



The Role of Mechanization in Agriculture and Its Potential for Job Creation and Skill Enhancement in Rural India

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Abstract

Growing at an average Compound Annual Growth Rate (CAGR) of 2.8%, Agriculture remains the backbone of the Indian economy, contributing approximately 14% to the Gross Domestic Product (GDP) and employing about 49.6% of the labor force. Despite its significance, the sector faces numerous challenges, including low productivity, labor shortages, and the predominance of small and fragmented landholdings. Mechanisation offers a viable solution to address these issues by enhancing efficiency, reducing labor dependency, and improving overall agricultural output. However, the adoption of mechanised farming in India has been relatively slow, with only 47% of agricultural activities mechanised as of August 2022, lagging behind countries like China (60%) and Brazil (75%). In rural India, where agriculture remains the primary livelihood for a significant portion of the population, mechanisation presents an opportunity for economic transformation. While concerns exist about job displacement, mechanisation has the potential to create employment opportunities through the development of new skill sets and industries. This paper explores the impact of mechanisation on agricultural productivity, its role in job creation, and the need for skill enhancement to facilitate the transition to a more modernized agricultural sector.

Key words: Mechanisation of Agriculture, Skill enhancement, Economic transformation

Introduction

Agriculture remains the backbone of the Indian economy, contributing approximately 14% to the Gross Domestic Product (GDP) and employing about 49.6% of the labor force. Despite its significance, the sector faces numerous challenges, including low productivity, labor shortages, and the predominance of small and fragmented landholdings. Mechanisation offers a viable solution to address these issues by enhancing efficiency, reducing labor dependency, and improving overall agricultural output. However, the adoption of mechanised farming in India has been relatively slow, with only 47% of agricultural activities mechanised as of August 2022, lagging behind countries like China (60%) and Brazil (75%)

Agricultural mechanization has emerged as a crucial driver of productivity, efficiency, and sustainability in India's agrarian economy. As the country moves toward modernization, the integration of advanced machinery and technology in farming practices is transforming traditional agriculture, reducing dependency on manual labour, and improving overall farm output. However, beyond its impact on productivity, mechanization has significant potential to create employment opportunities and enhance skill development in rural India.

With increasing rural-to-urban migration and a declining agricultural workforce, mechanization presents a viable solution to labour shortages while also generating new job prospects. The adoption of farm machinery, precision agriculture, and automation leads to the demand for skilled operators, technicians, and maintenance professionals. This shift necessitates training and capacity-building initiatives, empowering rural youth with technical expertise and increasing their employability in the agricultural and allied sectors. Additionally, the

rise of Custom Hiring Centers (CHCs) and agri-tech startups offers entrepreneurial avenues for rural populations, fostering self-employment and economic growth. Mechanization also promotes gender-inclusive employment, as women can engage in non-traditional roles such as machine operation and agribusiness management with proper training.

Despite its advantages, challenges such as high initial costs, lack of awareness, and limited access to training facilities hinder widespread mechanization adoption. Addressing these issues through targeted policies, government support, and private sector participation will maximize the potential of mechanization, ensuring both agricultural prosperity and rural employment growth. The integration of mechanization with skill development initiatives holds the key to a more resilient and self-sufficient rural economy in India.

Objectives of the Study

1. To assess the present status of agricultural mechanisation in India.
2. To study the potential of agricultural mechanisation for job creation in rural India.
3. To study the potential of agricultural mechanisation in skill enhancement in rural India.

Data Sources

The study is mainly based on secondary data from various sources that include

1. The National Sample Survey Office's (NSSO) Periodic Labour Force Survey (PLFS) for the years 2022-2023
2. Population Census (2011)
3. National Institution for Transforming India (NITI) Aayog Discussion Paper (1/2022)
4. Livestock Census (2019) published by the GoI.
5. Standing Committee Report Summary- Farm Mechanisation for Small and Marginal Farmers (2023)
6. Reports from organizations such as the Food and Agriculture Organization (FAO) and the World Bank on agricultural mechanization

The need for mechanization in Indian agriculture

In 2017, the number of people employed in agriculture were 145.66 million which dropped down to 143.4 million during the pandemic. The rural to urban migration trend has been observed in all parts of the country which led to the situations like labour shortage in agriculture. With growing migration, labour shortages have been felt during peak season of agriculture relative to the lean seasons. With growing demand of labour in non-agricultural sector due to urbanization and increasing infrastructural capabilities, labour wages have been rising. All of the trends highlighted above have been pivotal in incentivizing farmers to shift towards mechanization of agriculture operations. The shift towards mechanization in agriculture has contributed to an increase in the area cultivated with crops, the timely execution of agricultural tasks, and improved positive impacts on crop yields.

There is need of technologies to improve labour efficiency and reduce drudgery for labour intensive methods of production. The level of agriculture mechanization in India stands at 40% which is less when compared to China (59.5%), Brazil (75%) and U.S (95%). The above discussed shift of labour from agriculture to non-agriculture sectors for various reasons of better employment opportunities, higher wages, urbanization and some government sponsored schemes like MGNREGA is also impacting the farm power availability. The gap has to be filled with mechanization of agriculture to ensure sustained productivity of the sector.

Status of Agricultural Mechanisation in India

Over the past fifty years, India has achieved significant advancements in the mechanization of agriculture. The extent of farm machinery utilization is contingent upon the various power sources accessible for both tractive and stationary agricultural tasks. In the fiscal year 2021-22, the power contributions from agricultural labourers, draught animals, tractors, power tillers, diesel engines, and electric engines were recorded at 0.08, 0.07, 1.93, 0.02, 0.37, and 0.57 kW/ha, respectively (refer to Table-1). In contrast to 1971-72, when animate power constituted 69% of the total available farm power for agricultural activities, mechanical power surged to dominate with a 95% share of the total farm power availability of 3.04 kW/ha in 2021-22. Notably, the states of Punjab, Haryana, and Bihar exhibit higher levels of farm power availability compared to other regions, while the northeastern states of India report the lowest availability. In an effort to expand irrigation coverage, the power available per hectare for groundwater and surface water extraction has risen from 0.73 kW in 1993-94 to 1.43 kW in 2017-18. Furthermore, the proportion of electric pumps utilized for irrigation purposes increased to 76% by 2017-18. Over the last 17 years, the area dedicated to micro-irrigation has grown at a compound annual growth rate (CAGR) of 9.2%, reaching 13.78 million hectares by 2022. Specifically, sprinkler irrigation accounted for 7.1 million hectares, while drip irrigation covered 6.32 million hectares.

table 1: farm power availability from different sources in india

Year	Power, kW/ha						Total power, kW/ha
	Agric. workers	Draught animals	Tractors	Power tillers	Diesel engines	Electric motors	
1971-72	0.045	0.212	0.020	0.001	0.053	0.041	0.372
1975-76	0.048	0.209	0.040	0.001	0.078	0.056	0.432
1981-82	0.051	0.206	0.090	0.002	0.112	0.084	0.545
1985-86	0.057	0.204	0.140	0.002	0.139	0.111	0.653
1991-92	0.065	0.193	0.230	0.003	0.177	0.159	0.827
1995-96	0.071	0.182	0.320	0.004	0.203	0.196	0.976
2001-02	0.079	0.172	0.480	0.006	0.238	0.25	1.225
2005-06	0.087	0.155	0.700	0.009	0.273	0.311	1.535
2011-12	0.100	0.134	0.804	0.012	0.295	0.366	1.711
2015-16	0.076	0.111	1.265	0.018	0.330	0.541	2.341
2021-22	0.082*	0.075	1.932	0.020*	0.368*	0.568*	3.045

Source: Compiled from the Population Census (2011), National Institution for Transforming India (NITI) Aayog Discussion Paper (1/2022) and Livestock Census (2019) published by the GoI.

The degree of mechanisation in Indian agriculture exhibits considerable variation across different farming activities. As reported for the period of 2019-2020, the mechanisation rates for primary crop production were 70% for soil preparation and seedbed establishment, 38% for seeding and planting, 31% for plant protection, and 32% for harvesting and threshing. These statistics reveal a substantial potential for enhancing mechanisation, especially in the areas of seeding, planting, and harvesting. By August 2022, it was noted that 47% of agricultural operations in India had been mechanised. Among the crops, wheat, rice, and maize demonstrated the highest levels of mechanisation, with rates of 69%, 53%, and 46%, respectively. This was followed by pulses at 41%, oilseeds at 39%, cotton at 36%, sugarcane at 35%, and both sorghum and millets at 33% (refer to Table-2). Additionally, small and marginal farms, defined as those less than two hectares, represent 86% of total operational holdings. The Committee on Farm Mechanisation for Small and Marginal Farmers (2023) emphasized that without the availability of machinery suited for small holdings or significant consolidation of farmland, small farmers will struggle to acquire their own equipment. The Committee also projected that it would take approximately 25 years for India to reach a mechanisation level of 75-80%. It underscored the urgent necessity for enabling farmers to diversify their crop production, thereby enhancing the attractiveness and profitability of agriculture. While acknowledging various initiatives such as the Sub-Mission on Agricultural Mechanisation, the Committee urged the government to prioritize the mechanisation of small farms and set a target of achieving 75% mechanisation within a 25-year timeframe.

table 2: mechanisation levels for major crops in india during 2022-23

Crop	Seed-bed preparation	Sowing/planting/Transplanting	Weeding and interculture	Harvesting and threshing	Crop wise average
Rice	80	35	35	60	53
Wheat	85	65	50	75	69
Maize	70	45	40	30	46
Sorghum and millets	60	30	20	20	33
Pulses	65	40	25	35	41
Oil seeds	65	40	20	30	39
Cotton	70	40	35	0	36
Sugar Cane	65	25	30	20	35
Operation wise average	70	40	30	34	47

Source: Standing Committee Report Summary- Farm Mechanisation for Small and Marginal Farmers (2023)

Role of Mechanization in Agricultural Development and Economic Upliftment of Farming Community

Mechanization allows for timely farm operations, reducing crop losses and enhancing productivity. With increasing urban migration and a declining rural workforce, mechanization provides an alternative to manual labour, ensuring farm activities are completed on time and efficiently. Advanced machinery facilitates better land preparation, proper seed placement, and precise irrigation, leading to improved soil fertility and conservation. Modern technologies, such as precision farming, drones, and AI-driven equipment, enable better decision-making, reduced wastage, and enhanced resource management, making farming more sustainable.

Several studies have been attempted in different parts of India by various organizations and individuals to assess the role of farm mechanization in agricultural development. The impact has been assessed in terms of agricultural inputs (seed, fertilizer, farm labour, fuel etc.), agricultural production and productivity, cropping intensity, employment generation etc. As a result of agricultural mechanization, various power sources, and improved farm tools and equipment are utilized to reduce the work of humans and draught animals to increase cropping intensity, precision and timelines of utilization of various inputs, and to reduce losses at different stages of crop production. Ultimately, farm mechanization should improve production and productivity while reducing cost. The seedbed preparation, seed and fertilizer placement, weed control, intercultural operation, harvesting and threshing operations are performed on time due to the farm mechanization which increases the quality of operation. According to household survey under SMAM, 1.9-20.8% reduction in seed rate, 11.2-21.1% reduction in fertilizer, 23.7-40.1% reduction in labour cost and 20.4-39.7% reduction in time of operation were reported due to use of improved farm machinery. These all factors contributed to increase of crop yield by 14.2-25.7% with reduced post-harvest losses (Anonymous, 2020b). Along with reduction in inputs, the use of power weeder, cono-weeder, garden tillers and other improved tools has impacted in reduction of weeds in the range of 20.9 - 45% and resulted into higher yield. However, the use of multi-crop planters or improved seed drills improved seed germination rate in the range of 7.7-32.3%. Hence, the crop yield has been enhanced with reduction in seed rate.

Cropping intensity was dependent on the available farm power and water availability. It increased by 156 and 165% for tractor using and tractor owning farms, respectively (Ramya et al., 2016). Furthermore, the facilities of canals, tube well irrigation and micro-irrigation increased the percent gross cropped area as well as the crop productivity (Prajapat et al., 2022). Thus, the states like Punjab, Haryana, Uttar Pradesh having high power availability and higher irrigated area also had higher grain yield per hectare.

Agricultural mechanization also significantly helped the farming community in the overall economic upliftment. The gross income per hectare was reported to be about 63% higher for tractor owning farms as compared to bullock farms (Ramya et al., 2016). Furthermore, farm mechanization increased agricultural productivity and profitability on account of timeliness of operations, better quality of work and more efficient utilization of crop inputs. Undoubtedly, farm mechanization displaced animate power from 60 to 95% and resulted in reducing time requirement for quality farm work.

Agricultural Mechanisation and its Potential for Job Creation in Rural India

Agricultural mechanization has significantly augmented the overall demand for human labor, driven by the adoption of multiple cropping practices, intensified cultivation efforts, and increased production levels. Furthermore, the agricultural sector is experiencing a notable rise in diverse employment opportunities, particularly in domains such as agri-warehousing, innovative agricultural technologies, and agri-financing. In the realm of agri-warehousing, there is an escalating need for positions including warehouse managers, quality control inspectors, inventory managers, and logistics coordinators, all of whom play crucial roles in ensuring the secure storage and efficient distribution of agricultural products. The emergence of new agricultural technologies has led to a growing requirement for professionals such as precision farming specialists, drone operators, IoT device technicians, data analysts, and agritech product developers, all of whom are essential for fostering innovation and enhancing farm productivity. In the agri-financing sector, roles such as credit analysts, rural loan officers, financial advisors, and customer relationship managers are vital for facilitating improved access to credit and financial services for farmers and rural enterprises, thereby making a substantial contribution to rural employment. Research has also indicated that mechanization has heightened the demand for hired labor; for instance, Rajkhowa et al. (2021) found that a unit increase in farm mechanization correlates with a 12% rise in the demand for hired labor. Additionally, farm mechanization positively influences women's participation in agricultural work.

Mechanization has significantly improved cropping intensity and productivity, resulting in a heightened need for skilled labour to operate and maintain agricultural machinery. The National Sample Survey Office's (NSSO) Periodic Labour Force Survey (PLFS) for the years 2022-2023 indicates that 45.76% of India's workforce is engaged in agriculture and related fields. Although this figure represents a minor decline from

the previous year, it is still above the 42.5% recorded in 2018-2019. Employment in agriculture remains a crucial source of livelihood in India. Furthermore, the agricultural machinery market in India is anticipated to expand from ₹9,200 crore in the financial year 2022 to ₹15,000 crore by 2026. This growth is expected to create job opportunities in the manufacturing, sales, and service sectors associated with agricultural equipment.

Furthermore, mechanization in agriculture significantly impacts employment across three main stages: **pre-farm, on-farm, and post-farm**. Here's how mechanization creates opportunities in each stage:

1. Pre-Farm Employment Opportunities: These are jobs created before actual farming takes place, mainly in the production, supply, and maintenance of agricultural machinery.

- Manufacturing of machinery & equipment – Engineers, technicians, and factory workers involved in producing tractors, ploughs, seed drills, harvesters, etc.
- Sales & distribution – Retailers, wholesalers, and agents selling farm machinery.
- Training & extension services – Agricultural engineers, trainers, and consultants teaching farmers how to use and maintain machinery.
- Research & development – Scientists and engineers innovating new agricultural technologies.
- Finance & insurance services – Professionals in banks and insurance companies providing loans and coverage for farm machinery.
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2. On-Farm Employment Opportunities: These are jobs directly related to farm operations where mechanization is applied.

- Machine operators – Trained personnel to operate tractors, combine harvesters, and irrigation systems.
- Mechanics & technicians – Workers specializing in repairing and maintaining agricultural machines.
- Precision agriculture specialists – Experts using technology (GPS, drones, AI) to optimize farming.
- Irrigation system managers – Specialists handling modern irrigation technologies.
- Farm supervisors & skilled labour – Managing mechanized farm processes like planting, spraying, and harvesting.

3. Post-Farm Employment Opportunities: These are jobs created after harvesting, primarily in processing, transportation, and marketing.

- Agro-processing industries – Jobs in food processing, milling, packaging, and preservation.
- Logistics & transportation – Truck drivers, logistics managers, and warehouse workers handling mechanized transport of goods.
- Cold storage & preservation – Workers managing refrigeration systems to reduce post-harvest losses.
- Agri-business & marketing – Entrepreneurs and marketers selling processed agricultural products.
- Export & trade specialists – Experts facilitating mechanized agriculture's entry into international markets.

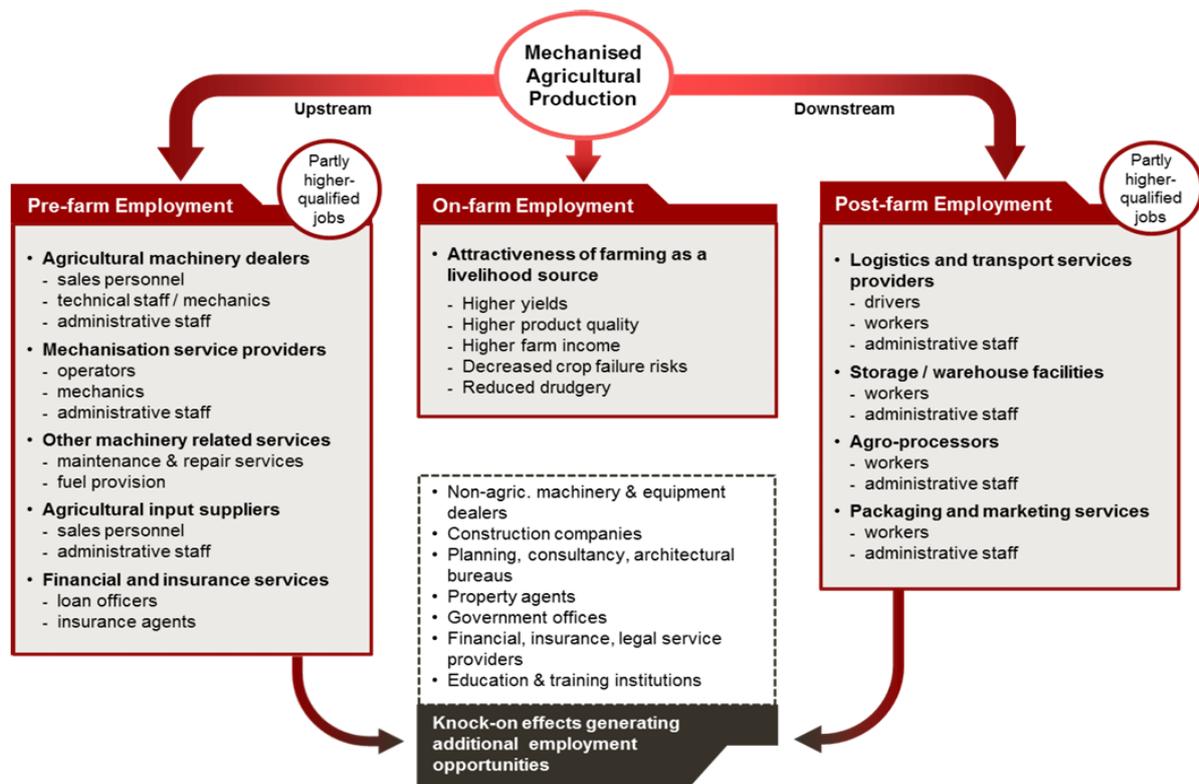


figure:1 employment opportunity through mechanisation of agriculture

Agricultural Mechanisation and its Potential for Skill Enhancement in Rural India

Mechanization is playing a crucial role in enhancing skills among rural workers in India, transforming traditional agricultural practices and improving employment opportunities. With the increasing adoption of tractors, harvesters, seed drills, and precision farming technologies, farmers and agricultural labourers are required to develop new technical skills. Operating and maintaining modern machinery necessitates specialized training, which is being provided by government initiatives, agricultural universities, and private training centers. Programs such as the Skill India Mission and Krishi Vigyan Kendras (KVKs) are actively educating rural youth on machinery handling, repair, and digital tools in farming. The Indian government, through initiatives like the Sub-Mission on Agricultural Mechanization (SMAM), has been focusing on skill development by conducting training programs and workshops aimed at enhancing the capabilities of farmers and rural youth.

The rise of precision agriculture has further boosted the need for digital skills. Farmers are now using GPS, drones, and AI-driven applications for tasks such as soil analysis, pest control, and yield prediction. This shift is fostering digital literacy, helping farmers make informed decisions, optimize resource use, and increase productivity. Additionally, mechanization is promoting entrepreneurial skills in rural India. Many farmers are becoming agripreneurs by offering custom hiring services, where they rent out agricultural machinery to small farmers who cannot afford to purchase equipment. This business model is creating new job opportunities in machinery operation, repair services, and agro-logistics.

Moreover, mechanization is facilitating the transition of rural workers from low-skilled manual labour to better-paying jobs in agro-processing, supply chain management, and industrial sectors. While it reduces the need for unskilled labour in traditional farming, it encourages workforce mobility by equipping individuals with technical and managerial skills. As a result, rural youth are not only improving their earning potential but also contributing to the modernization of India's agricultural sector. With continuous investment in mechanization and skill development, rural India is witnessing a transformation that fosters economic growth and self-reliance.

Conclusion

Mechanization in agriculture is a transformative force in rural India, driving productivity, job creation, and skill enhancement. While it reduces the reliance on traditional manual labour, it creates new employment opportunities in machinery operation, maintenance, agro-processing, and agribusiness. The shift towards mechanized farming has led to the emergence of skilled jobs, particularly in precision agriculture, digital farming, and custom hiring services, enabling rural workers to transition to higher-paying roles.

Moreover, mechanization fosters entrepreneurial growth, as many farmers are now renting out farm equipment and providing mechanization-based services. Government initiatives like Skill India Mission and

Krishi Vigyan Kendras (KVKs) are actively supporting rural workers in acquiring the technical expertise needed for modern agriculture. Additionally, the integration of AI, GPS, and drones into farming is enhancing digital literacy, making rural youth more competitive in the evolving job market.

Despite these benefits, challenges such as high initial costs, unequal access to machinery, and displacement of unskilled labour must be addressed through inclusive policies and training programs. With the right investments in skill development and mechanization infrastructure, rural India can achieve sustainable agricultural growth, increased employment opportunities, and a more skilled workforce, ensuring long-term economic prosperity.

References

- [1].C. R. Mehta (2024), Farm Mechanization in India: Status and Way Forward, Agricultural Mechanisation in Asia, Africa and Latin America, VOL.54, NO.2, SPRING 2023
- [2].Chand, R. and J. Singh. 2022. Workforce Changes and Employment: some findings from PLFS Data Series. NITI Aayog Discussion Paper 1/2022, NITI Aayog, Government of India.
- [3].Mehta, C. & Bangale, Rashmi & Chandel, Narendra & Kumar, Mohit. (2024). Farm Mechanization in India: Status and Way Forward. 54. 75-88.
- [4].SK. Gousiya and k. Suseela (2024), Impact of farm Mechanization on Income and Employment and Constraints in Mechanisation of Rice Cultivation in West Godavari District.
- [5].Ms. Svenja kirsch, Junior Advisor, AMPT (2021), Impact of farm mechanization on income and employment and constraints in mechanisation of rice cultivation in west Godavari district.
- [6].Mehta, C. R., N. S. Chandel and T. Senthilkumar. 2014. Status, challenges and strategies for farm mechanization in India. Agricultural Mechanization in Asia Africa and Latin America. 45(4): 43 50.
- [7].<https://www.giz.de/en/downloads/giz2019-EN-Agricultural-Mechanisation-Rural-Employment.pdf>
- [8].<https://blog.kisansabha.in/index.php/2024/02/21/farm-mechanization-in-indias-agriculture-sector-challenges-and-opportunities/>
- [9].<https://prsindia.org/policy/report-summaries/farm-mechanisation-for-small-and-marginal-farmers>

