Electric Tractor: Reviewing the Awareness and Factors Impacting Adoption in Indian Market

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Abstract **- India is primarily an agriculture-propelled economy. The primary source of livelihood of the majority of the population is agriculture. India has in recent years taken mechanization in farming to sustain and fulfill the demands of its 1.39 billion strong population. Tractors have been the primary focus of this mechanization process. With the boon of mechanization came the high level of pollution caused by this diesel-guzzling off-road motor vehicle. Since 2013 Indian government is regularizing agriculture farm machinery and are supporting an environment friendly alternative in form of electric tractors.**

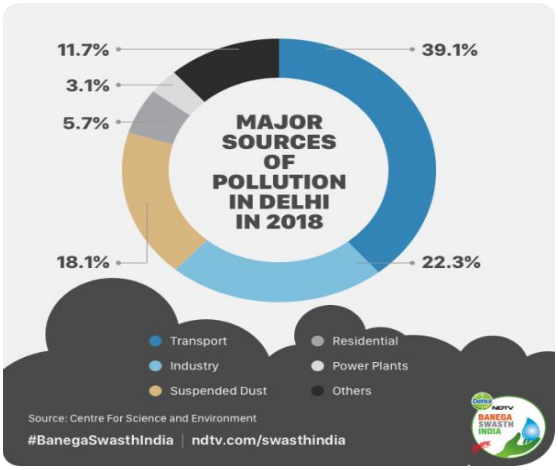
This paper presents a review the awareness about electric tractors in Indian markets. It also assesses factors impacting diffusion of electric tractors.

Index Terms **- Electric vehicle, Electric tractor, technology adoption, Indian tractor market, Electrification of farm machinery**

INTRODUCTION

Air is sustenance. It is the denomination for the existence of life and the concoction to health is breathable clean air. Though, the considerations for healthy life are very rudimentary but manmade conditions have created an existential crisis named "Pollution" for humans and the planet alike.[1], Pollution is caused by a series of activities including the power sector, domestic, industrial pollution, and transport sector to name a few. The spike in the population and activities to sustain it, like agriculture coupled with developmental activities have fueled increased levels of air pollution in the country. The following figure represents the share of various sectors in pouring pollution.

Fig: 1



The alarming pollution deluge and decades of worsening of air quality in all of the leading economies have impelled countries around the globe to reassess their pecuniary representations. This is the opportunity to bring the talks of sustainability into action. This crisis has emphasized the need to rethink the issue that is steeping progressively over and leads us to one goal that is to renew the world. The aim is to decarbonizing human exertion over the next few years. The spell is to steer off the disastrous effects of climate change. There are various expenses that need to be functioned on but transport with 39% contribution in the stake stands tall and asks prioritizing decarbonization of the sector.

VEHICULAR POLLUTION

The tailpipe emissions from the vehicles are detrimentally impacting human vigor and the ecosystem. The type and efficiency of engines coupled with the type of fuel used underline the severity of the exhausts emitted. The obnoxious composition of the pollutants varies from, carbon monoxide (CO), nitrogen oxides (NOx), photochemical oxidants, air

toxins, namely benzene (C6H6), aldehydes, 1,3 butadiene (C4H6), lead (Pb), particulate matter (PM), to name a few. Diesel-based vehicles emit a concoction of nitrogen oxides and particulates whereas petrol vehicles emit carbon monoxide and hydrocarbons.

The Government of India has resorted to belligerent actions to control emissions from on-road motor vehicles. A robust plan is in place to lower-sulfur in fuel and strictly implementing Bharat Stage VI (BS-VI) emission standards, equipping all the vehicles with the latest emission control technologies, including diesel particulate filters (DPFs), to maximally reduce tailpipe emissions.

AGRI-VEHICLE POLLUTION

India is predominantly an agricultural society. Agriculture and its associated sectors are the key sources of income for approximately 55% of the Indian population [4]. India's agriculture sector holds 18% of India's overall domestic product (GDP) and contributes employment to 50% of the nation's population and also aids meaningfully to production and demand generation through various backward and forward integrations [5]. Agriculture in India is steadily changing keeping up with the pace of the world. Farmers in India are now not shying away from farm mechanizations and are considering acceptance like never before, supported by favorable government policies has occasioned a surge in tractor sales in the country. India is the largest tractor market in the world – accounting for about 1/3 of global tractor production [2].

The Indian rural economy has bounced back much faster than the urban economy post lockdown. The Indian agriculture industry has posted robust demand channelized growth post covid, putting tractor industry on a never heard before growth trajectory. Tractors were pivotal in increasing the country's agricultural capacity and market was valued at progress in recent decades [6,7]. Farm machinery market in India was estimated at Rs. 320 billion in 2018–19 and is predicted to reach Rs. 500 billion by 2021–22. Major domestic players in the market with an 80% market share in the tractor industry are Mahindra and Mahindra, TAFE, ITL-Sonalika, Escorts, and John Deere [8]

Nevertheless, derisory deliberation has been given to NRMS (non-road (land-based) mobile sources) as most of these vehicles operate on diesel engines, emitting substantially higher pollutants in comparison to other on road-vehicles [9]. The scenario further exaggerates considering that the NRMS is the least regulated category. This increases the chances of the revelation of the general public to a serious health hazard in terms of harmful emissions like fine particulate matter (PM2.5) and nitrogen oxides (NOx) [10].

In view of the exponential demand increase in the mentioned segment, there is a crucial obligation to adequately regularize, monitor, and innovate in this segment, necessitating the characterization of the market and shift the focus to renewable energy sources in agriculture. Integration of electric drives in tractor and agricultural machinery presents advantages in terms of increased energy efficiency and expanded functionalities.

The aim of this study is to assess the paradigm shift in the tractor industry towards electric tractors as an alternative to polluting Internal Combustion Engine - based tractors. Keeping with trends of electric mobility in the automotive industry several tractors and farm machinery manufacturers such as John Deere, Fendt, Solectrac, Rigitrac, Claas, Escorts, Kubota and Schaffer have been developing electrification of farm machinery. With initial models in market and the pilot scale implementations in process this is the right time to study the awareness and the benefits and challenges associated with adaptation of electric tractors in the Indian scenario.

E VEHICLES: Electric vehicles or EV's are the vehicles that are either partially or fully powered on electric power [16]. To define an electric vehicle (EV), it is a mode of transport powered by electricity. Distinct to the Internal Combustion Engines (ICE) vehicles that run on petrol or diesel engines [17]. Electric vehicles use an electric motor powered by electricity from batteries or a fuel cell. Pollution reduction is the main advantage derived out of the new technology of Electric vehicles that come with nill exhaust emissions.

Types of Electric Vehicles

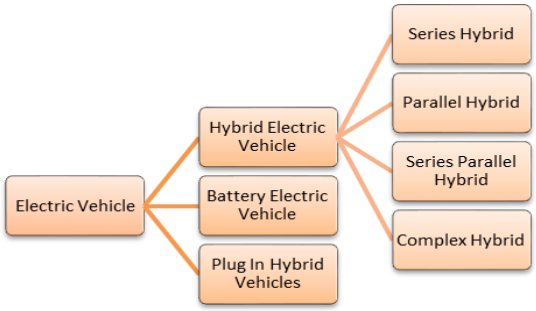
Battery Electric Vehicles (BEV) : BEV are referred as pure electric vehicle. It draws its power from

rechargeable battery to power the vehicle, in complete absence of ICE (Internal Combustion Engine). BEV's need to be charged for the next ride.

Hybrid Electric Vehicle (HEV): As the name suggests it comprises of both ICE and battery. Equipped with regenerative breaks the battery of HEV charges itself on its own. Further the HEV are classified as parallel HEV, series parallel HEV, and complex HEV on the basis of hybridization density.

The Plug-in Hybrid Electric Vehicles (PHEV) is similar to that of HEV with provision of charging the battery in the vehicle easily by a plug-in electricity source at home or commercially.

Fig 2: Types of Electric Vehicles



Electric Tractors: Electric tractors have taken over the consideration set of the agriculturists as it comes with positive deliberations when compared to internal combustion engines. The biggest cause of concern for the farmers is the maintenance cost which gets easily addressed to owing to reduced number of moving parts in the machinery. Reduced emission, low running cost also adds to the benefits of the E-tractors. The aforesaid factors add to likelihood of adoption by farmers and boost the sale of electric tractors, complemented by rigorous guidelines related to the emissions, and alternate energy advocates all the more to imbibe the sustainable innovate solution in farming called E tractors the vision of future.

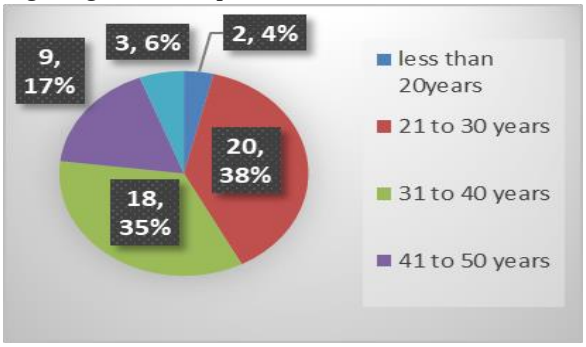
The vision of future the electric tractors is struggling for viability and acceptance in the market owing to certain stark disadvantages associated or perceived by the purchasers, to mention a few, limitations pertaining to battery charging, replacement of battery, initial accqusiiton cost, power of the machinery, low speed, extreme operating conditions, lack of skills etc. The technological inhibitions are coupled with psychological aspects like spatial effect, fear of innovation, social acceptance that needs attention while charting the course for Electric tractors in Indian markets.

The research aims at exploring the factors impacting the perception and adoption of electric tractors in Indian markets.

Methodology The following research methods were used in the work: - a paper pen personal questionnaire survey was conducted with 50 respondents. The data collected was investigated and graphically denoted. The survey had 10 multiple choice questions.

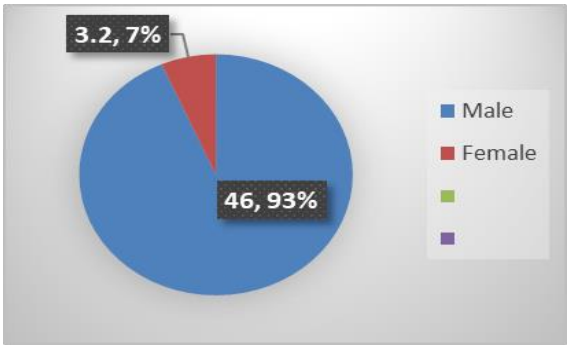
Analysis : The graphical representation of the survey result is as following:

Fig:3 Age of the respondent



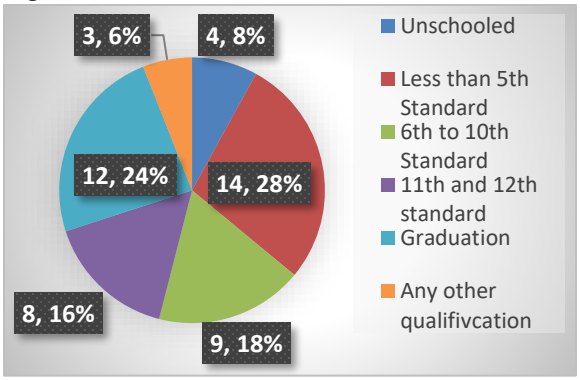
The above representation categorizes the respondents according to age.

Fig 4: Gender of respondent



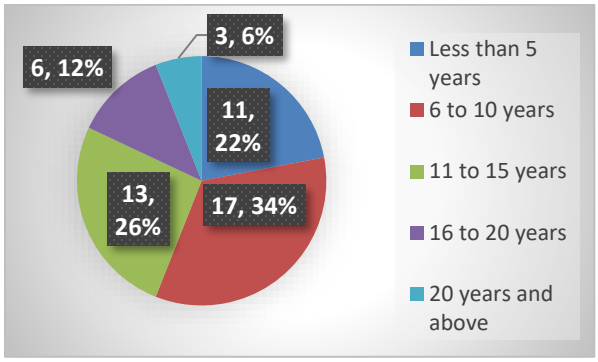
The representation shows stark gender difference in agriculture segment with only 4 females out of 50 respondents.

Fig: 5 Education



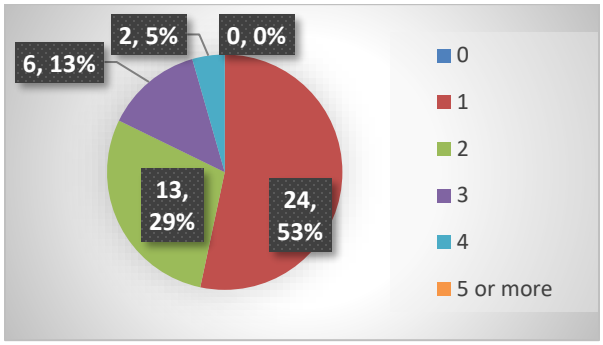
The representation profile the respondents on the basis of education received

Fig 6: Period of running the farm



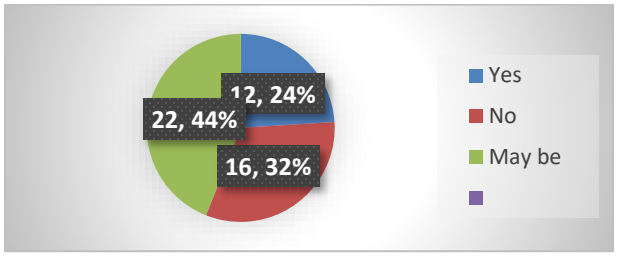
The above chart depicts the period of operating the farm by the respondents

Fig 7: Number of tractors owned



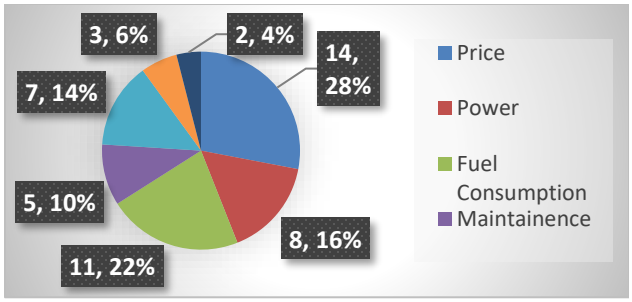
The chart summarizes the number of tractors currently owned by the respondents

Fig 8: Purchase in near future



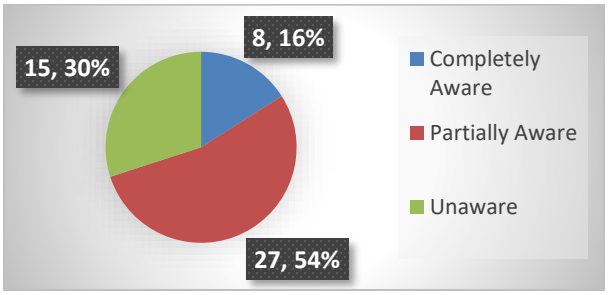
The chart identifies the futuristic purchase considerations of the respondents

Fig 9: Factors impacting purchase



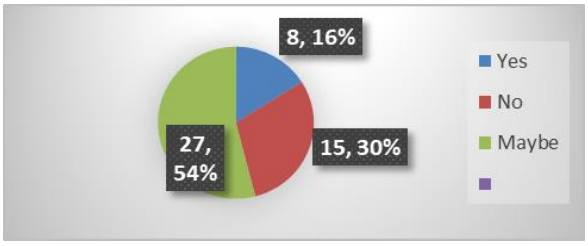
The above chart represents the most important factor listed by the respondents that they consider deciding to purchase a new tractor. Here 28% respondents consider price the most important factor followed by fuel consumption and then power or capacity of the tractor. Whereas maintenance resale and subsidies provided stand at 10%, 14%, and 6% respectively and the least importance is given to impact on environment.

Fig 10: Awareness about electric tractors



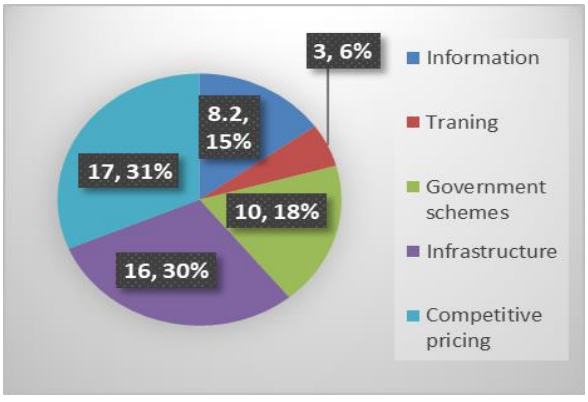
The above chart decodes the awareness levels about electric tractor as an alternative present in the market. The chart clearly depicts a lack of awareness and information amongst the users.

Fig 11: Planning to buy electric tractor



The acceptance of the product in the market is depicted by the above chart with majority 54% of the market undecisive again emphasizing the need for awareness and information.

Fig 12: Factors positively impacting decision to buy electric tractors



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CHALLENGES IN ADOPTION OF ELECTRIC TRACTORS IN INDIA:

Tractor industry is pivoted at a point wherein meeting fluctuating and spiraling expectations from the customers is a task.

1. Derisory charging infrastructure: With the massive population and peak demands of 180 GW India is aiming to fulfill 24_7 electricity to every individual in the country. With this pretext, establishing charging infrastructure in villages seems a humongous task and off the grid power supply is still a distant dream.
2. Lack of Skilled manpower: Usage of advance machinery becomes a challenge for Indian farmers as they do not possess adequate skill st to operate advance machinery. As usage of tractors require easy understanding of functionality hence unconventional driver user interface will present a challenge of adoption.
3. High initial cost: The high initial cost of electric tractor technology makes its diffusion exceedingly difficult in a price sensitive consumer market like India. The price is 3 to 4
4. times higher than comparable internal combustion engines making electric tractors beyond the purchasing power of agriculturists in India.
5. Compatible Battery technology: Battery efficiency, size, weight, power and associated high cost are the major challenge battery technologies that needs to be addressed to make electric tractors competitive.
6. Extreme operating environment: Another India specific factor is the extreme working conditions for farm machinery. Extreme heat, cold, rainfall may be detrimental in functioning of power electronics components and efficient thermal management for electronics components, battery pack and electric motor.
7. Lack of Quality management and repair workshop: Another area of concern is the lack of after sales service and maintenance as the technology is in nascent stage.

CONCLUSION

Electric tractors may be coming to a field near you, at least ten years sooner than many commentators had anticipated, writes NFU renewables expert Dr Jonathan Scurlock

Scouting for premium options and evaluating product on the value delivered is becoming the way Indian rural consumers are making purchase decisions. Though, the price sensitivity of the agriculturists rooting from inconsistent flow of income regulated by monsoon makes the demand for farm machinery volatile. The study also highlights high price and lack of after sales service and maintenance as the major factor for farmer incredulity.

In such difficult market scenario the electric tractor companies need to provide desired product, robust dealer network, flexible financing options, and impeccable service with spare parts.

Uptake of progressive technology in farming will prosper the farmers with better yield and reliable income. Revolutionary technology like electric tractors will put the power in the hands of the farmers by regularizing their fuel and maintenance expenditure and alos will be beneficial for the environment and the country. The tractor industry is on the verge of disruptive innovation ushering in a new phase intended at farm mechanization at optimal costs and address the issue of affordability among Indian farmers.

The industry sits at the dawn of new era that will eventually positively assist in upliftment of tractor customers, at large. The promising technological revolution the electric tractors are at a nascent stage and evolving. Nevertheless, the environment for holistic diffusion of electric tractors and pan-India usage will unquestionably take span of decades but certainly will be value of time.

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