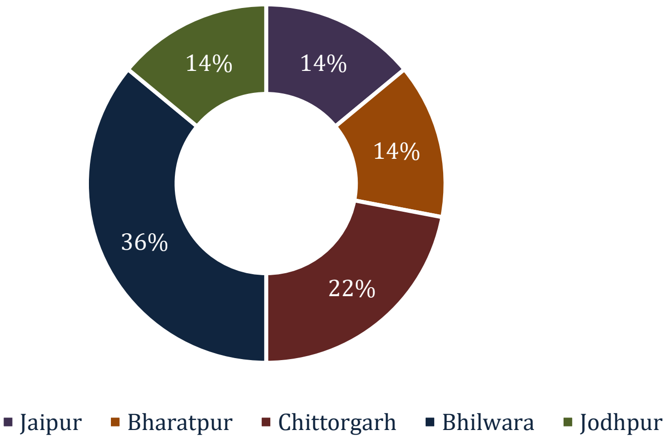


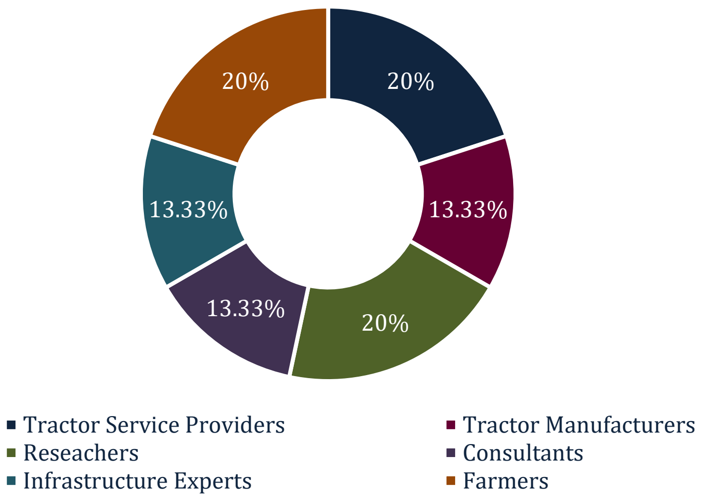
Figure 2: Non-Farm Survey Distribution Across Five Districts of Rajasthan



Additionally, perception surveys were conducted with 30 stakeholders, including tractor service providers, manufacturers, researchers, consultants, infrastructure experts, and farmers.

The aim was to evaluate various aspects of electric tractors, focusing on factors such as cost, durability, and operational efficiency, while also identifying market trends and key focus areas.

Figure 3: Perception Survey



Objectives of the Study

The initiative aimed to define the key interventions needed by state agencies to develop a market for e-tractors through the introduction of policy and regulatory reforms in the agriculture sector. It also seeks to create an enabling environment for e-tractor adoption by addressing barriers and promoting the technology's benefits among farmers in Rajasthan. The specific goals included:

- Engaging with farmers to document the costs associated with diesel tractors and conduct a cost-benefit analysis comparing e-tractors to diesel tractors.
- Conducting a value chain analysis of the tractor market to identify opportunities for e-tractors in the non-farm sector.
- Organising an exhibition of e-tractors and electric farm machinery to address consumer barriers and raise awareness among farmers about the socio-economic benefits of e-tractors.
- Advocating for policy measures to state policymakers aimed at developing the market for e-tractors in Rajasthan.

Schemes Promoting the Adoption of Tractors

Several state governments have introduced various schemes to ease the financial burden on farmers when procuring tractors. These initiatives offer subsidies ranging from 40 to 50 percent, as seen in Rajasthan's Free Tractor and Agricultural Machine Scheme and the Mini Tractor Anudan Yojana. Table 3 provides a comprehensive overview of these schemes, detailing the subsidy structures and the associated eligibility criteria.

Table 3: Existing Policies to Promote Tractors in Various States of India

S. No	State	Scheme Name	Details of the scheme	Eligibility
1.	Maharashtra	Mini Tractor Anudan Yojana[1]	• Under this scheme, the government will pay 90 percent of the total cost of a mini tractor, while the self-help groups will contribute 10 percent.	• This scheme applies to self-help groups that have 80 percent members from Scheduled Castes and Neo-Buddhists.
2.	Telangana	Yantra Lakshmi Scheme[2]	• Under this scheme, individual farmers and cooperative societies are eligible for a 50 percent subsidy on tractor purchases, with the remaining 50 percent amount financed through loans from nationalised banks. • SC/ST farmers receive a 100 percent subsidy covering tractors, trolleys, and matching equipment.	• The scheme is open to progressive individual farmers and cooperative societies residing in Telangana.
3.	Rajasthan	Free Tractor and Agricultural Machine Scheme[3]	• Under this scheme, farmers are eligible for 40 percent to 50 percent subsidies, depending on their category, for purchasing approved agricultural equipment.	• This scheme is exclusive to permanent resident small and marginal farmers of Rajasthan, including those with agricultural land.

1 https://sjsa.maharashtra.gov.in/en/providing-mini-tractor-and-its-sub-parts-self-help-group-scheduled-castes

2 https://govinfo.me/yantra-lakshmi-scheme-telangana-tractor-subsidyloan-scheme-eligibility-documents-required-apply/

3 https://indiascheme.com/rajasthan-free-tractor-and-agricultural-machine-scheme/

S. No	State	Scheme Name	Details of the scheme	Eligibility
4.	Andhra Pradesh	Rythu Radham (2018-19)[4]	• Under Rythu Radham 2018-2019, subsidies are ₹2,00,000 for 4 Wheel Drive (WD) tractors (35 HP and above) and ₹1,50,000 for 2WD tractors (35 HP and above).	Under this scheme: • SC/ST Farmers: Must own at least 1 acre of land. • Other Farmers: Must own at least 2 acres of land.
5.	Assam	Chief Minister Samagra Gramya Unnayan Yojana (CMSGUY)[5]	• Under this scheme, farmers will receive a 70 percent subsidy, with a bank loan covering 20 percent of the total price. • The government will provide a maximum subsidy of ₹5.5 lakhs for tractors to cater to the needs of various farmers and crops.	• Under the CMSGUY, farmer groups of 8–10 members from the same village can apply jointly using a common bank account. • Only one member per family is allowed in the group.
6.	Karnataka[6]	Uber For Agricultural Services.	• Karnataka plans to invest ₹175 crore in subsidies to reduce farming equipment rental costs by a third. The state will cover 75 percent of capital costs, and equipment makers will rent to farmers over three years. • Additionally, ₹87.5 crore has been allocated to partner with two non-profits to establish 175 Custom Hire Service Centres.	• General Eligibility

4 https://www.agrifarming.in/tractor-subsidy-bank-loan-eligibility-schemes-process

5 https://vikaspedia.in/schemesall/state-specific-schemes/welfare-schemes-of-assam/samagra-gramya-unnayan-yojana--cmsguy-

6 https://www.agrifarming.in/tractor-subsidy-bank-loan-eligibility-schemes-process

Key Findings from The Literature Review

Tables 4 and 5 summarise the findings from the review of existing literature on the adoption of zero-emission farm machinery and the challenges associated with it. The review covered various aspects of e-tractors, including cost, durability, operational efficiency, charging infrastructure, battery technology, and resale value.

Table 4: Challenges Faced by Farmers

S. No.	Challenge	Description
1	**High Upfront Cost**	Electric tractors are 2-3 times more expensive than diesel tractors, primarily due to the high costs of electric motors and battery technology. This price disparity places electric tractors beyond the reach of many farmers in India's price-sensitive market.[7]
2	**Inadequate Charging Infrastructure**	Villages often lack reliable electricity and charging infrastructure, with frequent power outages making it challenging to charge e-tractors. The absence of off-grid power solutions further exacerbates this issue, limiting the feasibility of e-tractor adoption in rural areas.[8]
3	**Lower Horsepower (HP)**	Diesel tractors offer a broad horsepower range (10 to 120 HP), while e-tractors have a more limited range (11 to 55 HP), offering fewer options for commercial farmers who require higher-powered machines for diverse tasks.
4	**Lagging Battery Technology**	Current battery technology does not yet offer the required power density, size, and durability to match diesel engines. Furthermore, batteries lack the reliability needed to perform effectively under extreme operating conditions.[9]
5	**Low Resale Value**	The resale value of e-tractors is lower due to the need for battery replacements over time, which diminishes their market value.[10]

[7] https://www.researchgate.net/publication/341532632_Electric_tractors_Survey_of_challenges_and_opportunities_in_India/link/6303416daa4b1206facc2ec6/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19

[8] https://ijirt.org/master/publishedpaper/IJIRT150773_PAPER.pdf

[9] https://ijirt.org/master/publishedpaper/IJIRT150773_PAPER.pdf

[10] https://the-ken.com/story/giants-and-minnows-compete-in-indias-electric-tractor-race/?utm_source=daily_story&utm_medium=email&utm_campaign=daily_newsletter

S. No.	Challenge	Description
6	**Lack of Skills for Operation and Maintenance**	Farmers may lack the necessary skills to efficiently operate and maintain e-tractors, which often feature more complex user interfaces compared to traditional diesel tractors.[11]
7	**Range Anxiety**	Farmers are concerned about the limited range of e-tractors on a single charge, particularly for tasks that demand 4-8 hours of continuous operation, such as hauling and transporting yields to markets.[12]
8	**Awareness and Perception**	There is limited awareness of the benefits of e-tractors, and farmers remain sceptical about issues such as battery durability, charging procedures, and performance under adverse weather conditions.[13]
9	**Limited Financing Options**	Access to financing for e-tractors remains a significant challenge. To facilitate adoption, innovative financial models, such as leasing options or subsidies for agricultural electricity, are proposed as potential solutions.[14]
10	**Limited Repair and Support Infrastructure**	Repair workshops and support services for e-tractors are scarce in rural areas, and the absence of proper infrastructure for maintenance and repairs causes farmers to hesitate in adopting this new technology.[15]

Table 5: Financing Challenges Decelerating the Adoption of E-tractors

Challenges	Description
Limited Financial Support and Subsidies	Limited subsidies and financial support are available, particularly in regions with underdeveloped infrastructure or low awareness of e-tractors. Existing subsidies often do not cover the high upfront costs, and the lack of tailored financing options discourages potential investment.[16]

[11] https://www.researchgate.net/publication/341532632_Electric_tractors_Survey_of_challenges_and_opportunities_in_India/link/6303416daa4b1206facc2ec6/download?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6InB1YmxpY2F0aW9uIiwicGFnZSI6InB1YmxpY2F0aW9uIn19

[12] https://the-ken.com/story/giants-and-minnows-compete-in-indias-electric-tractor-race/?utm_source=daily_story&utm_medium=email&utm_campaign=daily_newsletter

[13] *Ibid*

[14] https://ijirt.org/master/publishedpaper/IJIRT150773_PAPER.pdf

[15] *Ibid*

[16] https://theicct.org/wp-content/uploads/2022/10/india-hvs-evs-incentives-elec-tractors-India-oct22.pdf

Challenges	Description
Cost of Battery Replacement and Maintenance	Expensive battery replacements contribute to higher total ownership costs over time, further discouraging the adoption of e-tractors.[17]
Uncertainty about Return on Investment (ROI)	Challenges to long-term profitability stem from substantial initial investments and high operational costs, particularly for small-scale farmers, who may struggle to recover their expenses.[18]
Depreciation and Resale Value	Uncertainty about e-tractor depreciation rates and the potential for lower resale value undermines farmers' confidence in investing in this technology.[19]
Operational Costs and Charging Infrastructure	High electricity charges and the limited availability of charging infrastructure in rural areas increase operational costs, making it more challenging to maintain financial feasibility and efficient logistics.[20]

Key Findings from the Farm Survey

A survey of 100 farmers across five districts was conducted to gather insights on fuel costs, repair expenses, service, maintenance, and other relevant factors. The majority of farmers surveyed were either unaware or had limited knowledge of electric tractors in these regions. However, in Bhilwara, 8 percent of respondents displayed a strong awareness of electric tractors.

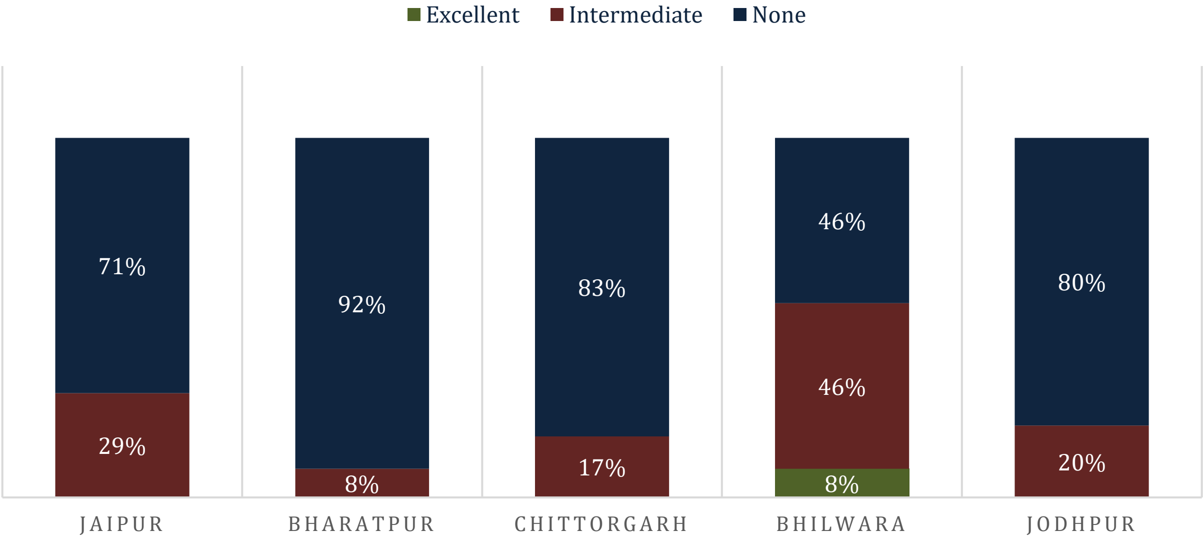
[17] *Ibid*

[18] https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3689250

[19] Based on literature review

[20] Ibid

Figure 4: Awareness on Electric Tractors (Farm)



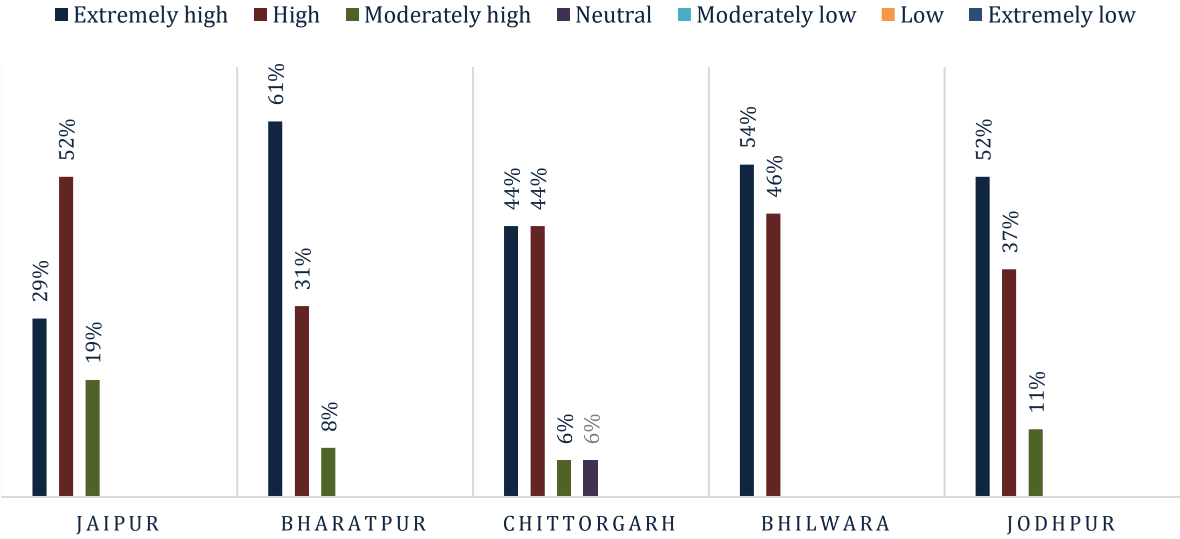
Source: Farmers' Survey

Impact of Fuel Cost on Overall Agricultural and Operational Cost

Fuel costs constitute a significant portion of a farm's operational expenses, making fuel efficiency a crucial factor for improving profit margins and ensuring financial success. On average, a tractor consumes between 0.203 to 0.24 litres of fuel per horsepower per hour. For example, a 310-horsepower tractor is estimated to use approximately 13.6 gallons of fuel per hour (Bareja, 2023).

The findings from the literature were further validated by surveys conducted in the farm sector across five districts of Rajasthan. In Bharatpur, 61 percent of respondents indicated that fuel costs contribute "extremely high" to their overall operational expenses.

Figure 5: Contribution of Fuel Cost to the Overall Operational Cost (Farm)



Source: Farmers' Survey

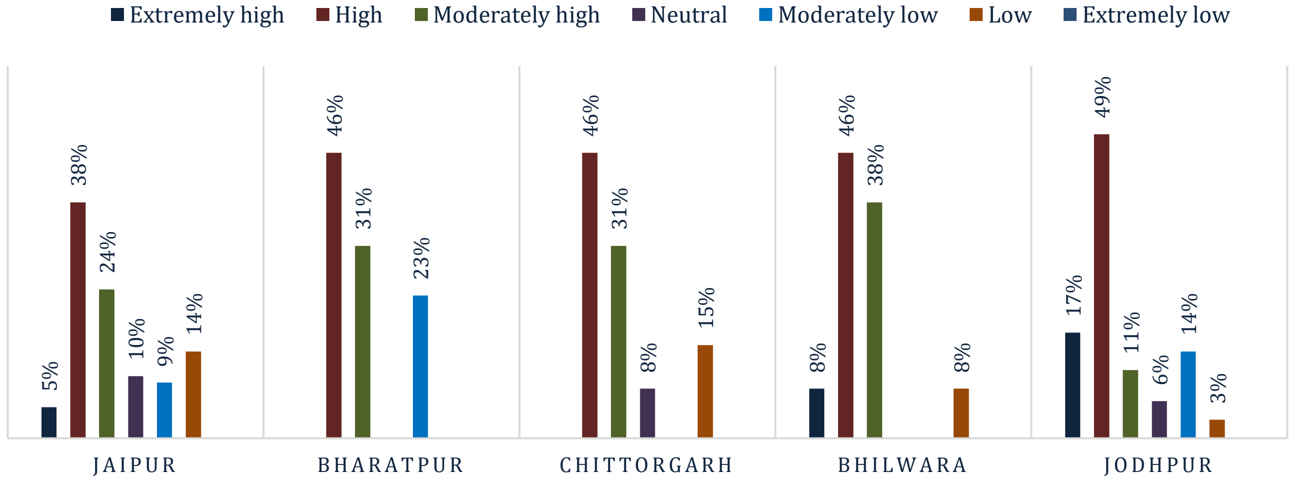
Impact of Cost of Tractor on Buying Decision

The high upfront cost is a significant barrier to the widespread adoption of electric tractors. This challenge is highlighted in a research paper, "Electric Tractors: Survey of Challenges and Opportunities in India,"[21] which also identifies the steep initial investment as a key obstacle to broader adoption.

These findings from the literature were reinforced by surveys conducted in the farm sector. Over 40 percent of respondents in Bharatpur, Bhilwara, Chittorgarh, and Jodhpur rated the impact of tractor cost on their buying decision as "high" on the Likert scale.

[21] https://www.sciencedirect.com/science/article/abs/pii/S2214785320332077?via%3Dihub

Figure 6: Impact of Cost of Tractor on Buying Decision (Farm)

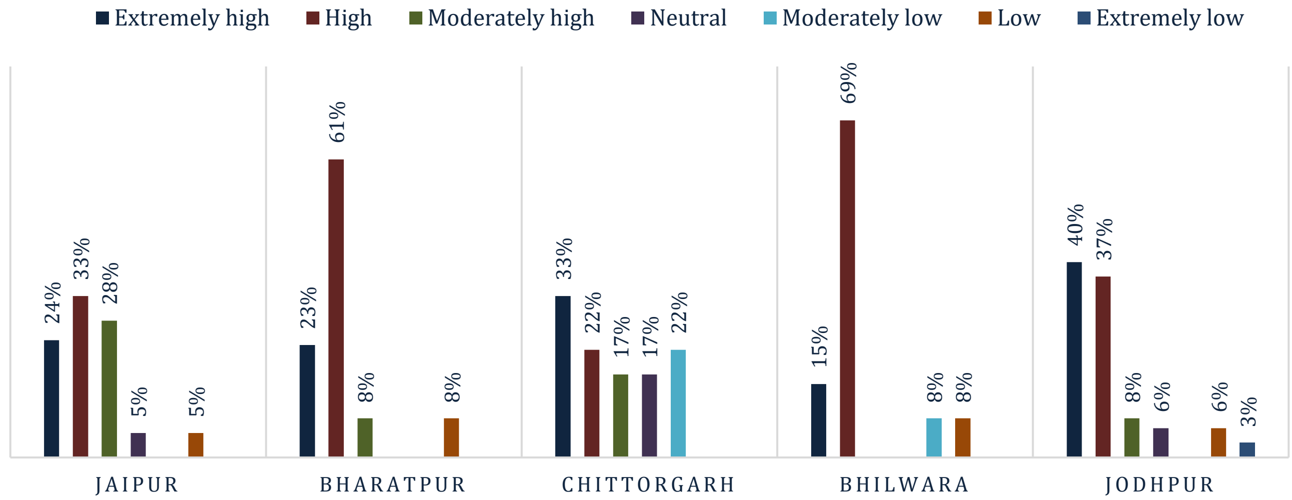


Source: Farmers' Survey

Impact of Resale Value of Tractor on Buying Decision

A comparative study by Tractor Gyan[22] highlighted that electric tractors have the lowest resale value compared to CNG and diesel tractors, primarily due to the need for frequent battery replacements. In contrast, diesel tractors maintain the highest resale value, as their engines can operate efficiently for 10-15 years.

Figure 7: Impact of Resale Value of Tractor on Buying Decision (Farm)



Source: Farmers' Survey

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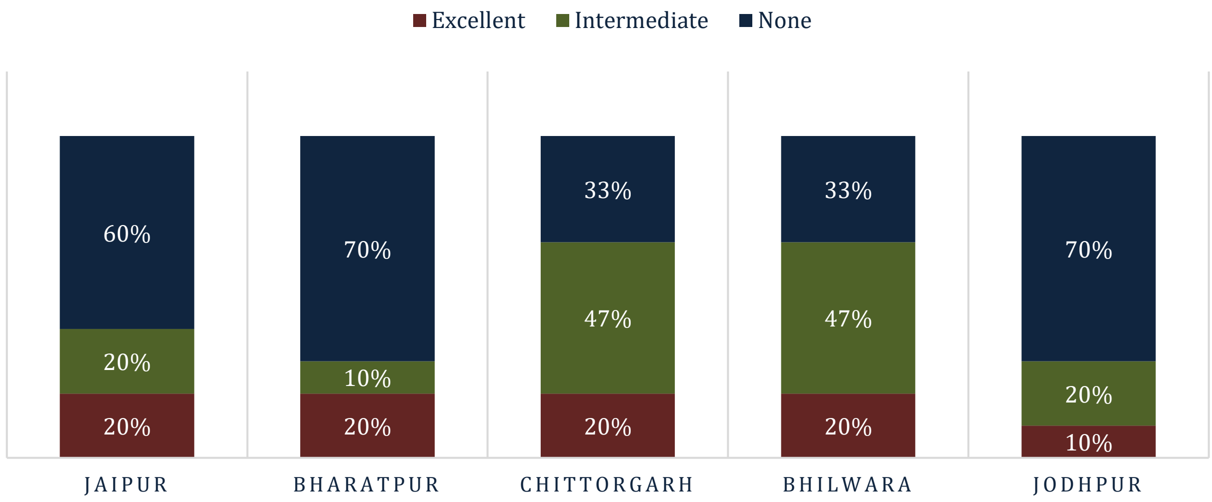
[22] https://tractorgyan.com/tractor-industry-news-blogs/1321/electric-tractor-vs-diesel-tractor-vs-cng-tractor

The survey findings underscored the significant impact of resale value on purchasing decisions. In Bhilwara, 69 percent of respondents from the farm sector and 61 percent in Bharatpur rated the influence of resale value as "high."

Key Findings from The Non-Farm Surveys

Agricultural tractors are widely used in the industrial sector, often extending beyond their primary agricultural functions to serve as alternative transportation for passengers and goods. A survey of 70 tractor owners across five districts was conducted to gather data on fuel costs, repair expenses, service, and maintenance, among other factors. The survey revealed that tractor owners had a greater awareness of electric tractors compared to farmers, with particularly high levels of awareness in Chittorgarh and Bhilwara.

Figure 8: Awareness on Electric Tractors (Non-Farm)

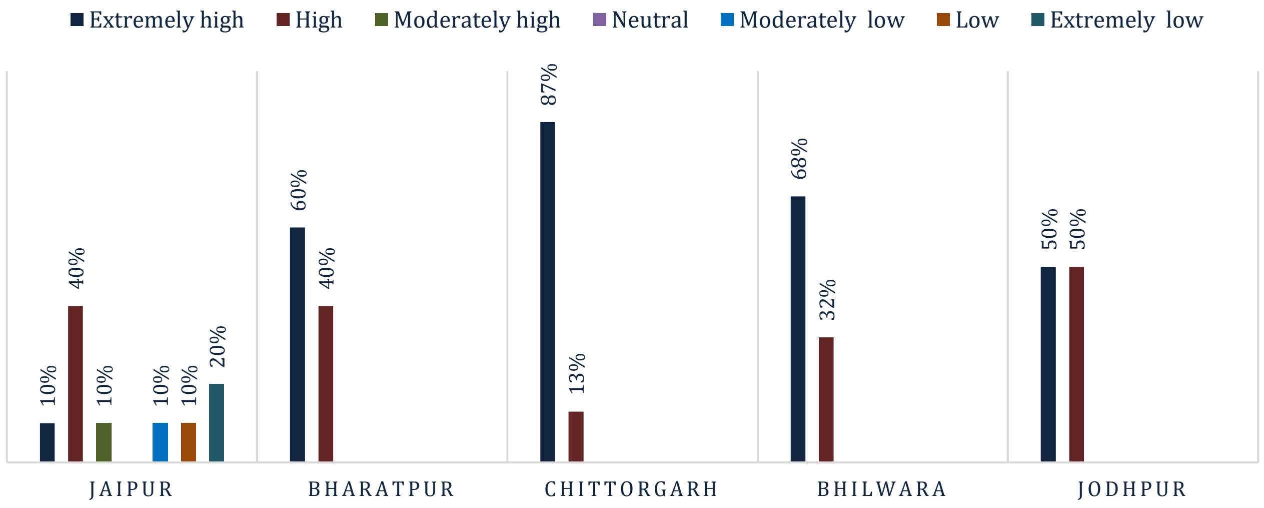


Source: Non-farm Survey

Impact of Fuel Cost on Overall Operational Cost

In the non-farm sector, which includes tractors used for transporting marble, stones, water tankers, and delivering water, 87 percent of respondents in Chittorgarh rated fuel costs as "extremely high" on the Likert scale. Tractor operators in these sectors expressed concerns that rising fuel costs could adversely affect their profitability and long-term sustainability.

Figure 9: Impact of Fuel Cost on Overall Operational Cost (Non-Farm)



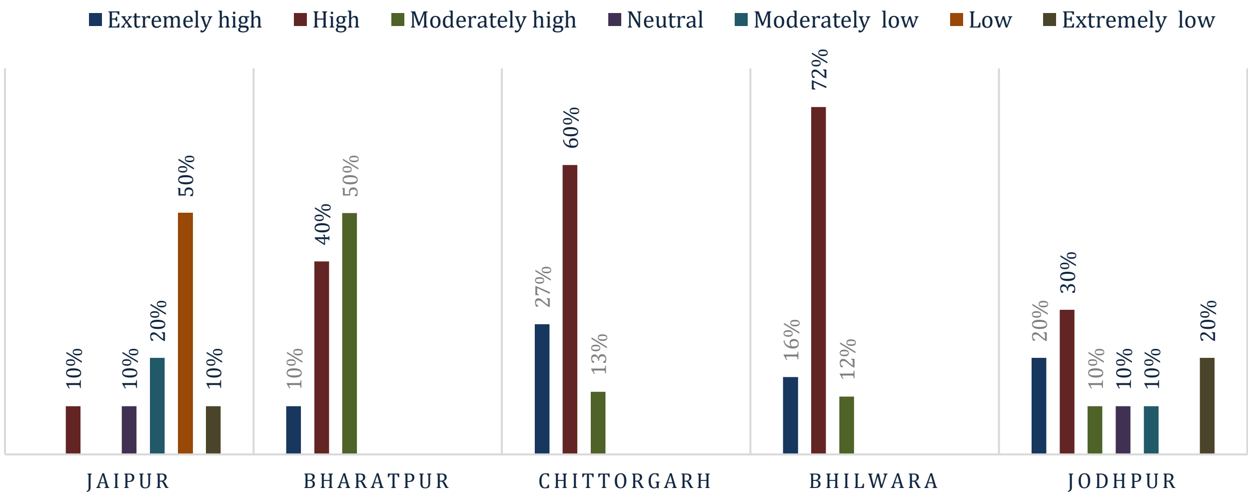
Source: Non-farm Survey

In the non-farm sector, fuel costs constitute a significant portion of overall operational expenses, with other associated costs remaining relatively low. Electric tractors, which run on electricity instead of fuel, present a valuable opportunity to reduce these costs. Emphasising this economic benefit could play a key role in encouraging the adoption of electric tractors among farmers and tractor operators.

Impact of Cost of Tractor on Overall Buying Decision

In the non-farm sector, the cost of a tractor had the most significant impact in Bhilwara, where 72 percent of respondents rated the influence of tractor cost on buying decisions as "high."

Figure 10: Impact of Cost of Tractor on Overall Buying Decision (Non-Farm)

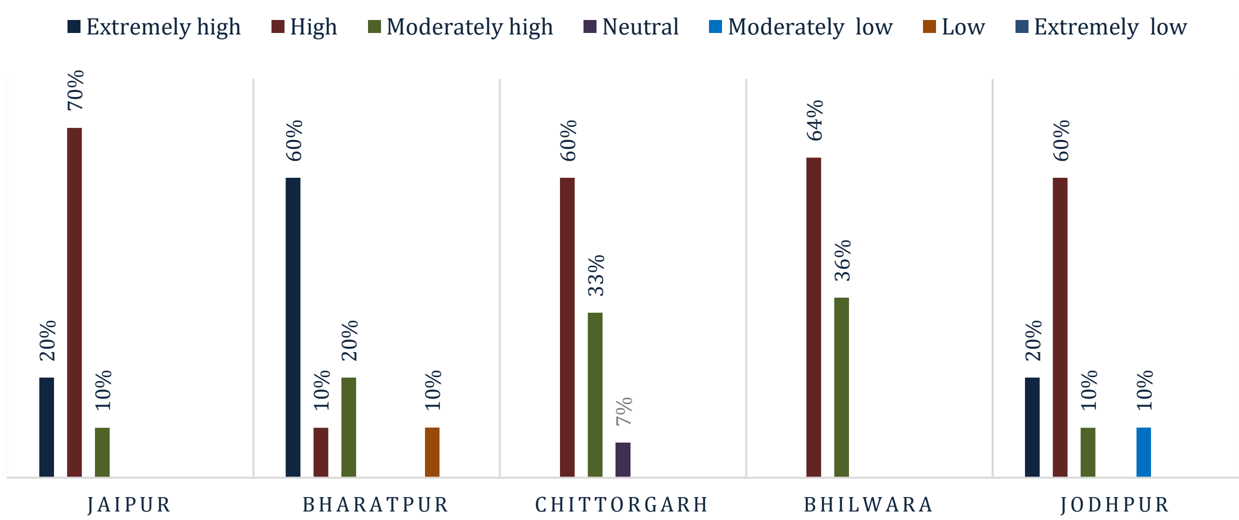


Source: Non-farm Survey

Impact of Resale Value on Buying Decision

In the non-farm sector, 70 percent of respondents in Jaipur rated the impact of resale value on their tractor purchasing decision as "high." These findings underscore the significant role resale value plays in buying decisions.

Figure 11: Impact of Resale Value on Buying Decision (Non-Farm)



Source: Non-farm Survey

Other Relevant Findings

- Service and maintenance costs are a significant contributor to operational expenses in both the farm and non-farm sectors, ranking just below fuel costs. On average, tractor operators spend ₹20,000–25,000 annually on servicing, with maintenance typically conducted twice a year. The need for maintenance is particularly high in the non-farm sector, where increased wear and tear on tractor components result from more frequent and demanding use.
- Although operators in both sectors are generally aware of emissions from internal combustion engine (ICE) tractors, there is a significant knowledge gap regarding their full environmental impact. This lack of awareness may present challenges in effectively promoting electric tractors as viable eco-friendly alternatives.
- Proximity to refuelling stations is a key factor affecting productivity and tractor purchasing decisions in both sectors. The convenience of having nearby petrol or diesel pumps significantly influences these decisions, as it impacts operational efficiency and overall costs.
- While insurance costs and taxes do play a role in purchasing decisions, their influence is comparatively less significant. The most important factor for tractor buyers is resale value, which often takes precedence over the initial purchase cost.
- Market dominance by specific original equipment manufacturers (OEMs) is prominent, with regional preferences clearly evident. For instance, Massey Ferguson commands 92 percent of the market share in Bharatpur.
- Insurance and taxes are typically included in the selling price of ICE tractors, which raises concerns among potential buyers about the pricing structure for electric tractors.
- Load-carrying capacity is a key factor for buyers, with concerns about whether electric tractors can efficiently manage heavy loads.
- Moreover, the noise and vibrations from ICE tractors can adversely affect operators' mental and physical well-being.
- The practice of renting tractors has sharply declined in recent years, driven by various economic and social factors. Additionally, tractor operators have raised concerns about the scarcity of repair shops and the lack of technical expertise required to maintain and service electric tractors.

Opportunities for Farmers, OEMs, and Government

An extensive literature review, surveys across both farm and non-farm segments, and consultations with key stakeholders—including tractor manufacturers, service providers, infrastructure experts, consultants, and researchers—highlighted numerous opportunities for farmers, OEMs, and state governments to explore in transitioning to electric tractors. The figure below outlines some of these potential opportunities.

Figure 12:Opportunities for Farmers, OEMS, and State Government

Farmers	OEMs	State Policymakers
• Reduction in overall operational cost • Ergonomical (no vibrations) • Alternate power bank • No exposure to emissions from tarctors	• New markets • Reduction in scope 3 emissions	• Emission reduction (alignment with net-zero goals) • Energy security

Source: Literature Review and Perception Surveys

Cost Benefit Analysis: Total Cost of Ownership

The cost-benefit analysis compared 40HP diesel tractors used in both farm and non-farm operations with electric tractors. The total cost of ownership (TCO) for diesel tractors in the farm and non-farm segments was calculated using survey data, while the TCO for electric tractors was derived from an EVReporter study[23]. This analysis spans a 10-year period, providing a comprehensive comparison of the two technologies.

The analysis took into account several parameters for both diesel and electric tractors. For diesel tractors, factors such as loan repayment instalments, diesel consumption (6 litres per hour for 15 days per month), monthly maintenance and repair costs, and miscellaneous expenses were considered. For electric tractors (30 kW), the parameters included loan repayment instalments, battery charging costs (25 units per day for 15 days per month), monthly maintenance and repair costs, battery replacement cost (estimated at ₹4.2 lakhs), and other miscellaneous expenses.

Table 6 presents a comparison of the Total Cost of Ownership (TCO) over 10 years for a 40HP diesel tractor used in both farm and non-farm segments, alongside a 30kW electric tractor.

Table 6: TCO calculation for Electric and Diesel Tractors (Farm and Non-Farm Segment)

Parameters	Cost (In INR) for a 40 HP Diesel Tractor in the Farm segment	Cost (In INR) for a 40 HP Diesel Tractor in the Non-Farm sector	Cost (In INR) for a 30 kW Electric Tractor,
Cost for Tractor	**700,000**	**700,000**	**15,00,000**
Down Payment	**150,000**	**150,000**	**300,000**
EMI	7,250	7,250	15,820
Diesel @ 6 litre /hour/15 days/month	20,000	25,000	-
Battery charging @ 25 units/day/15 days/month	-	-	2,625
Maintenance and Repair/month	4,000	5,000	1,500

23 https://evreporter.com/tractor-industry-in-india-ripe-for-electrification/

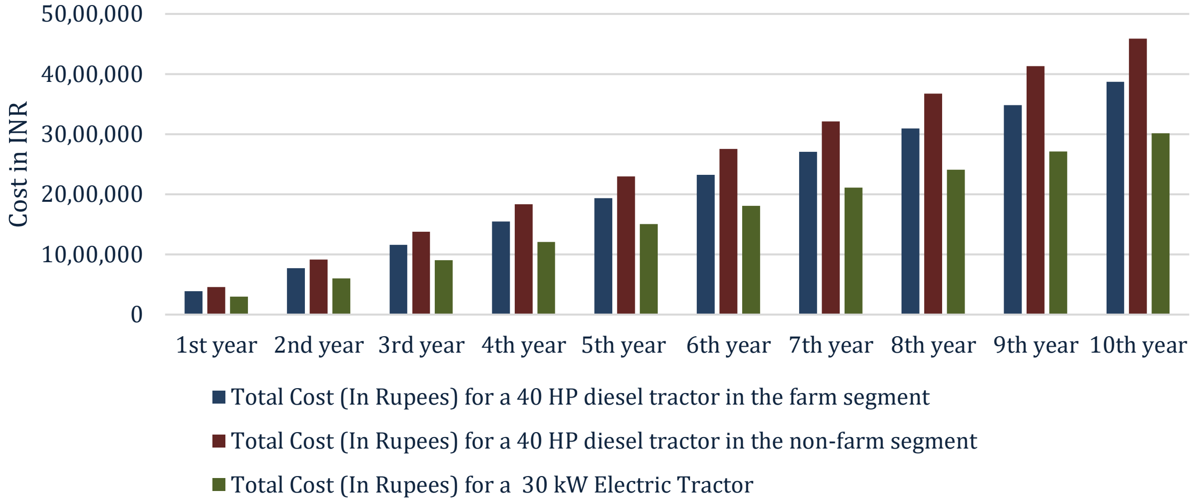
Parameters	Cost (In INR) for a 40 HP Diesel Tractor in the Farm segment	Cost (In INR) for a 40 HP Diesel Tractor in the Non-Farm sector	Cost (In INR) for a 30 kW Electric Tractor,
Battery Replacement cost/month (cost of the battery is 4.2 lakhs)	-		4,166
Miscellaneous costs	1,000	1,000	1,000
Total Cost Per Month (EMI+Diesel/Battery Charging+Maintenance +Battery replacement+ Miscellaneous Costs)	32,250	38,250	25,111
Cost Per Year	387,000	459,000	301,332
TCO over 10 years	**38,70,000**	**45,90,000**	**30,13,320**

Source: EVReporter, Survey Analysis

Table 7: TCO Comparison for Diesel Tractors (Farm and Non-Farm Segments) vs. Electric Tractor Over a 10-Year Period

Total Cost Per Year	Total Cost (In INR) For A 40 HP Diesel Tractor in The Farm Segment	Total Cost (In INR) For A 40 HP Diesel Tractor in The Non-Farm Segment	Total Cost (In INR) For 30 Kw Electric Tractor
1st year	387,000	459,000	301,332
2nd year	774,000	918,000	602,664
3rd year	11,61,000	13,77,000	903,996
4th year	15,48,000	18,36,000	12,05,328
5th year	19,35,000	22,95,000	15,06,660
6th year	23,22,000	27,54,000	18,07,992
7th year	27,09,000	32,13,000	21,09,324
8th year	30,96,000	36,72,000	24,10,656
9th year	34,83,000	41,31,000	27,11,988
10th year	38,70,000	45,90,000	30,13,320

Figure 13: Total Cost of Ownership Over 10 Years for a Diesel Tractor (Farm and Non-Farm Segment) and Electric Tractor



Recommendations for the State Government

- **Introducing low-emission zones could promote electric tractors**

The Air (Prevention and Control of Pollution) Act of 1981 grants state governments the authority to designate specific areas as air pollution control zones and regulate the permissible fuel types within these zones. Public institutions like district courts, secretariats, hospitals, universities, and crowded markets can be classified as low-emission zones. This would impact the non-farm tractor segment, including water tankers, construction equipment, and garbage collection vehicles, encouraging operators to adopt more sustainable transport options.

- **Lowering upfront Cost of electric tractors**

One of the primary barriers to the adoption of electric tractors is their high upfront cost. To encourage widespread adoption, a targeted subsidy scheme offering at least 50 percent off the purchase price of electric tractors is essential. Additionally, promoting a localised supply chain for electric tractors could help balance out the costs of subsidies and contribute positively to state revenues. Haryana’s Electric vehicle Policy offers a purchase incentive of 50 percent or up to ₹5 lakh for first 1,000 e-tractors. Other states like Karnataka and Uttar Pradesh are in the process of preparing subsidy schemes and tax waivers for electric tractors, while the Yantra Lakshmi Scheme in Telangana provides similar financial support for diesel tractors, helping to alleviate the financial burden on farmers.

This could be accomplished through the inclusion of e-tractors in the State Electric Vehicle Policy, the introduction of a dedicated subsidy scheme for e-tractors, or the development of a standalone policy for zero-emission vehicles within the agricultural sector.

- **Concessional financing for electric tractors**

Establishing partnerships with financial institutions such as the National Bank for Agriculture and Rural Development (NABARD), State Bank of India (SBI), Regional Rural Banks (RRBs), Cooperative Banks, and Non-Banking Financial Companies (NBFCs) to offer low-interest loans for electric tractors on a priority lending basis is essential. A proposed interest rate of 5 percent, coupled with a seven-year repayment period, would make financing more accessible and manageable for farmers. For example, a ₹3 lakh loan would result in a monthly instalment of approximately ₹4,240, ensuring that credit remains both affordable and within reach for farmers.

- **Adopting battery as a service model for electric tractor**

Although an industry-driven initiative, state policymakers can develop a regulatory framework to promote the Battery-as-a-Service (BaaS) model in the e-tractor market. This approach will significantly alleviate the upfront cost burden for both the farm and non-farm sectors, making electric tractors more accessible and financially viable for farmers and operators. By encouraging the adoption of BaaS, the state can facilitate a seamless transition to electric tractors.

- **Inclusion of electric tractors in custom hiring centres for agriculture machinery**

Under the Sub-Mission on Agricultural Mechanisation, the Department of Agriculture supports the establishment of Custom Hiring Centres (CHCs) to provide farmers access to various types of farm machinery, including conventional tractors. Integrating electric tractors into these CHCs can serve as pilot projects to evaluate their operational feasibility and address consumer concerns regarding performance.

Additionally, CHCs can play a crucial role in managing and disseminating technical know-how related to electric tractors, such as charging and servicing procedures, thereby enhancing farmers' awareness and confidence in adopting this emerging technology.

- **Integration of renewable energy into the charging infrastructure for e-tractors**

The current power supply scenario in rural areas is insufficient to support the widespread adoption of electric tractors. Integrating renewable energy systems into rural power supply networks can help address concerns about inadequate charging infrastructure. This renewable energy push can be facilitated through central schemes like PM-KUSUM or state-specific initiatives. Additionally, electric tractors have the potential to contribute to rural energy resilience by acting as mobile power banks, providing backup power during extreme events that damage transmission infrastructure, thereby offering a dual benefit of advancing agricultural mechanisation and enhancing energy security.

- **Awareness campaigns**

The numerous advantages of electric tractors, such as lower operational and maintenance costs, often go unnoticed due to limited awareness among farmers. Targeted awareness campaigns highlighting the long-term savings from reduced fuel and maintenance expenses can play a crucial role in educating farmers about the benefits of transitioning to electric tractors. Allocating funds for a comprehensive multimedia campaign—including radio, television, and social media—can ensure that these benefits reach a broader audience, thereby fostering greater adoption of electric tractors across farm and non-farm segments.

- **Training and skill development programmes**

Tractor operators in both farm and non-farm sectors often depend on local after-sales services beyond the initial free service agreements offered by OEMs due to their cost-effectiveness. To address the growing need for localised service and maintenance, policymakers can introduce dedicated training and skill development programmes focused on electric vehicles, including electric tractors. Such initiatives would not only create livelihood opportunities but also help establish a robust after-sales ecosystem for the e-tractor market, enhancing accessibility and confidence among users.

- **Financial incentives for OEMs to strengthen supply side ecosystem**

Ther farmers' survey revealed that tractor operators tend to prefer well-established OEMs when making purchase decisions. However, the current e-tractor market is primarily dominated by emerging start-ups offering customised agricultural solutions. To address this challenge and build confidence in the e-tractor ecosystem, incentive-driven schemes such as the Production Linked Incentive (PLI) Scheme and the Rajasthan Investment Promotion Scheme (RIPS) can be leveraged. Additionally, tax rebates and other fiscal incentives can be introduced to attract investments, advancing the development of a robust supply-side ecosystem for e-tractors. These measures will help bridge the gap between market expectations and the evolving e-tractor industry.

- **Monitoring and Evaluation**

Establishing a dedicated task force to oversee the adoption and performance of electric tractors is crucial for evaluating the success of related schemes and programmes. This task force would play a key role in analysing data, monitoring progress, and identifying challenges in real time. By incorporating farmer feedback and assessing market dynamics, it could recommend targeted interventions and policy adjustments to ensure the sustained growth and effectiveness of electric tractor initiatives.

Conclusion

The adoption of electric tractors in India presents a promising opportunity to revolutionise agricultural practices while contributing to sustainable environmental goals. However, several challenges, such as high upfront costs, lack of awareness, and insufficient infrastructure, need to be addressed to encourage their widespread adoption.

To overcome these barriers, state governments can implement low-emission zones, which would promote the use of electric tractors, particularly in non-farm sectors such as construction and waste collection. Coupled with targeted subsidies, such as a 50% reduction in purchase price, electric tractors could become more accessible to farmers, ensuring their transition to a sustainable future. States like Haryana, Karnataka, and Uttar Pradesh are already working towards introducing subsidy schemes and tax waivers.

Further, financial institutions can partner with policymakers to provide concessional loans for electric tractors, with favourable interest rates and long repayment periods. A proposed model for loan financing can ease the burden on farmers by ensuring affordability and manageable repayment terms. Additionally, the introduction of a Battery-as-a-Service (BaaS) model can reduce the financial impact of electric tractors, offering a sustainable and cost-effective alternative.

Custom Hiring Centres (CHCs), integrated with electric tractors, can serve as effective pilot projects to showcase their viability while educating farmers on operational processes such as charging and maintenance. The integration of renewable energy systems into the rural power supply can address concerns over charging infrastructure, positioning electric tractors as key enablers of rural energy resilience.

Awareness campaigns and skill development programmes are crucial to inform farmers about the operational savings and benefits of electric tractors. Training local service providers and developing a strong after-sales support network will help ease the transition and ensure long-term success.

Incentives for Original Equipment Manufacturers (OEMs) will strengthen the supply-side ecosystem, fostering innovation and ensuring reliable e-tractor options for farmers. Policymakers should also explore fiscal incentives and regulatory support through schemes like the Production Linked Incentive (PLI) and Rajasthan Investment Promotion Scheme (RIPS).

Finally, to ensure that the adoption of electric tractors remains on track, a dedicated task force should be established to monitor progress, gather feedback, and propose adjustments to the policies. With these coordinated efforts, electric tractors have the potential to significantly transform India's agricultural landscape, making it more sustainable, efficient, and resilient.

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