EMERGING TRENDS ON FARM MECHANISATION: A CATALYST FOR SUSTAINABLE AGRICULTURAL GROWTH

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Abstract: Global food production may require an increase of approximately 60% by 2050 to accommodate the growing global population. It is important to highlight that agricultural production in developed regions has already stabilized. Consequently, developing or least-developed regions possess the greatest potential for satisfying the rising global food demand. Agricultural productivity intricately connects to the availability of farm power. Agricultural mechanization is one of the most overlooked facets in undeveloped areas, with the majority of farming activities conducted manually. The absence of agricultural mechanization leads to subsistence farming in many undeveloped areas globally. So, enhancing the degree of farm mechanization is essential as it will serve as a catalyst for global agricultural development. In this article, emerging trends on farm mechanisation: a catalyst for sustainable agricultural growth has been discussed.

Keywords: Farm, Mechanisation, Catalyst, Sustainable, Agricultural, Growth.

INTRODUCTION:

Farm mechanization can address some of the ongoing difficulties in agricultural operations. Given that the vast majority of the working people in India are either employed in the industry or depend on it for a living, this becomes even more crucial. By increasing production and lowering total costs, farm mechanization can be a key factor in turning agriculture into a profitable endeavour. Mechanization can reduce the labor-intensive tasks associated with ploughing and other agricultural tasks. According to estimates, a farmer must walk around 66 kilometres to use bullocks to plough one hectare of land. By reducing the obstacle of physically difficult work, the mechanization of such activities can also aid in expanding the participation of women in agricultural activities. (Singh, G., 2006)

FARM MECHANISATION:

The term "farm mechanization" describes the creation and application of devices that can replace human and animal labor in agricultural operations. The drudgery of agricultural labor is eliminated by agricultural mechanization, which also solves labor and time constraints to complete activities within ideal time frames and can impact agriculture's environmental impact, producing sustainable results. Agricultural mechanization includes using more power sources and better tools and equipment on farms to increase the number of crops grown, be more accurate when measuring and placing inputs, and speed up the time it takes to use different inputs efficiently. This is done to cut down on losses at different stages of crop production. Improving overall production and productivity while lowering production costs is the ultimate goal of farm mechanization. Additionally, it aids in protecting produce and byproducts from both qualitative and quantitative harm; it permits value addition and the formation of agro processing businesses to generate extra revenue and jobs from agricultural produce. In rural India, it is one of the most crucial inputs for overall development. (Tiwari, P. S. et al., 2019)

Types of farm machinery:

➢ Agriculture mechanisation: It is a broad term generally used for all types of agriculture-related machines, tools and equipment.

➢ Farm mechanisation: Although used interchangeably with agricultural mechanisation, it actually refers to machinery used inside the boundaries of a farm unit or plot.

➢ Tractorisation: Tractorisation refers to the utilization of various sizes of tractors to carry out various farm activities. Indian agricultural machinery is usually dominated by tractors, as they are easily available.

➢ Agriculture equipment: This term describes mechanical machinery used in agriculture which is stationary in nature – e.g. irrigation pump set.

Factors affecting farm mechanisation level:

➢ Average of the landholdings and plot size.

➢ Accessible to capital and technology.

➢ Agricultural investments.

➢ Availability of the workforce.

➢ Government & institutional policies.

Utility of farm mechanisation:

➢ Drudgery reduction.

➢ Timely completion of agricultural operation.

➢ To encourage more women participation by removing physical work.

➢ To enhance the crop productivity.

➢ To reduce the production cost.

➢ Capable to diversification by enabling through the farmers to cultivate various crops.

FARM MECHANIZATION AS A CATALYST FOR SUSTAINABLE AGRICULTURAL GROWTH:

By 2029, the Indian agricultural machinery industry is expected to have grown from its 2024 valuation of US$16.73 billion to US$25.15 billion. Favourable government policies, growing farm earnings, and the crucial role of mechanization are the main drivers of growth. Through effective resource use, farm mechanization helps reduce cultivation costs and increase production. In India, the National Bank for Agriculture and Rural Development (NABARD) estimates that machinery powers 40–45% of farm operations. The majority of India's income and the raw materials for many industries come from agriculture, which employs about 50% of the nation's workforce. The growing production of grains, cereals, and oilseeds demands intense harvesting techniques to optimize output and decrease waste, which in turn led to the necessity for sophisticated agricultural equipment. According to estimates from the Indian Ministry of Agriculture and Farmers Welfare, the country produced about 288 million MT of grains (including rice, wheat, barley, millet, ragi, and others) by the end of the fiscal year 2022. India is the world's second-largest producer of rice and wheat. Consequently, the growing number of farming activities required to sustain the yield pushes farmers toward agricultural mechanization.

As a significant industry, agriculture necessitates ongoing modernization. A variety of agricultural equipment is required due to the diversity of farming, whether it be small-scale or large-scale. From simple tractors to complex combine harvesters, the industry needs a deep comprehension of the unique uses of each piece of machinery. Additionally, livestock husbandry has its own set of needs, including corral systems, gear for raising poultry, and feeding equipment. India's power availability per hectare has increased from 0.3 kW in 1970 to 2.54 kW, although the goal of 4 kW per hectare by 2030 has not been met. The direct correlation between yield and farm power availability underscores the need to increase farm power availability. In relation to the overall budget of the Government of India, the Department of Agriculture and Farmers Welfare's (DA&FW) share of the budget has steadily declined. Over the last four years, budgetary allotments for the Research and Development (R&D) to Farm Mechanization Scheme have steadily decreased, with a notable drop of almost 30% from 2019–20 to 2022–23. India's agricultural workforce is becoming smaller due to the country's rapid urbanization; statistics indicate that the proportion of workers in agriculture fell from 44% in 2017 to 41.4% in 2020. ((Mehta, C. R., 2020) One factor contributing to manpower shortages in agricultural operations is workers' preference for associated industries over farm-oriented ones. We predict a shortage of labor in the upcoming years, despite the continued rise in market demand for farm equipment. Sustainable growth requires tax and duty incentives to assist manufacturing facilities in low-mechanization areas. In 2022, the farmtech startup industry in India raised US$1.1 billion, a minor decrease from US$1.3 billion in 2021. Upstream agriculture technology, or the production side of the agri-supply chain, as well as climate-related agritech solutions and innovation, are expected to receive more financing in the upcoming years.

With a 6.1 percent compound annual growth rate (CAGR), the worldwide agriculture and farm equipment/machinery market is expected to reach USD 184.69 billion in 2024 after reaching USD 174.12 billion in 2023. Education, research, infrastructural development, agricultural modernization, crop science improvements, and the lack of manpower in rural areas are some of the reasons contributing to this expansion. Rising worldwide food demand, more automation and mechanization, smart farming solutions, sustainable agriculture programs, and precision agriculture are all anticipated trends that will make the industry more attractive to investors. Collaboration, labor efficiency and scarcity, customization, climate change adaptation, and the use of IoT sensors are key trends for the forecast period. India's fast-growing worldwide population impacts the country's agricultural and farm equipment industry. UN estimates predict that India's population will grow by two billion people over the next 30 years, reaching 9.7 billion by 2050. To meet the rising demand for food, farms must become more mechanized. The relationship between population expansion and rising food demand emphasizes how crucial agricultural machinery is to raising productivity and meeting demand for food. Additionally, we anticipate that an increase in the demand for organic food will drive the growth of the markets for farm equipment and agriculture. Precision farming, weed and pest control, soil health promotion, and agricultural machinery are all advantages of organic food, which is produced without the use of synthetic pesticides, fertilizers, genetically modified organisms, antibiotics, or other artificial additions. (Amoozad-Khalili, M. et al., 2020)

The Indian government is considering the suggested steps to improve the quality of farm mechanization. Some of these are testing different companies' equipment, attachments, and parts to make sure they meet BIS standards and specifications; making sure that the design of equipment, attachments, and parts is standardized at the Bureau of Indian Standards (BIS) level and that these standards are followed by manufacturers; and encouraging different companies to use standard parts that are available in stores in their manufacturing processes. Standard parts make production easier and improve component and attachment interchangeability. They also help manufacturers learn manufacturing techniques, with a particular emphasis on the use of jigs, fixtures, die-punches, templates, and other tooling aids. Enhancing component compatibility and matching as well as manufacturing process quality are the goals of this training.

EMERGING TRENDS IN FARM MECHANISATION:

Agricultural precision:

Numerous technological improvements have occurred and are now occurring in farm mechanization. The usage of drones, precision agriculture, agro-robotics, and artificial intelligence (AI) will help unlock the agricultural industry's potential globally as technological interventions increase throughout the sector. Depending on variables including soil, rainfall, and crop type, precision agriculture employs precise amounts of different agricultural inputs, such as water, fertilizer, insecticides, and herbicides. This is a cutting-edge method of farming that uses data analysis and technology to boost crop output and lower input costs. Due to its many advantages in agriculture, precision farming is becoming more and more popular. By 2030, its market is anticipated to reach USD 23.06 billion. (Ma, W. et al., 2018) As a result, numerous new

competitors are entering the market, bringing even more innovations to the table. In nations like India, where resources like land and water are scarce, precision agriculture is particularly crucial. In the early phases of precision agriculture's development, the global positioning system (GPS) technology was crucial. Farmers were able to precisely evaluate their entire field. Precision agriculture has progressed significantly in recent years, employing advanced, data-driven techniques to boost agricultural operations' overall effectiveness. GPS, the Internet of Things (IoT), remote sensing, automation and machine learning, data analysis, drones, and application control are some of the tools and technology used in precision agriculture. Farmers can use them to guarantee improved crop monitoring, yield estimation, disease forecasting, efficient input use, and minimal waste. (Paudel, G. P. et al., 2019)

Drones:

A drone is an autonomous robotic device that operates remotely. Farmers and other stakeholders have expressed a great deal of interest in the application of drone technology in agriculture. Furthermore, precision agriculture includes drone technology. Despite the growing use of drones in agriculture, some people are worried about how they may affect environmental standards and compliance. Nonetheless, most policymakers concur that its advantages in agriculture greatly exceed its disadvantages. The adoption rate of drone technology in agriculture varies globally. Adoption has significantly increased in wealthy nations in recent years. Experts estimate that 84% of US farmers use drones for one or more agricultural tasks. India is a major drone importer, accounting for 22% of all drones worldwide.

AI and agri-robotics:

Nowadays, the terms "artificial intelligence" and "robotics" are used in practically every industry. AI and robotics together have enormous potential to reduce the need for human intervention while resolving urgent and complicated agricultural problems. It has the potential to greatly alter agricultural mechanization and boost productivity. AI can simplify complex decisions related to plantation, weeding, irrigation, and harvesting. AI and robotics can automate many agricultural tasks, saving money, time, and human labor. AI is already assisting with data collection and refinement for precise planning and forecasting. Additionally, we anticipate its essential role in reducing the numerous risks associated with agricultural activities.

SUGGESTED STRATEGIES:

The tactical methods and actions required to advance India's agricultural mechanization are critical. Despite significant advancements over the years, farm mechanization in India has not yet reached its full potential. Therefore, it is crucial to develop a comprehensive strategy including several stakeholders to guarantee growth in the right direction in order to meet the ambitious goal of increasing farm power availability to 4 kW/ha by 2030. First and foremost, it is necessary to examine the diverse preferences of distinct farmer types with regard to farm equipment. Farm tools used for physically demanding tasks like clearing land and harvesting have already gained popularity among farmers of all stripes. While small and marginal farmers

prefer to rent such equipment, medium- and large-scale farmers typically prefer to purchase it. However, tasks that require more control and accuracy, such as weeding and transplanting, require greater mechanization. As a result, creating equipment that is appropriate for small and marginal farmers is crucial.

Interventions pertaining to agricultural operations:

Tractors are the most common type of farm machinery in India. Due to India's over-reliance on tractors, smaller, more reasonably priced farm equipment that is appropriate for small and medium-sized farms is not being developed. Estimates suggest that Indian farmers use their tractors for an average of 500–600 hours annually. Due to a scarcity of appropriate farm equipment for small plot sizes, it is also customary to use a tractor for at least 1,000 hours annually in order to fully utilize its potential. Power tillers initially showed some promise, but their low acceptance was caused by issues including manoeuvrability in rough terrain and operational constraints. Therefore, we urgently need to develop and promote appropriate machinery for small and marginal plot sizes. In eastern Indian states, particularly Bihar and Jharkhand, there is a significant rate of male family migration. We must develop women-friendly agricultural equipment to address the issue of heavy physical labor in households without males. The creation of compact, accurate machinery is necessary to eliminate the drudgery associated with agricultural chores. Policymakers have already taken important measures in this regard.

Interventions pertaining to finance and economics:

From INR 7.3 lakh crore in 2013–14 to INR 20.390 lakh crore in 2023–24, institutional credit to India's agriculture industry has grown rapidly in recent years. Nonetheless, short-term loans, which cover the cost of inputs like seeds and fertilizer, make up the majority of the credit flow to agriculture. As a result, expanding credit is crucial for buying farm equipment. We need to increase the sensitivity of formal financial institutions to this issue. For this reason, it may be possible to investigate the idea of adding a sub target, exclusively for the acquisition of agricultural machinery under the priority sector loan. With a total production of 9.45 lakh tractors in FY 22–23, India has emerged as one of the world's leading tractor producers. This isn't the case for other kinds of farm equipment, though. In 2020–21, non-tractor farm machinery imports totalled USD 226 million. Furthermore, China now imports 53% of non-tractor farm tools. The substantial subsidies offered by the Chinese government make it impossible for domestic producers to compete on price with China. (Zhou, X. et al., 2020) Furthermore, the after-sale support service for Chinese implements disproportionately impacts farmers, posing another significant obstacle. (Zhang, C. et al., 2015) To speed up the growth of holistic farm mechanization, it is important to do research and development on how to make non-tractor farm equipment in the United States (Benin, S., 2015).

Increasing institutional mechanism strength and leverage:

In order to guarantee the best possible use of farm equipment, it is crucial that different stakeholders get training and capacity building. Large-scale training and capacity-building initiatives can benefit greatly from the assistance of reputable organizations like FMTTI and KVK. We desperately need instruction on

the preventive maintenance of agricultural machinery, in addition to its operating aspects. A lack of preventive maintenance results in damage to most farm tools given to collective bodies. We anticipate that collective community-based organizations like FPOs and SHGs will play a crucial role in the advancement of agriculture. The necessary economy of scale in agriculture can be attained with the aid of these organizations. CBOs possess the ability to provide robust collective platforms, enabling the agricultural community to acquire collective farm equipment. Large upfront capital expenditures that would normally be necessary for the acquisition of farm equipment can be avoided by farmers through collective ownership. Additionally, it can assist CBOs in generating additional rental income. Additionally, fostering collective ownership is necessary to fortify the current CHCs platform. In order to promote institutional efficiency, private sector participation is equally crucial. Therefore, we should investigate the potential for public-private partnerships to assist small and marginal farmers.

Exploration of the new developments in mechanization:

The agricultural industry could undergo a change because of new developments like artificial intelligence, robotics, and precision farming. As a result, coordinated measures are needed to guarantee that these trends are adopted more widely in India. Plans such as the SMAM can include special allowances for the purchase of such machinery. In addition, authorities may want to consider implementing programs that focus on entrepreneurship development. These businesspeople can offer farmers rental services for sophisticated equipment.

CONCLUSION:

With over 156 million hectares of fertile land, India is a major agricultural power in the world. Arable land will soon become a valuable resource since it is essential to meeting the needs of the world's fast-growing population in terms of food security. India is now in a fantastic position to use this resource to further the growth of its agriculture industry as a whole. Only by paying considerable attention to raising agricultural yields and productivity can we realize the sector's potential. Raising the degree of farm mechanization will aid in modernizing Indian agriculture and make it possible for it to significantly contribute to meeting the demands of global food security. (Hormozi, A. A. et al., 2012) Furthermore, India can develop into a major exporter of food items by making the most of the world's greatest arable land. Achieving the goal of becoming a developed nation by 2047 can be facilitated by increased farm mechanization, which can also raise per capita income in rural areas. A multifaceted strategy is necessary to achieve the targeted degree of farm mechanization in the nation. Utilizing the full potential of farm mechanization is made possible by emerging technologies like drones and precision agriculture. In order to promote awareness and adoption of agricultural mechanization, measures aimed at expanding smaller farmers' access to emerging technology should be developed, all the while fostering a cooperative attitude.

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