WRI INDIA

CONFERENCE PROCEEDING

Electric-tractor manufacturing and adoption in India

A SUMMARY OF EXPERT PERSPECTIVES ON ACTIONS REQUIRED TO ENABLE E-TRACTOR MANUFACTURING AND ADOPTION IN INDIA

August 6, 2024 | New Delhi | Compiled by: Anusrita Kundu, Chandana K, Sharvari Patki, and Pawan Mulukutla

BACKGROUND

India, the world's largest tractor market, sold over 10 lakh units in 2022, (Malik and Kohli 2020) accounting for 45 percent of global production. Tractors have become essential to modern farming due to their versatility across tasks like plowing, sowing, and hauling, a trend that began with the green revolution when agricultural growth closely aligned with the rise of tractor usage.

However, diesel-powered tractors dominate with 8.81 lakh registered units, consuming 7.4 percent of the country's annual fuel supply. This reliance on diesel not only raises costs for farmers but also contributes significantly to greenhouse gas (GHG) emissions. Agriculture and transportation contribute 14 percent and 8.36 percent to India's national GHG emissions, respectively, with diesel-powered tractors being a key contributor. Due to their versatility, there is no alternative to using tractors in farming. However, with a compound annual growth rate (CAGR) of 8.29 percent from fiscal year (FY) 2016 to FY2024 in the diesel tractor market, the need for electrification is pressing, presenting an opportunity to reduce emissions and also to lower operational costs for farmers. (JMK Research 2024)

Global decarbonization efforts are now shifting focus toward electric tractors (e-tractors). India is uniquely positioned to capitalize on such a shift as manufacturing capacity increases and the demand for cleaner alternatives grows. This transition therefore presents an opportunity to significantly reduce the country's GHG emissions while also offering economic benefits, energy independence, improved performance, and enhanced farm mechanization, solidifying India's role as a global leader in e-tractor manufacturing.

CONTENTS

1 Background
4 Tractor landscape
10 E-tractor scenario in India
12 Roundtable conference outcomes
17 Conclusion
18 References
19 Participants
20 Acknowledgements
20 For more information
21 About WRI India

These conference proceedings reflect the presentations and discussions of participants and do not necessarily represent the views of WRI India or other participating institutions.

On August 6, 2024, WRI India hosted a roundtable conference "EV Revolution: Accelerating E-tractor Manufacturing and Adoption" in New Delhi. The event brought together key stakeholders from the tractor ecosystem—industry leaders, financial institutions, knowledge partners, and farmers from Uttar Pradesh—to discuss how India can leverage its status as a global tractor-manufacturing hub to drive this critical transition. The primary intent of the meeting was to discuss the following:

- **Market readiness and adoption barriers.** Assess the current state of the e-tractor market in India and identify key barriers to adoption, including initial cost, infrastructure, and popular awareness.
- **Technological advancements and innovations.** Review and discuss the latest advancements in and opportunities for innovation, thereby exploring various avenues for collaboration between the government, industry, and academia.
- **Policy support and incentives.** Analyze existing government policies and incentives for electric vehicles and thereby develop a framework for advocacy and engagement with key decision makers.
- **Integration with renewable energy.** Explore the potential and feasibility of integrating electric tractors with renewable energy sources, aligning with the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM KUSUM) scheme.
- **Economic and environmental impact.** Assess and evaluate the economic benefits and environmental impacts of transitioning to electric tractors, thereby developing an indicator to measure success and impact at a larger scale. This could be initiated by small-scale pilot projects for realistic comparison between diesel and electric tractors for various use cases.

FIGURE 1 | Convening of key stakeholders to accelerate e-tractor manufacturing and adoption in India: Roundtable conference in New Delhi

Photo credit: WRI India.

The discussion delved into formulating diverse strategies to integrate e-tractors into the existing tractor ecosystem while identifying collaborative opportunities to accelerate their adoption across the sector.

Some key highlights and takeaways of the discussions:

- **India's potential as a global manufacturing hub.** India is well-positioned to become a global leader in e-tractor production, building on its traditional dominance in tractor manufacturing.
- **Technological shift.** The conference highlighted the shift in technological focus from urban to rural areas, recognizing e-tractors as key to transforming agriculture and rural livelihoods.
- **Policy support.** Extending subsidies and incentives through schemes like Faster Adoption and Manufacturing of Electric Vehicles (FAME) and PM KUSUM is critical for boosting e-tractor adoption and market penetration. In addition, stricter emission norms, interest subventions, support for charging infrastructure, and skill-development initiatives will be crucial for enabling widespread e-tractor adoption.
- **Role of financial institutions.** Tailored financial products, including low-interest loans and subsidies, are essential to make e-tractors accessible, especially for small farmers.
- **Addressing barriers.** Battery capacity, charging infrastructure, and costs were identified as challenges that must be addressed for wider e-tractor uptake.
- **Product sizing.** Ensuring tractors are appropriately sized, especially in the 45–55 horsepower (HP) range, will boost adoption.
- **Scalable pilot programs.** Scalable pilots are key to building trust, validating e-tractor performance, and comparing costs and benefits with diesel tractors.
- **Charging infrastructure.** Developing fast-charging infrastructure in rural areas, with collaboration from distribution companies (DISCOMs) and local stakeholders, is vital for scaling e-tractors.
- **Custom hiring centers (CHCs).** CHCs and farmer producer organizations (FPOs) can reduce upfront costs by leasing e-tractors, ensuring broader access and usage.
- **Small farmer inclusion.** Supporting small farmers, particularly those relying on 20 HP tractors, is crucial for wider mechanization and e-tractor adoption.
- **Collaborative business models.** Engaging CHCs, financial institutions, manufacturers, and farmers in risk-sharing business models will drive e-tractor adoption.
- **Testing standards.** Establishing clear testing standards for e-tractors is essential for building consumer trust, ensuring product reliability, and facilitating access to financing.
- **Building trust and awareness.** Education and training programs are necessary to build farmer confidence and support the widespread adoption of e-tractors.
- **Future of agriculture.** Establishing agricultural incubation centers, as proposed by the National Bank for Agriculture and Rural Development (NABARD), can support e-tractor innovation and adoption, particularly in Uttar Pradesh.

TRACTOR LANDSCAPE

Overview of tractor landscape

The discussion began with a welcome note and a context-setting presentation by Sharvari Patki, Program Head, WRI India, where she highlighted the current tractor landscape in India and potential ways to accelerate the adoption of electric tractors.

In the context-setting presentation, Patki provided an insightful overview of the global tractor industry, emphasizing its vital role in enhancing agricultural productivity, with key markets in North America, Europe, and Asia experiencing significant technological advancements. She noted that the global tractor market, which was valued at US$73.72 billion in 2022 is projected to grow from US$77.79 billion in 2023 to US$119.56 billion by 2031, reflecting a CAGR of 5.52 percent during the forecast period 2024–2031 (SkyQuest, 2024). This growth, she explained, is primarily driven by increased mechanization in agriculture and a rising demand for efficient farming solutions. She also described how modern tractors are increasingly equipped with precision farming technologies, autonomous capabilities, and eco-friendly powertrains, illustrating a global shift toward sustainable agriculture. This trend not only promotes innovation in tractor manufacturing but also emphasizes the importance of efficiency and environmental impact across a diverse range of tractor types and applications, from small compact models for light-duty tasks to large high-power tractors suited for heavy-duty agricultural and industrial use.

Globally, tractors are utilized across a wide range of applications, with agriculture remaining the dominant sector. They play a crucial role in essential farming activities, such as plowing, sowing, harvesting, and hauling. The discussion highlighted that beyond agriculture, tractors are widely used for commercial purposes in construction and mining, where they assist in heavy-duty tasks like earthmoving and transportation. Based on their intended use, the horsepower requirement varies, with tractors in the 45–55 HP range being the most commonly used due to their versatility (JMK Research 2024). Given that agricultural tractors account for the majority of sales and usage, focusing on mechanizing them is essential for improving efficiency as well as to drive sustainable farming. In this context, Patki emphasized that the push for e-tractors aligns seamlessly with the broader goals of boosting productivity, reducing the environmental impact of India's agricultural sector, and addressing the nation's reduce fossil fuel dependency and enhance India's energy security objectives.

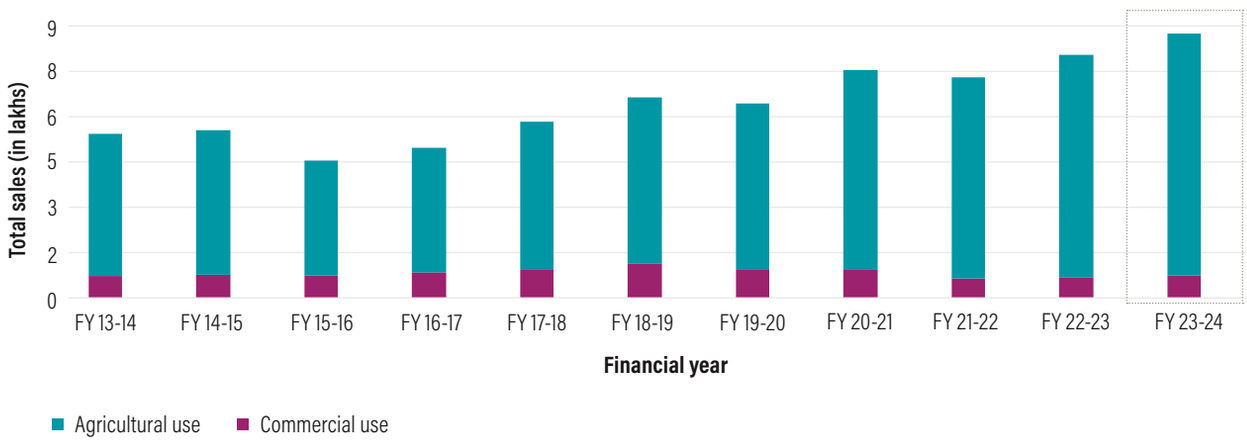
The presentation also emphasized the centrality of agriculture to India's economy, supporting 60 percent of the population and ensuring food security for 1.4 billion people (Malik and Kohli 2020). Agriculture contributes 18.3 percent to the nation's Gross Value Added (GVA), playing a crucial role in economic stability and growth IBEF, 2024). While biotechnology and mechanization have helped increase yields from 522 kg/ha to 2143 kg/ha, the current mechanization level remains low at 40 percent–45 percent, compared to countries like the US (95 percent) and China (57 percent) (FICCI and Grant Thornton, 2015). This gap has led to labor-intensive practices and higher operational costs, particularly in rural areas. With the agricultural labor force expected to decline from 40 percent to 26 percent by 2050 and food grain production projected to rise from 329 million tonnes (MT) in 2023 to 400 MT by 2050, (FICCI and Grant Thornton 2015), accelerating mechanization is essential for meeting future demands.

In her presentation, she also discussed how India's current agriculture scenario stands at a pivotal point, especially in tractor mechanization. The Indian tractor industry saw substantial growth during the green revolution of the 1960s and 1970s, which introduced high-yielding seeds and modern irrigation methods, driving the need for mechanization. This positioned tractors as essential for boosting farm productivity. Today, India is embracing the global shift toward sustainable farming with initiatives like the PM KUSUM Yojana and some state electric vehicle (EV) policies, aimed at reducing fossil fuel reliance. The idea of including electric tractors under these programs was discussed, a move that could accelerate the transition to greener practices, reducing emissions and enhancing efficiency. With rising labor shortages and a focus on sustainable farming, India can leverage its expertise in tractor production, adopt clean energy solutions, and lead the global agricultural machinery market through innovation, government support, and strategic partnerships.

India's current tractor landscape

The presentation highlighted India's rapidly growing tractor market, which has seen remarkable expansion over the past decade, driven by the increasing demand for agricultural mechanization. Between FY2014 and FY2024, the market grew significantly from 0.55 million to 0.88 million units, reflecting a CAGR of 4.9 percent (VAHAN 2024).

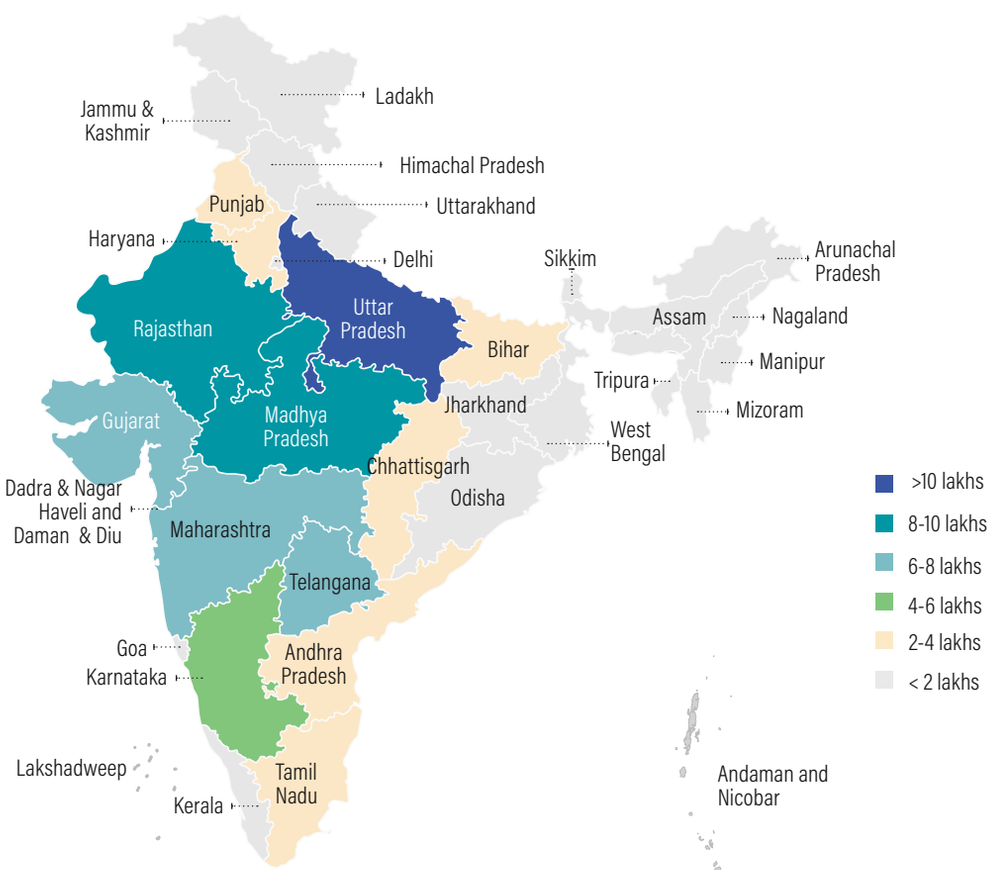
FIGURE 2 | Tractor sales in India, FY2014–FY2024



Source: VAHAN.

As discussed, the steady rise (as shown in Figure 2) indicates the increasing need for tractors to support productivity in agriculture, particularly as the country embraces modern farming techniques to meet the demands of its large agrarian population.

FIGURE 3 | State-wise cumulative tractor sales in India over the last 10 years



Source: VAHAN.

The presentation included state-level data from the VAHAN database, as illustrated in Figure 3. This revealed that Uttar Pradesh leads in tractor registrations, holding the highest number of units sold between FY2014 and FY2024, reflecting the state's large agricultural base. Madhya Pradesh, Rajasthan, Maharashtra, and Telangana also exhibit large volumes of tractor sales, highlighting the degree of mechanized farming across major agricultural hubs in India.

The annual average growth rate (AAGR) from FY2022 to FY2023 stands at 10.12 percent, while the growth from FY2023 to FY2024 is slightly lower at 8.84 percent (VAHAN 2024). These figures suggest a temporary deceleration but overall stable growth. With the continued growth in agricultural industry, supported by government schemes and initiatives as discussed, these figures are expected to improve over time, reflecting a positive trajectory in tractor adoption. The geographic distribution of tractor sales also reflects the agricultural diversity across the country, with states like Uttar Pradesh, known for intensive farming, showing higher adoption rates.

To support this growth, the presentation underscored the role of central government initiatives like the PM KUSUM scheme (MNRE n.d.) and the Sub-Mission on Agricultural Mechanization (SMAM) scheme, (myScheme, n.d.), along with the support of financial institutions like NABARD (NABARD n.d.), to ensure financial security for farmers by boosting agricultural production through farm mechanization and by promoting renewable energy sources. These are comprehensively outlined in Table 1.

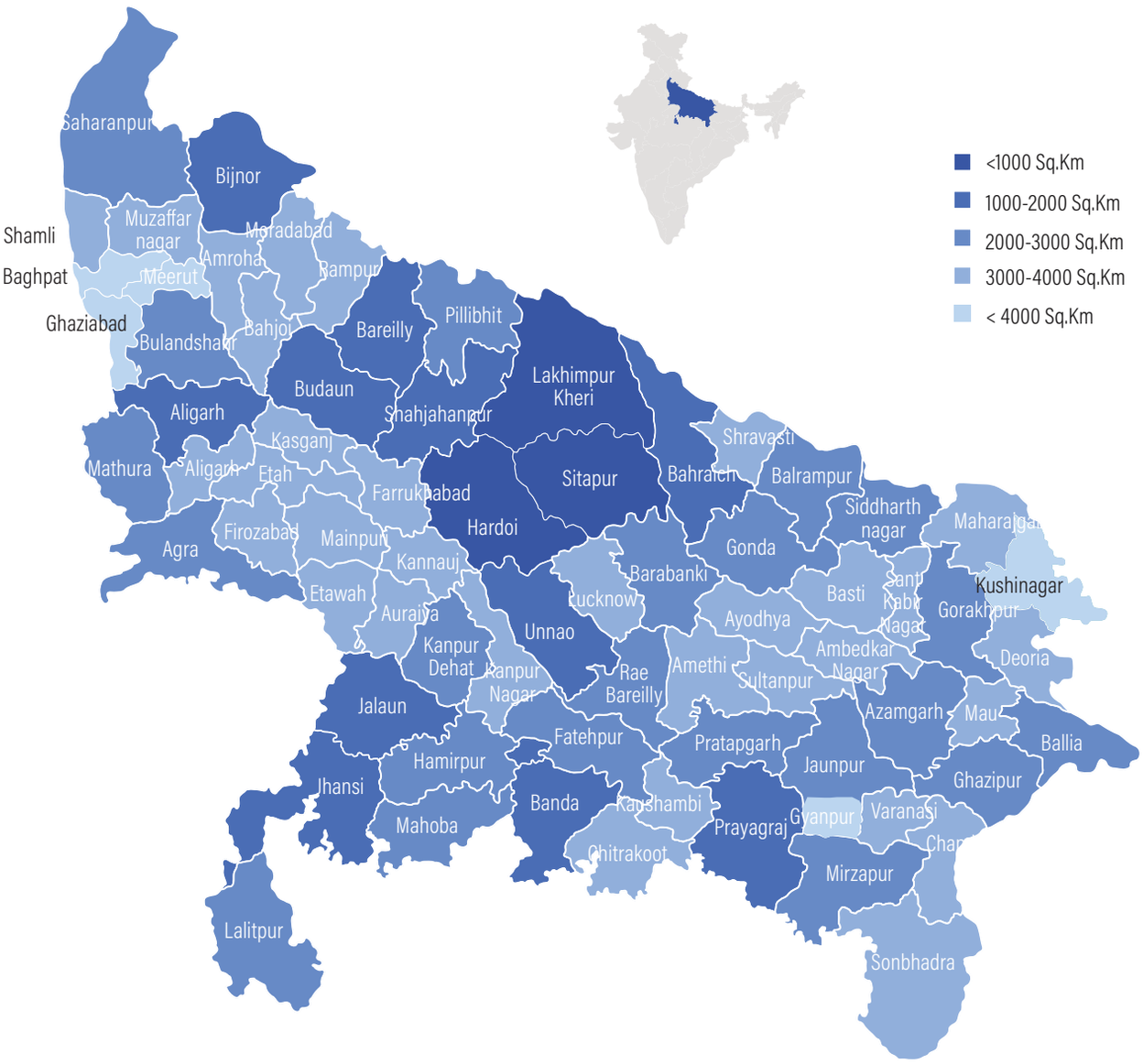
TABLE 1 | Central government incentives for internal combustion engine tractors

SCHEME	YEAR	OBJECTIVE	ICE-TRACTOR INCENTIVES/SUPPORT
PM KUSUM	2019	Ensure energy security for farmers and increase non-fossil-fuel-based installed capacity to 40% by 2030.	Not directly related to tractors, but sustainable fuel for e-tractors. Up to 60% subsidy for solar pumps and tube wells
SMAM	2014	Promote agricultural mechanization.	Up to 80% subsidies for various forms of agricultural equipment
NABARD loans	NA	Promote agricultural mechanization.	Allows farmers to buy tractors with a 15% down payment. NABARD provides a 30% subsidy for tractors.

Source: Compiled by WRI India.

The presentation emphasized the critical position of Uttar Pradesh in India's agricultural landscape, with approximately 59 percent of the state's population and one-third of its economy relying heavily on agriculture. The state is recognized as the largest producer of food grains in India, contributing a significant 18.89 percent of the nation's total food grain production, which amounted to 58.32 million tonnes in 2020–2021 (Ministry of Agriculture & Farmers Welfare, 2022).

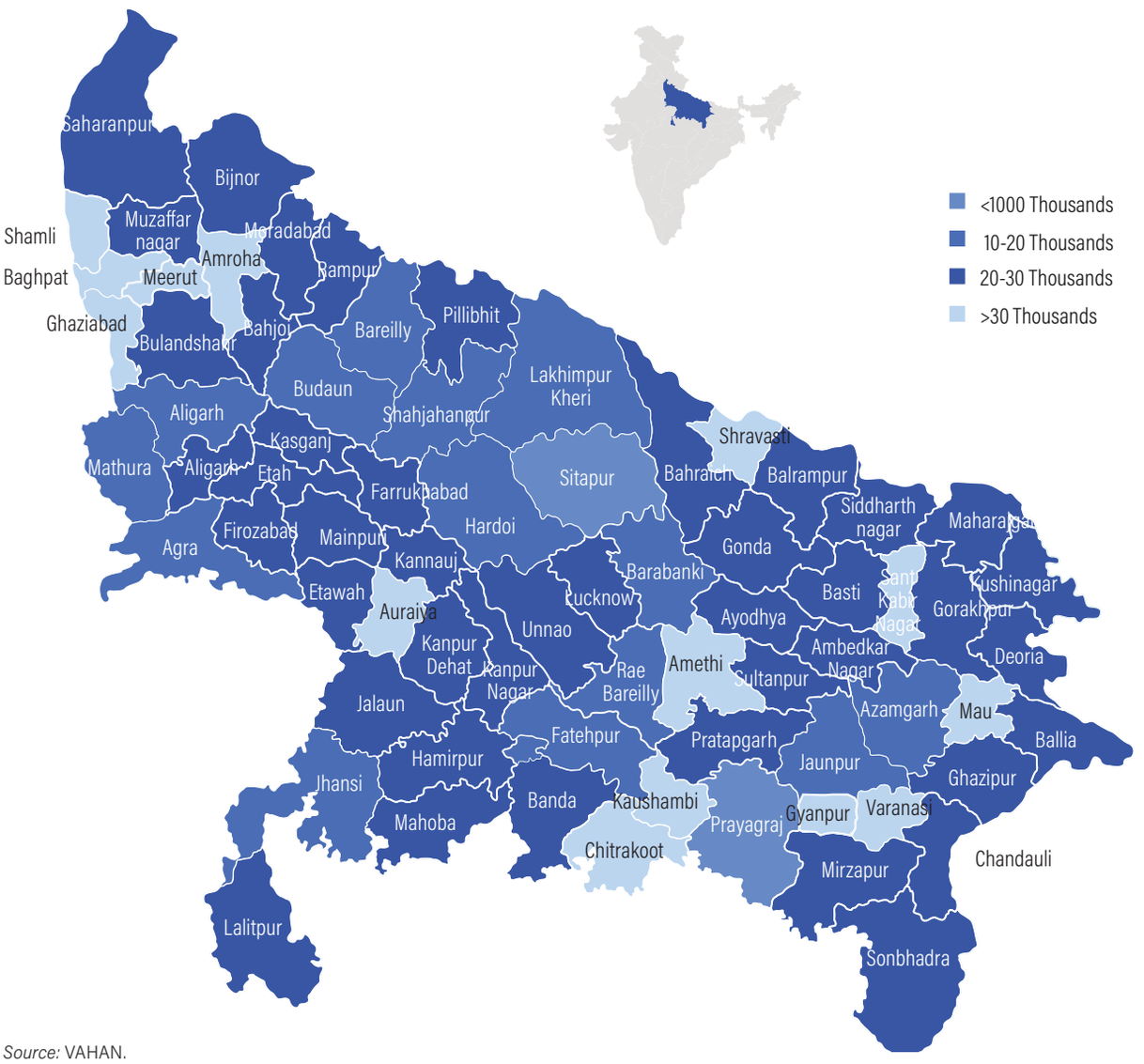
FIGURE 4 | District-wise agricultural land share of Uttar Pradesh



Source: Agricultural Statistics at a Glance, 2022.

The agricultural strength of Uttar Pradesh lies in its vast stretches of arable land, as shown in Figure 4, which shows that over 50 percent (Agricultural Statistics at a Glance, 2022) of the state's districts each contain more than 2000 km^2 of cultivable land. This extensive availability of fertile land significantly contributes to the state's high agricultural output and its dominance in food grain production. The presentation also highlighted that, with continued emphasis on mechanization and modernization, the production rate would increase further in the future.

FIGURE 5 | Tractor sales in Uttar Pradesh by district (cumulative from FY2014 to FY2024)



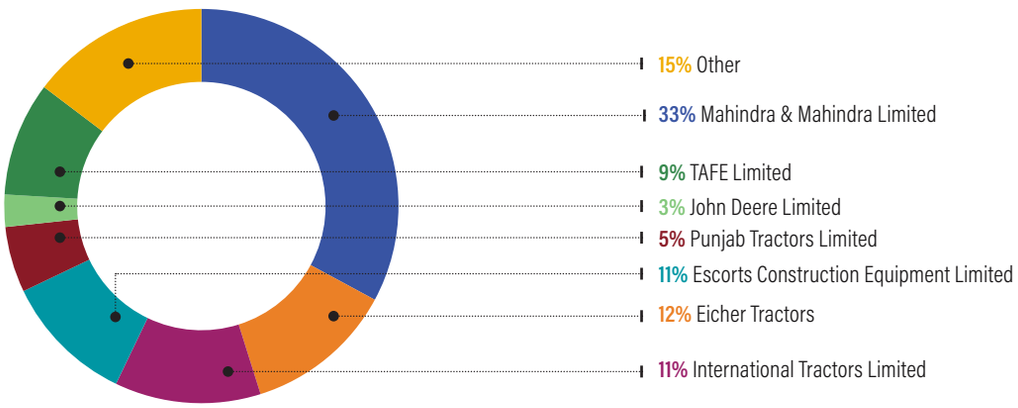
Source: VAHAN.

WRI India analysis further demonstrated that Uttar Pradesh recorded the highest tractor sales in India over the past decade. When the tractor sales data by district, as illustrated in Figure 5, is overlaid with the state's arable land map, a clear correlation emerges. Districts such as Sitapur, Prayagraj, Kheri, and Hardoi, each containing over 4000 km^2 of cultivable land, have significantly higher tractor sale volumes.

From FY2014 to FY2024, Uttar Pradesh's tractor market demonstrated a CAGR of 3.28 percent (VAHAN 2024). Figure 7 also illustrates an AAGR of 7.46 percent in tractor sales from FY2022 to FY2023, with a further increase to 9.35 percent from FY2023 to FY2024 (VAHAN 2024). This increasing rate highlights the state's potential to become a major tractor manufacturing hub but also raises concerns about the environmental impact, particularly the rise in emissions due to the growing number of tractors. The discussion underlined the need to explore alternative solutions like e-tractors to promote sustainable farming practices.

To further support this mechanization, the Uttar Pradesh government has recently launched an initiative to provide subsidies for tractor and power tiller purchases. Since 2023, the state has been offering ₹ 50,000 as a subsidy for tractors (20 HP) and ₹ 75,000 for power tillers (8 BHP) (Chetia, 2020). This initiative aims to make mechanization more accessible to farmers, especially small and marginal farmers, by reducing the financial burden of acquiring modern equipment.

FIGURE 6 | Major tractor manufacturers' market share in Uttar Pradesh

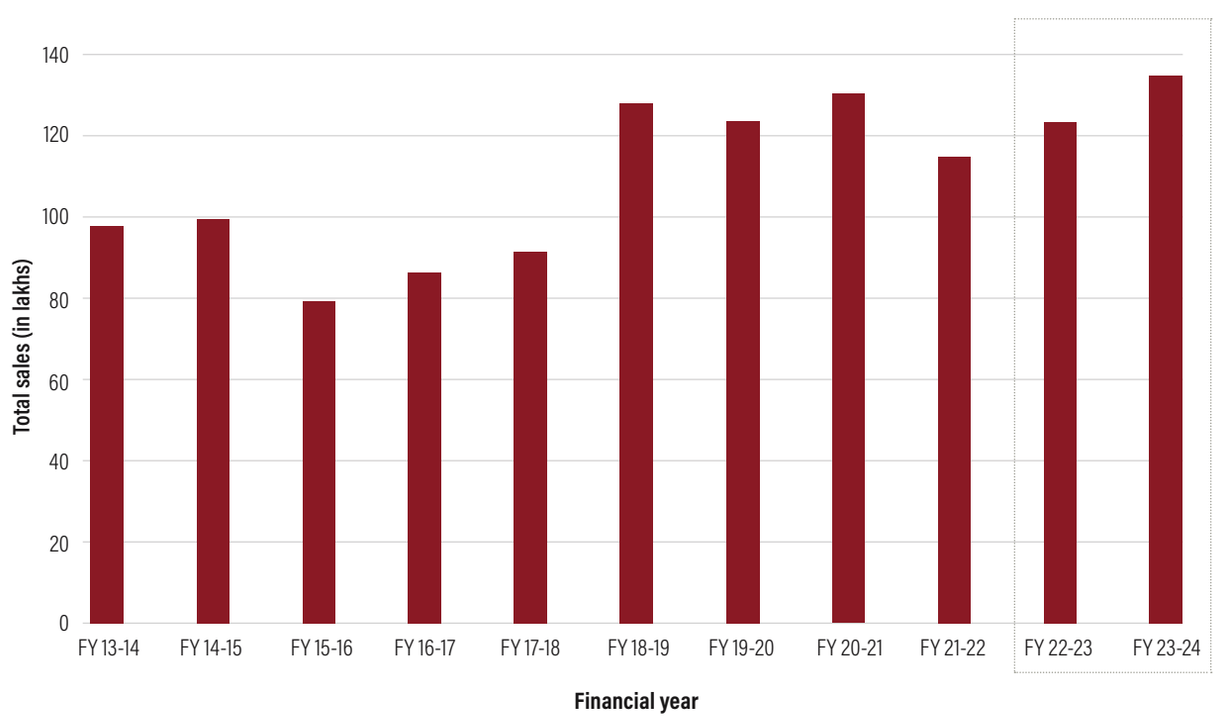


Source: VAHAN.

The presentation also underscored the importance of key stakeholders in shaping the tractor ecosystem. Farmers are central, influencing ownership and usage patterns, procurement, and decision-making around key purchase considerations. Custom hiring centers (CHCs) contribute through fleet ownership, leasing models, and procuring equipment for tractors. Major manufacturers leading the market are Mahindra & Mahindra Limited and Eicher Tractors, followed closely by other notable players like Escorts and John Deere, as illustrated in Figure 6 (VAHAN, 2024). This continued rise in tractor sales along with the active participation of major industry players further reinforces Uttar Pradesh's potential to become a hub for the tractor industry.

Moreover, tractor dealers provide insights into demand trends, seasonal cyclicity, and sales patterns, while mechanics offer expertise on maintenance issues and the challenges in operating and maintaining diesel tractors. Lastly, decision-makers are involved in exploring the potential schemes and policies that can increase the e-tractor uptake along with support to establish robust infrastructure, procurement facilities, and fleet management. Together, these stakeholders shape the evolving landscape of the tractor market.

FIGURE 7 | Uttar Pradesh tractor sales, FY2014–FY2024



Source: VAHAN.

Need for tractor electrification

India's agricultural sector is facing critical challenges, including a shrinking labor force and rising food demand, requiring improvements in both the quality and quantity of production. Increasing farm mechanization, while essential for enhancing productivity, has led to a higher reliance on diesel-powered tractors, contributing to rising operational costs and carbon emissions.

To address these issues sustainably, the adoption of electric tractors presents a viable solution. As discussed, e-tractors offer a sustainable alternative by reducing dependence on fossil fuels and cutting greenhouse gas emissions, but also offer lower operational costs by reducing fuel and maintenance expenses. This reduction in diesel consumption can also eliminate the fiscal burden on the state, which provides subsidies for fossil fuels. Through this transition, as highlighted at the roundtable event, India can align its agricultural practices with global climate goals while ensuring long-term profitability for farmers. By embracing e-tractors, India can modernize farming while minimizing its environmental impact and supporting global climate targets (Ministry of Information & Broadcasting, 2024.)

E-TRACTOR SCENARIO IN INDIA

Tractor electrification: Challenges and opportunities

In her presentation, Patki highlighted that India's electric tractor ecosystem is still in its nascent stage, characterized by early discussions among experts and a limited pool of stakeholders addressing the challenges and opportunities of this emerging technology. These conversations, however, have not yet matured into a comprehensive strategy for transitioning from diesel-powered to electric tractors. Advancing this shift requires a thorough understanding of the challenges hindering adoption, interventions required to dismantle these barriers, and an appreciation of the opportunities e-tractors offer for modernizing Indian agriculture.

One of the primary barriers discussed was the high initial cost of e-tractors, making them less accessible, particularly for small and marginal farmers. Without sufficient subsidies or dedicated policy support, the high upfront cost may deter adoption. FAME I and II, which promote EVs, currently exclude e-tractors, creating a significant policy gap. Another significant challenge is the lack of clarity around the operational performance of e-tractors. Many farmers and stakeholders are uncertain about the efficiency, reliability, and long-term benefits of e-tractors compared to diesel tractors. Additionally, the inadequate charging infrastructure, especially in relation to the fast-charging system (FCS), represents an obstacle to the adoption process. Setting up such infrastructure will incur additional cost, making it difficult for rural areas with limited resources to support this transition. Lastly, there is a general lack of awareness about e-tractors among farmers and stakeholders and the shortage of skilled drivers trained to operate these new technologies represents a brake on the potential uptake.

Despite these challenges, the presentation emphasized the significant opportunities that e-tractors offer. Globally, India has the potential to become a leader in e-tractor manufacturing, tapping into export markets and driving innovation in sustainable agriculture. Integrating e-tractors with renewable energy sources, supported by schemes like PM KUSUM, would help reduce fossil fuel dependency and enhance energy security in rural areas. This transition aligns with both national and global sustainability goals, ensuring a greener future for Indian agriculture.

Furthermore, the adoption of e-tractors could induce economic growth and job creation. By fostering new industries and technologies, e-tractors can generate employment opportunities across the supply chain, from manufacturing to maintenance. This shift could also lead to improved rural infrastructure, enhancing transportation, energy distribution, and connectivity in underserved areas, ultimately modernizing rural India. The advancement of smart farming technologies through the adoption of e-tractors would further enhance precision agriculture, optimize resource usage, and boost overall farm productivity, paving the way for more efficient and sustainable farming practices.

To establish an early market to support the widespread adoption of e-tractors, government incentives and schemes are crucial. Some Indian states have already taken steps in this direction.

TABLE 2 | State government incentives for electric tractors

STATE	YEAR	E-TRACTOR INCENTIVE
Haryana	2022	50% price incentive for first 1000 e-tractors up to ₹ 5 lakh (Haryana Government, Industries & Commerce Department, 2022)
Telangana	2020	Road tax and registration exemption for applicable e-tractors (Government of Telangana, 2020)
Punjab	2022	Incentives to set up anchor units for e-tractor manufacturing

Source: State EV policies | Compiled by WRI India.

Table 2 shows the comprehensive list of incentives formulated to date by some Indian states for e-tractors. These initiatives serve as milestones for India's progress toward electrifying its agricultural sector. With proper government support through subsidies and incentives, India can accelerate the adoption of e-tractors and position itself as a global manufacturing hub for this technology.

As a result of these initiatives, there are currently 127 e-tractor units registered in India. This includes vehicles imported from other countries, as well as sale of prototype e-tractor vehicles built in India. Table 3 shows the most advanced e-tractor models with a HP equivalent to ICE tractors manufactured in India. The comparison clearly highlights the high upfront cost of e-tractors, making procurement difficult for farmers.

TABLE 3 | Available e-tractor models in India

E-TRACTOR MODEL	OEM/ BRAND	POWER	BATTERY SIZE	LIFTING CAPA CITY	PRICE (₹)	COMPARATIVE ICE TRACTOR MODESL	POWER	LIFTING CAPACITY	PRICE (₹)
Tiger Electric 4WD	Sonalika	15 HP	25.5 kWh	500 kg	~6 lakhs	▪ M&M Yuvaraj 215 NXT ▪ Swaraj 717	▪ 15 HP ▪ 15 HP	▪ 778 kg ▪ 780 kg	3-3.5 lakhs
27HP	Cellestial E-mobilty	27 HP	18 kWh	1,200 kg	-	▪ M&M 265 DI ▪ Swaraj Target 630	▪ 30 HP ▪ 29 HP	▪ 1,200 kg ▪ 980 kg	4.5-5.5 lakhs
X45H2	Autonxt	45 HP	38.4 kWh	1,800 kg	~15 lakhs	▪ M&M Arjun 55 DI ▪ John Deere 5050 D	▪ 49.3 HP ▪ 50 HP	▪ 1,850 kg ▪ 1,600 kg	7.5-9 lakhs


Tiger Electric 4WD

27 HP

X45H2

Source: Tractor Junction Analysis.

Photo credits: Sonalika Tiger Electric 4WD, Cellestial E-mobility 27HP, AutoNxt X45H2.

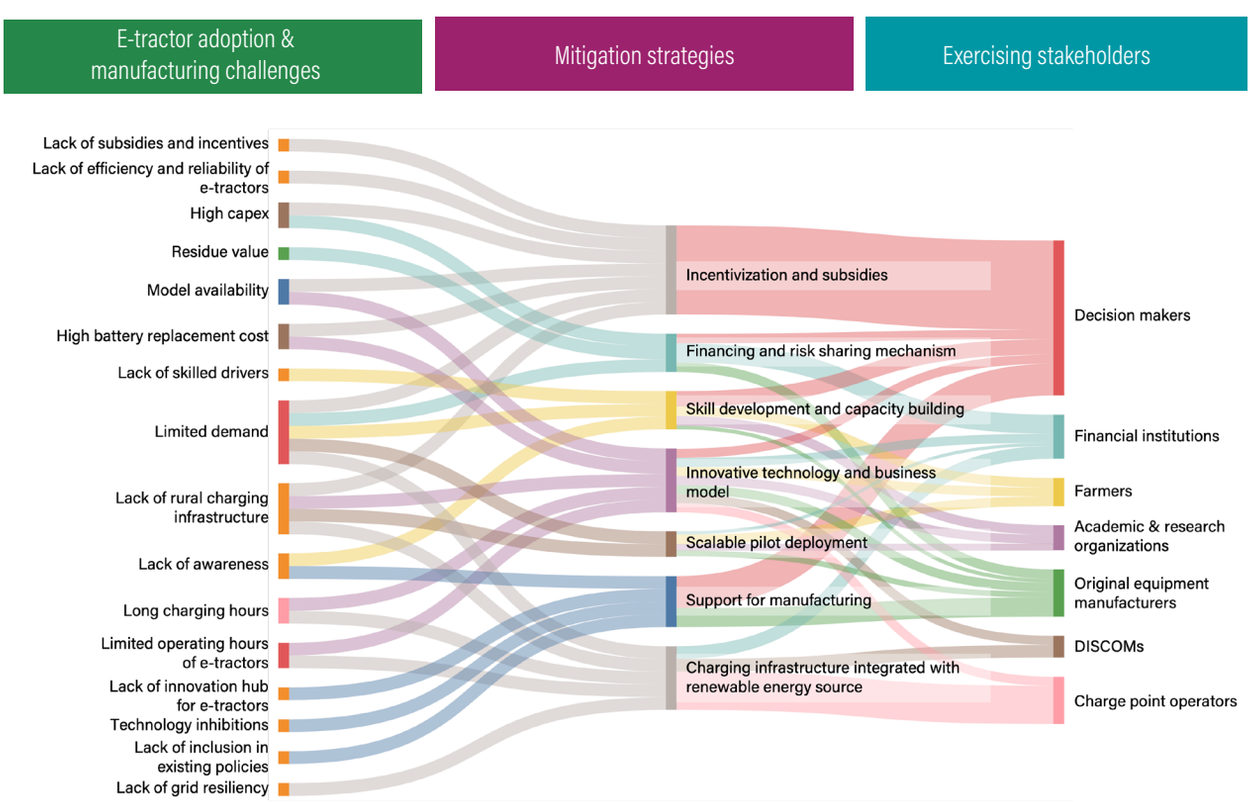
ROUNDTABLE CONFERENCE OUTCOMES

Key lessons and entry points for actions

The roundtable discussion identified several critical actions necessary to develop a comprehensive e-tractor ecosystem in India, focusing on both the technical and the economic feasibility of the technology for the near future. The discussions revealed the vital importance of a comprehensive policy framework to guide the transition to e-tractors, supported by purchase incentives to make them affordable for farmers. Additionally, innovative financing solutions are essential to ensure farmers can access the capital required for e-tractor adoption. The deployment of scalable pilot projects will offer insights into the real-world feasibility and performance of these tractors.

The development of rural charging infrastructure emerged as another key area; this will ensure that e-tractors can operate efficiently, even in remote areas. Furthermore, there is a need for business models that facilitate collaboration among key stakeholders, such as financial institutions, manufacturers, and farmers, with a focus on risk-sharing and mitigation strategies to ensure smoother adoption. These efforts, driven by coordinated stakeholder collaboration, will support the widespread adoption of e-tractors and promote sustainable agricultural practices. The figure below illustrates the key stakeholders, their challenges, and the strategies proposed to overcome these barriers, laying the groundwork for India's transition to e-tractors.

FIGURE 8 | E-tractor adoption and key stakeholders: Challenges and facilitating factors



Note: A comprehensive policy framework encompasses incentives, subsidies, and financial risk-sharing mechanisms, which are to be overseen and implemented by key decision-makers.

Source: Sankey diagram representing the challenges and facilitating factors for e-tractor adoption and manufacturing.

Policy framework for supporting e-tractor adoption

To enable the adoption of electric tractors, there is a clear need for a comprehensive and holistic policy framework that aligns national and state-level policies with sustainable agricultural goals. Such a framework will serve as a blueprint for integrating e-tractors into agricultural practices, drawing parallels from policy efforts such as the Bharat Zero Emission Trucking (ZET) Policy Advisory. As with the Bharat ZET framework, operational policies for e-tractors must cover critical areas such as testing standards, financing options, rural infrastructure planning, and cross-sectoral collaboration. While diesel tractors benefit from well-established testing standards that ensure reliability, similar protocols for e-tractors, which are needed to enhance their credibility in the market, are still being developed. As **Shefali Agarwal**, Director of **Bankers Institute of Rural Development (BIRD) of NABARD**, said, "Quality standards for e-tractors need to be established in a way similar to diesel tractors to qualify for financial incentives." Thus, a comprehensive policy framework that addresses these issues through policy guidance and regulatory clarity is crucial for advancing e-tractor adoption, while helping align stakeholders across industries, government bodies, and farmers toward a common goal.

ENTRY POINTS FOR ACTION: A clear need for developing a policy roadmap tailored for e-tractors unfolded during the discussion. This roadmap would align with national priorities for decarbonization and farm mechanization, ensuring regulatory clarity and stakeholder alignment. Establishing testing standards similar to those for diesel tractors is crucial for gaining market credibility and enhancing access to financing options. Another essential element is the development of a rural charging infrastructure, which will require coordination among DISCOMs, local authorities, and service providers to meet the added power demand.

A well-rounded policy advisory will lay the foundation for India's agricultural decarbonization, reduce the nation's reliance on fossil fuels, and promote sustainable farming. Through coordinated policy efforts, India can emerge as a leader in sustainable agricultural machinery.

Subsidy support for e-tractor adoption

While policy frameworks provide structure, **subsidies and financial incentives** are critical enablers of early market creation. Existing schemes, such as the **Sub-Mission on Agricultural Mechanization** (SMAM), PM KUSUM, Pradhan Mantri Kissan Samman Nidhi (PM KISAN), and **FAME**, have played a significant role in promoting agricultural machinery and electric vehicles. However, while SMAM provides subsidies of up to 80 percent on agricultural equipment, it currently focuses on diesel tractors. The lack of similar support for e-tractors remains a significant gap. While **FAME** has incentivized electric vehicles, it primarily targets two- and three-wheeled vehicles, buses, and light commercial vehicles, leaving electric tractors outside its scope. The lack of incentives widens the capital expenditure (capex) gap, leading to lower demand and insufficient confidence for original equipment manufacturers (OEMs) to scale up production. This hampers economies of scale, limiting opportunities to further reduce the capex gap.

ENTRY POINTS FOR ACTION: The discussion emphasized that **expanding subsidies to e-tractors** is essential for fostering market confidence and incentivizing manufacturers to scale production. This would help lower the high upfront costs of e-tractors, making them more attractive to farmers. As discussed during the conference, some states, as shown in Table 2, have demonstrated strong intent to support e-tractors by offering subsidies, such as Haryana's announcement of a 50 percent purchase incentive for e-tractors. Similar schemes could be implemented across other states.

Additionally, financial support through low-interest loans from NABARD, tax rebates, and carbon credits will enhance the economic feasibility of e-tractors, especially for small and marginal farmers. Aligning these incentives with broader sustainable farming programs will reduce farmers' operational costs, improve profitability, and help India meet its climate goals by reducing its carbon footprints. Through cohesive policies and financial incentives, India can position itself as a global leader in e-tractor production, driving sustainable agricultural growth.

Financial support for enabling more inclusivity in the e-tractor ecosystem

Government support, such as NABARD loans, currently provides critical financial assistance to farmers purchasing tractors. Farmers can access loans with a 15 percent down payment (Bindhu, 2020), along with a 30 percent subsidy, which makes diesel tractors more affordable. Such schemes can also include e-tractors. However, as the transition to e-tractors begins, additional financial support will be required, particularly for small and marginal farmers. These farmers often lack sufficient collateral or capital to secure traditional loans; more inclusive financing instruments therefore need to be developed for the e-tractor ecosystem. To ensure inclusivity, adjustments in interest rates or modifications to Goods and Services Tax (GST) slabs could be explored, providing targeted financial relief based on farmers' income levels. These measures would help bridge the affordability gap and ensure that small and marginal farmers farmers are not excluded from the benefits of e-tractors.

ENTRY POINTS FOR ACTION: The discussion emphasized the importance of financial institutions and financiers in ensuring e-tractor market inclusivity and enabling adoption, particularly for small and marginal farmers. NABARD, agricultural banks, and private financial institutions stressed the importance of collaborating to develop tailored financing instruments. This could include flexible credit terms, reduced interest rates, and innovative loan structures that consider the seasonal nature of farmers' incomes. Currently, e-tractors face a 12 percent GST, compared to 5 percent for EVs, and are not eligible for the 15 percent insurance discount EVs receive. The provision of agricultural loans at reduced interest rates could help famers cope with the challenge of the higher initial cost of e-tractors as compared to their diesel counterparts. The role of creditworthiness and farmer portfolio assessment will also be essential, as many small farmers may not have formal credit histories. This can be addressed by developing alternative assessment methods, such as using cooperative or community-based credit ratings. Additionally, the introduction of guarantee funds or government-backed credit guarantees could help de-risk loans to small farmers, making it easier for financial institutions to extend credit.

Participants also noted the importance of policy initiatives that focus on reducing GST rates for e-tractors and related equipment, making them more accessible. Adjusting tax policies to favor low-income farmers would further incentivize adoption. For financial institutions and financiers to trust this technology, extensive pilot programs are essential to demonstrate the feasibility and reliability of electric tractors, providing confidence in both the market and the technology.

Implementing scalable pilots for feasibility evaluation

To ensure the successful adoption of e-tractors, it is critical to validate their performance and feasibility in real-world scenarios. As stated by a progressive farmer, Subhash Deswal, "the only permanent thing is 'change'; therefore, this change should also be brought into the farming scenario by leveraging the existing mechanization technology." While financial support and policy incentives can accelerate adoption, the operational efficiency and reliability of e-tractors must be tested on the ground to determine if they can fully replace diesel-powered tractors. Scalable e-tractor pilot deployment programs are essential in this context, providing a direct comparison of cost-effectiveness, operational performance, and sustainability between electric and internal combustion engine tractors. To make an informed decision, pilot programs need to collect key data points which will help determine whether e-tractors are a viable and financially sustainable alternative to diesel models.

ENTRY POINTS FOR ACTION: Participants noted the importance of deploying scalable pilot programs, emphasizing the need for carefully designed use cases that reflect real-world agricultural activities, such as haulage, rotavating, tilling, and harrowing. These pilot programs would compare the performance of e-tractors with their HP-equivalent diesel counterparts in specific field applications, evaluating metrics like power output, operational efficiency, fuel or electricity consumption, and long-term durability. The discussion

also highlighted that cost-benefit analyses should factor in total savings in running costs, including reduced fuel expenses, maintenance costs, and emission savings. A thorough total cost of ownership (TCO) analysis over the tractor's lifespan (10–15 years) was suggested to assess the technology's long-term viability.

Additionally, it was stressed that for scalable pilot deployments to be successful, adequate rural infrastructure must be in place to support a smooth and efficient transition.

Building a sustainable rural charging network: Enabling infrastructure for e-tractors

The roundtable discussion highlighted the importance of developing a robust charging infrastructure in rural areas to enable the transition to electric tractors. Unlike urban settings, where charging infrastructure is steadily expanding, rural regions require specialized planning to ensure efficiency and accessibility. It is not enough to simply install charging stations; these must include fast chargers to minimize downtime and ensure that e-tractors can meet the high operational demands of agricultural work. Collaboration between farmers and service providers will be pivotal to ensure the seamless integration of this new technology.

ENTRY POINT FOR ACTION: During the discussions, participants highlighted the need for a clear plan to develop scalable rural charging infrastructure, emphasizing land procurement and aggregation as critical steps. It was suggested that governments and local authorities should collaborate with farmers, cooperatives, and landowners to identify suitable sites for charging stations. Incentivizing charge point operators will be critical to lowering the initial costs of installing fast chargers, helping to make the business model more sustainable. These incentives could come in the form of subsidies, tax rebates, or low-interest loans. Power grid planning must also be aligned with this expansion of charging infrastructure. DISCOMs will play a key role in ensuring that the rural power supply can support the added demand created by fast chargers. Strategic upgrades to the rural grid, including strengthening power lines and increasing capacity, will be necessary to fast-track the rollout of an e-tractor charging infrastructure.

Additionally, integrating **renewable energy sources** into the rural charging infrastructure was noted as an important opportunity for sustainability in the future. Schemes such as **PM KUSUM**, which promotes the use of solar power for agricultural purposes, could be leveraged to power rural charging stations, thereby reducing the burden on conventional electricity generation. This integration would not only lower operating costs in the long term but also align with India's broader renewable energy goals, creating a **self-sustaining charging network** that supports both e-tractors and rural electrification. By harnessing renewable sources like solar energy, the transition to e-tractors can also contribute to India's energy independence and sustainability efforts.

For this plan to work effectively, participants recognized the importance of developing business models that engage farmers and key stakeholders to ensure smooth implementation. Capacity building is also crucial to accelerating and enhancing the transition, ensuring that all stakeholders understand the technical, operational, and economic benefits of integrating e-tractors into agricultural practices.

Developing sustainable business models for e-tractor adoption

The transition to e-tractors requires innovative business models to distribute the risks and costs among multiple stakeholders, ensuring shared responsibility by all. As stated by Kaustubh Dhondhe, CEO, AutoNxt, "E-tractors should be put out for rent for small and marginal farmers and this could be overlooked by procurement centers." Engaging with CHCs and FPOs, and adopting models like tractor-as-a-service (TaaS), e-tractors can be made more accessible and affordable for farmers.

ENTRY POINTS FOR ACTION: One effective model that emerged from the stakeholder discussion is to involve CHCs, where electric tractors are rented out to farmers, reducing the need for significant upfront investment. Similarly, FPOs can collectively purchase and manage electric tractors, ensuring optimal use while sharing the cost among members. Another model explored was leasing, allowing farmers to pay over

time and thereby lowering the barrier to entry. The tractor-as-a-service (TaaS) or pay-per-use model was also highlighted, enabling farmers to pay only for the hours or tasks they need, thereby providing flexibility and minimizing expenses. Additionally, to promote adoption and innovation, incubation centres have been identified as effective hubs for developing sustainable business models, fostering innovation in the e-tractor sector.

The discussion also underscored the relevance of leveraging green finance instruments. These will provide favorable loan terms linked to environmental performance, making e-tractors more financially viable. Accessing carbon credits can create additional revenue streams for farmers who reduce emissions by using electric tractors, making the transition not only eco-friendly but economically advantageous. These diverse business models ensure that the financial and operational risks are distributed, supporting the broader adoption of e-tractors across India's agricultural landscape.

For this transition to succeed, it is essential to bring all key stakeholders onto a common platform, ensuring alignment and collaboration for a smoother, more efficient adoption process.

Collaborative efforts to enhance capacity building and skill development for the e-tractor ecosystem

The successful transition to e-tractors hinges on the collaborative efforts of multiple stakeholders across the government, agriculture sector, financing institutions, and research organizations, aligning their efforts to ensure a seamless transition. This discussion among various stakeholders emphasized that the transformation is not only about introducing new technology but also about creating a sustainable ecosystem that can support and maintain its growth. The synergy among these stakeholders is essential to addressing the challenges associated with electric tractors, such as infrastructure development, financing, and technological understanding.

ENTRY POINTS FOR ACTION: Capacity building is at the core of this transition. Stakeholders emphasized that farmers, being the end users of e-tractors, will need extensive training on their operation and maintenance. Skill development programs should be introduced to equip farmers with the knowledge required to handle e-tractors efficiently, including understanding the benefits of reduced operational costs and sustainability. Additionally, technicians and service providers must be trained to support the growing number of e-tractors on the ground, ensuring that any technical issues are addressed promptly.

Furthermore, the role of financial institutions was discussed at they are crucial in providing innovative financing models, such as low-interest loans and subsidies tailored to small and marginal farmers. DISCOMs will also play a pivotal role in ensuring that the rural energy grid can support the added demand for fast chargers. The government must facilitate these partnerships by creating policies that foster collaboration among all these stakeholders, ensuring that resources, incentives, and training programs are available. This collective effort will build an inclusive ecosystem that not only supports the adoption of e-tractors but also empowers farmers and rural communities through skill development and enhanced capacity. Such a holistic approach will be key to the long-term sustainability and success of the e-tractor movement in India.

FIGURE 9 | Concluding the discussions at the roundtable conference in New Delhi

Photo credit: WRI India

CONCLUSION

The transition to electric tractors represents a significant step forward in India's agricultural landscape, contributing to increasing productivity with sustainability. Throughout the discussion, it became evident that the successful adoption of e-tractors requires a multi-faceted approach, integrating policy reforms, financial support, infrastructure development, and capacity building. Government schemes like AGR-50 Scheme-Assistance to Purchase Tractors and SMAM, while effective for diesel tractors, must evolve to provide targeted incentives for e-tractors. This will not only make the technology more accessible but will also catalyze its adoption across rural areas. It is equally important to develop a rural charging infrastructure. Without fast-charging capabilities and a reliable power supply, the operational efficiency of e-tractors will be compromised. Integration of renewable energy sources in charging infrastructure can not only make it environmentally sustainable but will also reduce operational expenses. Collaboration between DISCOMs, charge point operators, and farmers will be essential in creating a charging network that supports large-scale e-tractor deployment. Financial instruments, such as leasing models, TaaS, and green finance options, will play a pivotal role in reducing the financial burden on farmers, especially small and marginal ones, ensuring that risk is shared equally by all stakeholders. Successful technology transition in any sector relies on developing a supportive ecosystem by building the capacity and developing the skills of stakeholders. Farmers and service providers must be equipped with the necessary skills to operate and maintain e-tractors, while financial institutions and policymakers must work closely to create the conditions that will foster investment and innovation in this space.

In conclusion, the successful deployment of e-tractors in India will depend on a comprehensive and collaborative effort across multiple sectors. By addressing key challenges through efforts for early market development, innovative business models, scalable pilot programs, and inclusive financial frameworks, India can position itself as a leader in sustainable agricultural mechanization. This collective approach will enhance productivity; it also aligns with national and global decarbonization goals, ensuring a brighter and more sustainable future for Indian agriculture. In addition, the accelerated adoption of e-tractors in the Indian agricultural ecosystem will foster early market development, enabling domestic manufacturers to strengthen their global leadership in e-tractor production and create export opportunities.

REFERENCES

Bindhu, H. 2020. "Subsidies for Farmers in India for Selected Machinery." *GrainMart*. https://www.grainmart.in/news/subsidies-for-farmers-in-india-for-selected-machinery/

Chetia, P. 2020. "State-wise Subsidies on Selected Agri Machinery." *Krishi Jagran*. https://krishijagran.com/state-wise-subsidies-on-selected-agriculture-machinery-in-india

Department of Transport. 2023. *Punjab Electric Vehicle Policy*. Government of Punjab. https://punjabtransport.org/Punjab%20Electric%20Vehicle%20Policy%20-%202022.pdf

FICCI and Grant Thornton. 2015. *Transforming Agriculture Through Mechanisation*. https://ficci.in/public/storage/SPDocument/20682/agrimach.pdf

Government of Telangana. 2020. *Telangana Electric Vehicle and Energy Storage Policy 2020*. https://www.nsws.gov.in/s3fs/2021-08/Telangana%20EV%20policy.pdf

IBEF (India Brand Equity Foundation). 2024. *Agriculture in India: Information About Indian Agriculture & Its Importance*. https://www.ibef.org/industry/agriculture-india

Industries & Commerce Department. 2022. *Haryana Electric Vehicle Policy-2022* [Gazette notification No. 20/01/2022-4IB-I]. Government of Haryana. https://investharyana.in/content/pdfs/EV%20Policy%202022.pdf

JMK Research. 2024. *Electric Tractors in India: A Concept or a Reality?* https://jmkresearch.com/electric-vehicles-published-reports/whitepaper-electric-tractor-market-in-india-a-concept-or-a-reality/

Malik, A., and S. Kohli. 2020. "Electric Tractors: Survey of Challenges and Opportunities in India." *Materials Today*: Proceedings 28: 2318–2324. https://doi.org/10.1016/j.matpr.2020.04.585

Ministry of Agriculture & Farmers Welfare. 2023. *Agricultural Statistics at a Glance 2022*. https://desagri.gov.in/wp-content/uploads/2023/05/Agricultural-Statistics-at-a-Glance-2022.pdf

Ministry of Information & Broadcasting. 2024. *10 Years of Transformation: Revolutionizing Agriculture*. http://pib.gov.in/PressNoteDetails.aspx?NoteId=151859

Ministry of New and Renewable Energy. PM-KUSUM Scheme. https://pmkusum.mnre.gov.in/#/landing Accessed November 8.

MyScheme. *Sub-Mission on Agricultural Mechanization (SMAM)*. https://www.myscheme.gov.in/schemes/smam Accessed November 8.

NABARD. *Role of NABARD in agriculture and rural development*. https://www.nabard.org/content1.aspx?id=23&catid=23&mid=530 Accessed November 8.

Pathak, H., J.P. Mishra and T. Mohapatra. 2022. *Indian Agriculture after Independence.* New Delhi. Indian Council of Agricultural Research. https://icar.org.in/sites/default/files/2023-02/Indian-Agriculture-after-Independence.pdf

SkyQuest Technology. 2024. *Global Tractor Market*. https://www.skyquestt.com/report/tractor-market

VAHAN. 2024. https://vahan.parivahan.gov.in/vahan4dashboard/vahan/vahan/view/reportview.xhtml

Accessed November 8.

PARTICIPANTS

Amit Kumar, Assistant General Manager (EV Policy), Invest UP

Anuraddha Kshatriya, General Manager, Invest UP

Subhash Deswal, Farmer – BulandShahr

Raghupat Singh, Farmer - Muzaffarnagar

Devkumar Tyagi, Farmer - Badkali, Muzaffarnagar

Sushil Tyagi, Farmer, Badkali, Muzaffarnagar

Omkar Tyagi, Farmer - Badkali, Muzaffarnagar

Shefali Agarwal, Director - BIRD, NABARD

Dr. Sriram Appulingam, General Manager, NABARD

Anil Saini, Business planning and Program Manager, TVS Credit

Sunil Chippa, Program Manager, TVS Credit

Kaustubh Dhonde, CEO, AutoNxt Automation Private Limited

Pankaj Goyal, Co-Founder & CEO, AutoNxt Automation Private Limited

Swadeep Pilarisetti, Board Member, AutoNxt Automation Private Limited

Hemant Kumar, CEO & Director, Bullwork Mobility

Gunasree Jayappa, Business Analyst and Strategy, Bullwork Mobility

Dr. IV Rao, Automotive Head, TERI

Piyush Saxena, Research Associate, TERI

Narayankumar Sreekumar, Associate Director - Electric Mobility Program, Shakti Sustainable Energy Foundation (SSEF)

Priyadarshini Alok, Assistant Program Manager, Shakti Sustainable Energy Foundation (SSEF)

Saurav Gupta, Partner, KPMG

Prakash Powdel, Associate Director - Business Consulting, KPMG

Mridula Pandey, Senior Manager, Children Investment Funds Foundation (CIFF)

Mr. Vikrant K. Aggarwal, Co-Founder and Director, EVI Technologies

Varun Chaturvedi, Founder & Manager, Volttic

Abhishek Tyagi, Business Development Manager - EV Charger, Sarvotech Power System Limited

Priyanka, Area Sales Manager – EV, Sarvotech Power System Limited

Sharvari Patki, Program Head, WRI India

Chaitanya Kanuri, Associate Director, WRI India

Kaustubh Gosavi, Consultant, WRI India

Rahul Tiwari, Senior Program Associate, WRI India

Yash Pratap Singh, Senior Program Associate, WRI India

Anusrita Kundu, Intern, WRI India

Anya George, Senior Program Associate, WRI India

Sama Arekal, Junior Program Communications Associate, WRI India

Chandana K, Senior Program Associate, WRI India

Manojna Polisetty, Senior Program Associate, WRI India

ACKNOWLEDGMENTS

The authors would like to thank all the participating individuals, organizations, and government departments for their valuable inputs during the roundtable conference, which were critical in identifying challenges, exchanging best practices, and brainstorming strategies for transformative change, thereby encouraging stakeholders to collaborate and take proactive measures to accelerate manufacturing and adoption of electric tractors in India. We thank our colleagues at WRI India who helped finalize this report, including the communications team that helped with the editing and design

FOR MORE INFORMATION

Sharvari Patki, Program Head – Electric Mobility, WRI India

Contact: Sharvari.patki@wri.org

ABOUT WRI INDIA

WRI India, an independent charity legally registered as the India Resources Trust, provides objective information and practical proposals to foster environmentally sound and socially equitable development. Our work focuses on building sustainable and liveable cities and working towards a low carbon economy. Through research, analysis, and recommendations, WRI India puts ideas into action to build transformative solutions to protect the earth, promote livelihoods, and enhance human well-being. We are inspired by and associated with World Resources Institute (WRI), a global research organization. Know more: www.wri-india.org

All the maps in this conference proceeding are for illustrative purposes and do not imply the expression of any opinion on the part of WRI India, concerning the legal status of any country or territory or concerning the delimitation of frontiers or boundaries.

WRI INDIA

LGF, AADI, 2 BALBIR SAXENA MARG, HAUZ KHAS,
NEW DELHI 110016, INDIA
+91 11 40550776
WWW.WRI-INDIA.ORG