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Status of Farm Mechanization in India: An Analytical Study

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Abstract: *Farm mechanization has become an important indicator of agricultural modernization in India because it directly affects the timeliness of farm operations, labour efficiency, productivity, and cost reduction. This paper examines the status of farm mechanization in India using secondary data from government reports, policy documents, and published institutional sources. The study highlights that although India has made notable progress in mechanizing agriculture, the overall level of mechanization remains only about 40–45%, which is still much lower than that of highly mechanized agricultural economies. The paper also reviews the steady increase in farm power availability, a major indicator of mechanization, which government sources link with higher productivity and improved efficiency in agricultural operations. Official policy documents have emphasized raising farm power availability further to support future food demand and sustainable agricultural growth. The abstract further points out that the progress of mechanization in India is uneven across states, farm sizes, and crop types. Large and agriculturally advanced states have adopted machinery faster, while small and marginal farmers continue to face barriers such as small landholdings, high machinery costs, limited access to credit, and inadequate repair and rental infrastructure. Government initiatives such as the Sub-Mission on Agricultural Mechanization (SMAM) and the promotion of Custom Hiring Centres aim to reduce these barriers and make mechanization more inclusive. Based on secondary evidence, this paper argues that the future of farm mechanization in India lies not only in increasing machine use, but in ensuring equitable access, region-specific adoption, and support systems that benefit smallholders. The paper combines data tables, graphs, and visual analysis to present a clear picture of India's mechanization progress, challenges, and policy direction.*

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Introduction

Agriculture continues to occupy a central place in the Indian economy because it supports livelihoods, food security, and rural employment on a very large scale. At the same time, Indian agriculture faces persistent structural challenges such as small and fragmented landholdings, seasonal labour shortages, rising cultivation costs, and the growing need to improve productivity with limited natural resources. In this context, farm mechanization has emerged as an important pathway for improving the efficiency, timeliness, and profitability of agricultural operations. The Department of Agriculture & Farmers Welfare notes that mechanization contributes to higher productivity by enabling timely operations and greater precision in input application.

Farm mechanization refers to the use of tools, implements, and machines in agricultural production and post-harvest activities in order to reduce human drudgery, save time, increase operational efficiency, and improve output. It includes a wide range of interventions, from simple manually operated tools to tractors, power tillers, seed drills, harvesters, threshers, sprayers, and precision-enabled machinery. In India, mechanization is not merely a technological issue; it is also a developmental concern because it intersects with questions of rural labour, equity, smallholder viability, and sustainable agricultural growth. The official mechanization overview of the Government of India states that while farm machinery use has increased steadily, India's overall mechanization level remains only 40–45%, compared with over 90% in industrialized economies. This shows both progress and a significant gap that still remains to be addressed.

The relevance of this topic becomes even stronger when viewed against the landholding pattern in India. According to a Ministry of Agriculture & Farmers Welfare PIB release citing the Agriculture Census 2015–16, small and marginal operational holders constitute about 86% of total operational holders in the country. (Press Information Bureau) This structure has serious implications for mechanization because ownership of expensive farm machinery is often uneconomic for farmers with very small plots. The Department of Agriculture & Farmers Welfare also notes that about 84% of holdings are below 1 hectare, making individual ownership of machinery both financially difficult and operationally inefficient. As a result, the challenge in India is not simply to increase the number of machines, but to make mechanization inclusive, affordable, and suitable for smallholders.

A key indicator widely used to assess the status of farm mechanization is farm power availability, measured in kilowatts per hectare (kW/ha). This indicator reflects the amount of mechanical and other power available per unit of cultivated land and serves as a proxy for mechanization intensity. Government data show that average farm power availability in India increased from 0.48 kW/ha in 1975–76 to 1.84 kW/ha in 2013–14 and further to 2.49 kW/ha in 2018–19. The same official source states that this must rise to 4.0 kW/ha by 2030 to meet the growing demand for food grains. (Agri Welfare) This long-term increase indicates steady advancement, but it also suggests that the present level is still insufficient for the scale and intensity of future agricultural requirements.

The push toward mechanization in India is being driven by several interconnected factors. These include labour migration from rural to urban areas, shortages of agricultural labour during peak seasons, the need to reduce turnaround time between crops, expansion of commercial agriculture, and increasing access to credit and agri-machinery markets. The government's mechanization overview also highlights the growing role of agri-startups and the farming-as-a-service (FaaS) model, which is beginning to reshape access to machinery through rental and service-based platforms. This is especially relevant in a country where many farmers cannot purchase high-cost machinery outright but can benefit from hiring it when required.

From a policy perspective, India has increasingly recognized that mechanization must be promoted in a targeted and inclusive manner. The Department of Agriculture & Farmers Welfare identifies Custom Hiring Centres (CHCs) as one of the best alternatives for improving access to machinery for small and marginal farmers. These centres, operated by cooperatives, self-help groups, and rural entrepreneurs, allow farmers to rent machinery on demand instead of owning it individually. A recent NITI Aayog sectoral report also emphasizes that CHCs can expand access to clean mechanization for smallholders while improving productivity and energy efficiency. Thus, the discussion on mechanization in India has shifted from a narrow focus on machine ownership to a broader focus on access models, efficiency, and sustainability.

At the same time, the status of mechanization in India remains highly uneven across states, crops, and farming systems. Agriculturally advanced states with better irrigation, stronger market linkages, and larger average farm sizes have generally adopted mechanization faster, while resource-constrained regions continue to lag behind. This creates regional disparities in productivity, labour dependence, and cost efficiency. Therefore, any serious assessment of farm mechanization in India must go beyond national averages and examine both the progress made and the inequalities that persist.

This paper, therefore, seeks to examine the present status of farm mechanization in India using secondary data from official government sources and institutional reports. It focuses on major indicators such as mechanization level, farm power availability, structural constraints related to landholding size, and policy mechanisms aimed at improving access. By combining narrative analysis with tables, graphs,

and visual presentation, the paper aims to provide a clear and evidence-based understanding of how far India has progressed in mechanizing agriculture and what barriers still need to be addressed for balanced and sustainable growth.

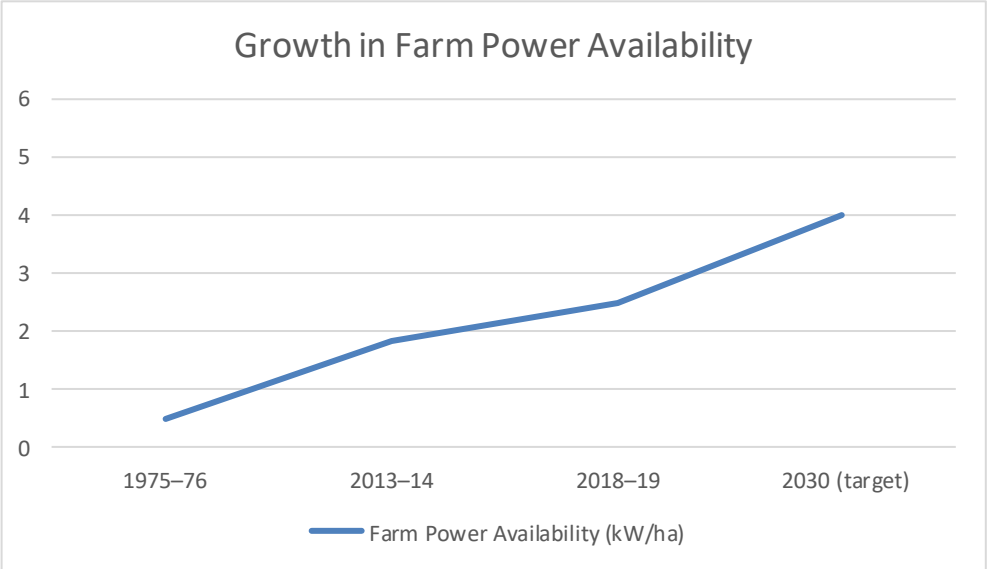

Figure 1: Growth in Farm Power Availability in India (kW/ha)

Source: Department of Agriculture & Farmers Welfare, Government of India

Review of Literature

The literature on farm mechanization in India consistently treats mechanization as a major driver of agricultural productivity, labour efficiency, and cost reduction. Early and policy-oriented studies have shown that mechanization improves the timeliness of farm operations and supports higher cropping intensity, especially in regions with irrigation and commercialized agriculture. A key official committee report on Doubling Farmers' Income notes that the average farm power availability in India increased from 0.30 kW/ha in 1960–61 to about 2.02 kW/ha in 2016–17, and it places the penetration of powered machines in farm activities in the 40–45% range. This establishes that mechanization has advanced substantially over time, but is still incomplete and uneven.

Figure 2: Major Themes in the Literature on Farm Mechanization in India

Source: Curated by the author

A major theme in the literature is the link between mechanization and productivity. The Government of India's mechanization documents argue that higher farm power availability is necessary for optimum farm productivity and explicitly state that farm power should rise to at least 4 kW/ha by 2030. This policy view is supported by broader agricultural planning literature, which sees mechanization as essential for meeting future food demand, reducing turnaround time between crops, and improving operational precision. Thus, most studies do not treat mechanization as an isolated technology variable; rather, they position it as a productivity-enabling component within the larger modernization of agriculture.

Another widely discussed finding is that mechanization in India is constrained by the dominance of small and marginal farms. The literature repeatedly emphasizes that the high capital cost of machinery makes individual ownership difficult for smallholders. An ICAR-linked article in Indian Farming notes that substantial investment in machinery is "neither essential nor feasible" for many small and marginal farmers and therefore identifies custom hiring as a practical institutional solution. Similarly, a more recent study on farmers' perceptions of custom hiring services points out that mechanization remains beyond the reach of many small and marginal farmers because of poor resource capacity, despite its usefulness and necessity. This strand of literature is highly relevant in the Indian context, where fragmented holdings reduce the economic viability of machine ownership and often require shared-access models.

A fourth major theme is the rise of Custom Hiring Centres (CHCs) as the most important inclusive mechanism for expanding mechanization. Government policy papers and NITI Aayog documents consistently identify CHCs and machinery banks as core mechanisms under the Sub-Mission on Agricultural Mechanization (SMAM). The Strategy for New India @ 75 specifically cites the success of the Madhya Pradesh CHC model and recommends replication across the country through rural entrepreneurship. Recent NITI Aayog analysis further strengthens this argument by linking CHCs not only to improved access for smallholders but also to productivity and energy-efficiency gains. Taken together, the literature suggests that India's farm mechanization strategy is gradually shifting from ownership-based expansion to service-based and access-based expansion.

The literature also highlights regional and crop-specific disparities in mechanization. Secondary-data studies on mechanization index and crop-level variation show that mechanization is much higher in crops such as wheat and in agriculturally advanced states such as Punjab, while other crops and regions remain less mechanized. One study cited through FAO's AGRIS database reports that the crop-wise mechanization index ranged from 8.22% in sorghum and paddy to 30% in wheat in the period studied, and it found lower cost of cultivation per quintal in more mechanized wheat-producing states. Another study on spatial and crop-specific diversity found wheat with a national mechanization index of 40.77%, with much higher levels in Punjab, again demonstrating strong inter-state variation. (Agris) These findings support the view that national averages can hide important disparities in mechanization by crop, state, and production environment.

A related issue explored in the literature is the transition from animate to mechanical power. FAO-linked regional assessments indicate that the number of draught animals used in Indian agriculture has been declining sharply over the long term, while mechanical power is projected to continue increasing. This reflects a structural transformation in Indian agriculture, where machinery has gradually replaced part of the burden previously carried by animal and human labour. However, studies also caution that this transition is not uniform and is shaped by affordability, terrain, crop pattern, and access to infrastructure. (Open Knowledge FAO) In other words, mechanization is advancing, but the pace and form of advancement depend heavily on local conditions.

Recent literature has also started to connect farm mechanization with entrepreneurship, rural service models, and sustainability. Newer policy discussions refer to "farming-as-a-service" and technology-enabled machinery access systems, where farmers can rent machinery instead of owning it. (NITI Aayog) This represents an important conceptual shift in the literature. Earlier studies focused mainly on machine adoption and farm power growth, while current discussions increasingly stress decentralized access, clean mechanization, climate-compatible productivity, and rural enterprise development. This is especially important for India, where future growth in mechanization is likely to come not only from more tractors and harvesters, but from stronger last-mile service ecosystems.

Overall, the literature reviewed suggests five broad conclusions. First, mechanization has a positive association with productivity and operational efficiency. Second, India has made progress but

remains only partially mechanized. Third, the smallholder structure of Indian agriculture is the central constraint to widespread ownership-led mechanization. Fourth, CHCs and machinery banks are the most frequently recommended inclusive solution. Fifth, mechanization remains highly uneven across states, crops, and farming systems. These conclusions directly justify the present study, which uses secondary data to assess the current status of farm mechanization in India with attention to growth, disparity, and policy support.

Objectives and Research Methodology

- **Objectives of the Study**

The present paper is designed to examine the status of farm mechanization in India through a structured analysis of secondary data. The specific objectives are:

- To examine the concept and importance of farm mechanization in the Indian agricultural context.
- To assess the current level and major indicators of farm mechanization in India, particularly farm power availability and overall mechanization level.
- To identify the major constraints affecting mechanization, especially in the case of small and marginal farmers.
- To review the role of policy interventions such as the Sub-Mission on Agricultural Mechanization (SMAM) and Custom Hiring Centres (CHCs) in promoting inclusive mechanization.
- To analyze the broad trends, disparities, and future directions of farm mechanization in India using tables, graphs, and visual interpretation.

These objectives are aligned with current policy discussions that emphasize both mechanization growth and accessibility for smallholders.

- **Research Methodology**

This study is based entirely on secondary data. The descriptive and analytical discussion draws upon official reports, policy documents, and institutional publications related to agricultural mechanization in India. The major sources include:

- Department of Agriculture & Farmers Welfare, Government of India annual reports and mechanization division documents. (Agri Welfare)
- Report of the Committee on Doubling Farmers' Income. (Agri Welfare)
- NITI Aayog policy reports and agricultural sector insights. (NITI Aayog)
- ICAR-linked articles and institutional publications on custom hiring and farm machinery access. (Indian Council of Agricultural Research)
- FAO-linked and AGRIS-indexed literature for broader contextual and comparative evidence. (FAOHome)

The use of secondary data is suitable for this paper because the topic focuses on national status, policy trends, and macro-level indicators rather than primary field-level behavior.

- **Nature of the Study**

The study is descriptive and analytical in nature. It is descriptive because it presents the status, trends, and patterns of farm mechanization in India. It is analytical because it interprets these trends in relation to structural constraints such as farm size, affordability, and institutional access. Since the paper is intended to be around 5,000 words and based on secondary data, the approach is appropriate for synthesizing evidence from multiple credible sources into a coherent policy-oriented narrative. (Agri Welfare)

- **Variables and Indicators Used**

The main variables/indicators proposed for the analysis are:

- Overall level of mechanization (%)
- Farm power availability (kW/ha)
- Share of small and marginal farmers / operational holdings

- Access through Custom Hiring Centres / machinery banks
- State- or crop-level mechanization variation (where secondary data permit)

These indicators are commonly used in policy and academic discussions on farm mechanization.

- **Method of Data Analysis**

The secondary data will be analyzed using:

- Trend analysis for farm power availability over time
- Comparative analysis for mechanization levels across crops, states, or institutional models
- Simple percentage-based interpretation of mechanization and smallholder structure
- Graphical presentation through bar charts, line graphs, pie charts, and conceptual figures
- Tabular presentation for summarizing indicators, policies, and comparative patterns

This method is suitable because the paper aims to present the status of mechanization in a clear, visually supported, and reader-friendly manner rather than undertake advanced econometric modelling.

- **Scope of the Study**

The scope of the study is limited to the Indian agricultural sector and focuses on the present status and broad trends in farm mechanization. The paper does not attempt a district-level empirical survey or primary data collection. Instead, it examines national-level and selective comparative evidence to understand the extent of mechanization, key constraints, and current policy mechanisms. The time horizon used in the paper is long enough to show historical trend movement in farm power, but the emphasis remains on recent policy context and current status.

- **Limitations of the Study**

Like most secondary-data studies, this paper has certain limitations:

- It depends on the availability and consistency of published data from official and institutional sources.
- Different reports may use slightly different years or indicators for mechanization.
- The study provides a macro-level picture and may not fully capture local differences in machinery access or usage.
- Since no primary survey is conducted, farmer-level perceptions and recent ground realities are discussed only through existing literature.

Despite these limitations, secondary data remain highly useful for assessing broad national trends and policy direction in a topic like farm mechanization.

Table 1: Research Design at a Glance

Particulars	Description
Type of Study	Descriptive and analytical
Data Type	Secondary data
Major Sources	Govt. reports, NITI Aayog, ICAR, FAO, AGRIS
Area of Study	India
Key Indicators	Mechanization level, farm power, CHCs, smallholder structure
Tools of Analysis	Trend analysis, comparative analysis, graphs, tables

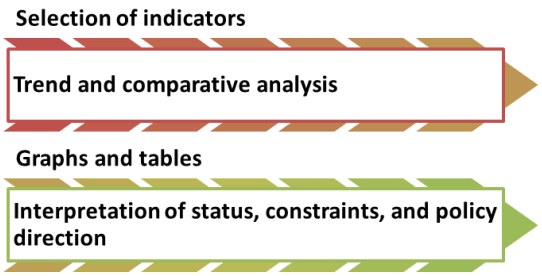

Figure 3: Methodological Flow of the Study

Source: Curated by the author

Status of Farm Mechanization in India

The status of farm mechanization in India can be understood through four core dimensions: the overall level of mechanization, growth in farm power availability, the structural pattern of farm holdings, and the expansion of institutional access mechanisms such as Custom Hiring Centres (CHCs). Taken together, these indicators show that India has made clear progress in mechanizing agriculture, but the pace and spread of this progress remain uneven. Official sources of the Department of Agriculture & Farmers Welfare state that India's overall farm mechanization level is still only 40–45%, whereas in industrialized economies it has exceeded 90%. This gap shows that India has moved forward, but still has substantial scope for further mechanization.

A central indicator used to assess mechanization status is farm power availability, measured in kilowatts per hectare (kW/ha). This reflects the amount of power available for agricultural operations per unit of cultivated land and is widely used as a proxy for mechanization intensity. Government reports show a steady rise in this indicator over time. The Committee on Doubling Farmers' Income reported that average farm power availability rose from 0.30 kW/ha in 1960–61 to about 2.02 kW/ha in 2016–17. More recent annual reports of the Ministry note that the level reached 2.49 kW/ha in 2018–19, and policy planning continues to emphasize raising this further to 4.0 kW/ha by 2030.

This long-term increase in farm power indicates that Indian agriculture is moving away from traditional dependence on human and animal labour toward greater reliance on mechanical power. The mechanization division of the Ministry explicitly links this increase with improved timeliness of operations and more precise input application, both of which are essential for raising productivity. At the same time, the present level of 2.49 kW/ha suggests that mechanization is still incomplete relative to India's future production requirements. In simple terms, India is no longer at an early stage of mechanization, but it has not yet reached the level needed for broad-based, high-efficiency agriculture.

Another important way to assess the status of mechanization is to examine it in relation to the structure of Indian agriculture. Mechanization in India is strongly shaped by the predominance of small and marginal farms. According to the Agriculture Census 2015–16, as cited by PIB, small and marginal operational holders account for about 86% of total operational holders in the country. A separate PIB release based on the NSS Situation Assessment Survey further noted that 89.4% of agricultural households own less than two hectares of land. This means that the majority of Indian farmers operate on land parcels that are often too small to make individual ownership of expensive machinery economically viable. (Press Information Bureau)

This smallholder structure has two direct implications for mechanization. First, it limits the spread of ownership-based mechanization, especially for high-cost equipment such as tractors, harvesters, and advanced implements. Second, it increases the importance of shared access models. Because most farmers cannot purchase machinery individually, mechanization in India increasingly depends on rental, cooperative, or service-based use. This explains why the status of farm mechanization cannot be judged only by counting machines; it must also be judged by how effectively farmers can access machinery when needed. (agriwelfare.gov.in)

In this context, Custom Hiring Centres (CHCs) have become a major indicator of inclusive mechanization. NITI Aayog's recent agriculture sector report notes that CHCs, along with the Sub-Mission on Agricultural Mechanisation (SMAM), are intended to improve access to farm machinery and enhance cultivation efficiency. The same report also highlights that over 85% of Indian farmers are small or marginal holders, which makes full-sized machinery expensive or logistically difficult for many of them. This gives CHCs a critical role in India's mechanization landscape, especially in regions dominated by fragmented holdings. (NITI Aayog)

The status of mechanization in India is therefore best described as progressive but unequal. On the one hand, the country has witnessed clear growth in machine use, rising farm power availability, and strong policy support. On the other hand, this progress is uneven across regions, farm sizes, and production systems. States with larger average holdings, better irrigation, and stronger agricultural commercialization generally display higher adoption of tractors, threshers, and harvesters, while poorer and more fragmented regions tend to depend more on manual labour and partial mechanization. Even where machines are available, their effective use depends on roads, fuel access, repair services, local availability of operators, and timely credit.

The government has responded to this challenge through targeted policy support. The mechanization division of the Ministry emphasizes subsidy support, access initiatives, and the strengthening of CHCs to improve machinery reach among small and marginal farmers. Policy thinking has also evolved beyond ownership: newer discussions increasingly mention "farming-as-a-service" models, where machinery is accessed as a service rather than purchased as an asset. This shift is significant because it reflects the actual structure of Indian agriculture. In a country dominated by smallholders, mechanization is becoming less about ownership and more about timely access, affordability, and suitability. (agriwelfare.gov.in)

A broader reading of the available evidence suggests that the present status of mechanization in India can be summarized in three ways. First, India has achieved meaningful progress in agricultural mechanization, particularly in terms of farm power growth. Second, the national average still remains moderate, indicating that large mechanization gaps continue. Third, the future of mechanization will depend on how effectively policy can bridge the gap between machine availability and machine accessibility for small farmers. In other words, India's mechanization journey is moving forward, but its real success will depend on whether mechanization becomes both wider and more inclusive.

Table 2: Key Indicators Showing the Status of Farm Mechanization in India

Indicator	Latest/Key Value	Interpretation
Overall mechanization level	40–45%	Moderate progress, still below advanced economies
Farm power availability (1960–61)	0.30 kW/ha	Low mechanization base
Farm power availability (2016–17)	2.02 kW/ha	Strong long-term improvement
Farm power availability (2018–19)	2.49 kW/ha	Current official benchmark used in recent reports
Farm power target (2030)	4.0 kW/ha	Indicates future mechanization need
Small & marginal operational holders	~86%	Mechanization must suit smallholders
Agricultural households below 2 ha	89.4%	Ownership-led mechanization is difficult for most farmers

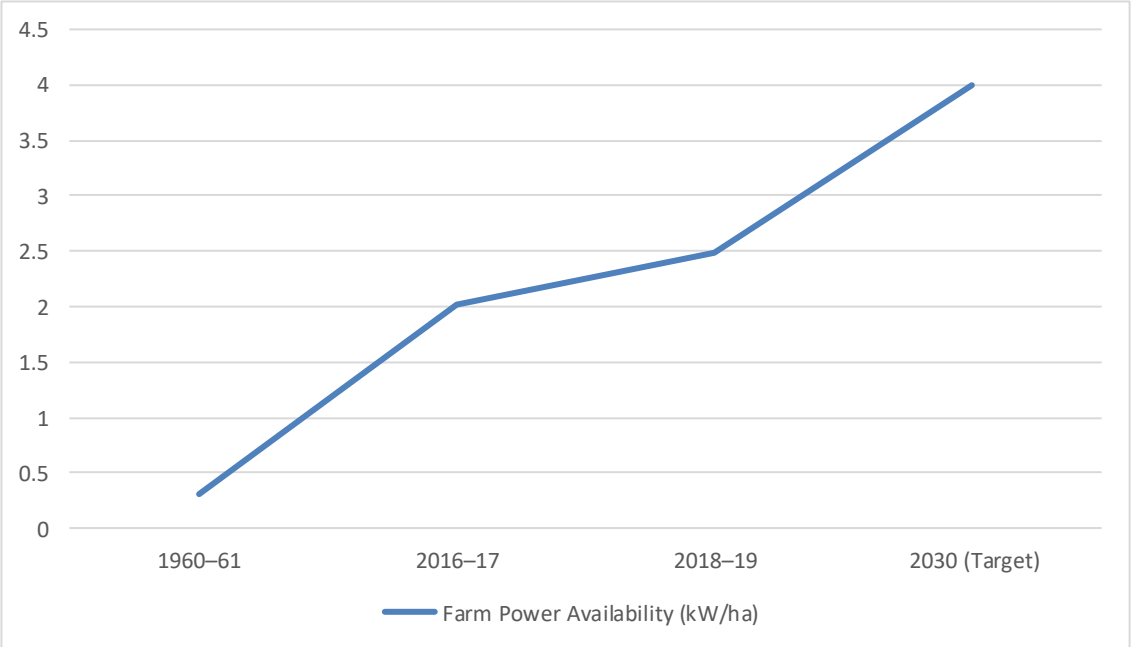

Figure 4: Trend in Farm Power Availability in India (kW/ha)
Source: Government of India and PIB. (agriwelfare.gov.in)

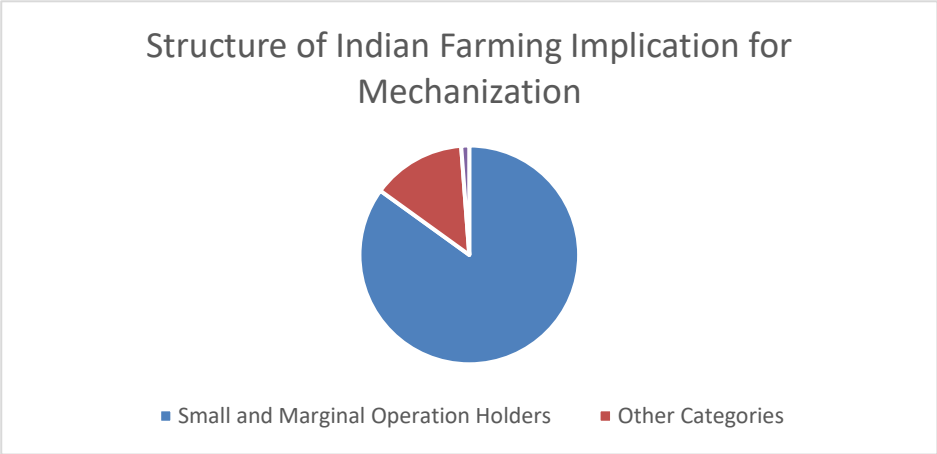

Figure 5: Structure of Indian Farming and Its Implication for Mechanization
Source: Press Information Bureau

Challenges in Farm Mechanization in India

Despite the steady growth of farm mechanization in India, several structural and operational barriers continue to limit its wider and more equitable adoption. The evidence from official reports and institutional analyses shows that the problem in India is not simply a shortage of machines; rather, it is a combination of small landholdings, high ownership costs, uneven regional development, limited custom hiring access, and data/infrastructure constraints. These challenges make mechanization progress uneven and prevent many farmers, especially small and marginal farmers, from fully benefiting from modern agricultural technologies.

The most fundamental challenge is the small and fragmented nature of landholdings. As discussed earlier, the majority of Indian farmers cultivate very small plots, which reduces the economic viability of owning large machinery. Official annual reports of the Department of Agriculture & Farmers Welfare explicitly identify small landholding and high cost of individual ownership as key issues in farm mechanization. When farms are fragmented into multiple small parcels, even if a farmer is willing to invest in machinery, the operational efficiency of such investment falls. Large machines may not be able to move easily across small or irregular fields, and the cost per unit of land cultivated becomes disproportionately high. This structural reality makes direct ownership difficult for most farmers and slows down the spread of ownership-led mechanization.

A second major challenge is the high capital cost of agricultural machinery. Farm equipment such as tractors, power tillers, seed drills, rotavators, threshers, and harvesters require substantial initial investment, which many small farmers cannot afford. Although subsidies exist under schemes such as the Sub-Mission on Agricultural Mechanization (SMAM), the upfront cost remains a barrier, especially for resource-poor farmers. The SMAM guidelines themselves recognize this and therefore include specific provisions for Farm Machinery Banks, Custom Hiring Centres, and financial assistance for mechanized operations. This policy design itself reflects the seriousness of the affordability problem. In addition to purchase cost, machinery also involves recurring expenses such as fuel, maintenance, repair, and operator charges, which further discourage ownership.

A third challenge is the uneven spread of mechanization across regions and farming systems. Mechanization is generally higher in agriculturally advanced and better-irrigated states, while many rainfed and less-developed regions remain under-mechanized. This disparity is linked with variations in income levels, cropping patterns, road access, irrigation, service networks, and local machine suitability. Government policy documents have repeatedly emphasized the need to promote mechanization in low-mechanized states and selected villages, which indicates that geographic inequality remains a major policy concern. Thus, even though national-level indicators show progress, the ground reality differs sharply from one region to another.

A fourth challenge is the limited reach and uneven quality of Custom Hiring Centres (CHCs) and machinery access systems. CHCs are widely recognized as a solution for small and marginal farmers,

but their availability and efficiency are not uniform across India. In some districts, CHCs are well established and functional, while in others they remain inadequate, poorly distributed, or limited in the range of machines available. NITI Aayog's recent agriculture sector insights note that CHCs aim to improve access and cultivation efficiency, especially for smallholders, but the continuing need for such support also suggests that access gaps remain significant. If farmers cannot access the right machine at the right time during sowing, transplantation, or harvesting windows, then the practical advantage of mechanization is reduced. Therefore, the issue is not only whether CHCs exist, but whether they are sufficiently available, affordable, and timely in-service delivery.

Another important challenge is the lack of location-specific and scale-appropriate machinery. Much of Indian agriculture is carried out on small, uneven, or scattered plots, and machinery designed for large, uniform fields may not always suit these conditions. This creates a mismatch between available machinery and local farming realities. NITI Aayog's demand–supply report highlights that while small farm implements may be needed at the household level, larger heavy-duty machines are better placed at custom hiring centres for shared access. (niti.gov.in) This indicates that mechanization in India must be adapted to farm size, terrain, and crop pattern rather than simply copied from large-farm systems. Where machinery is not suitable to field conditions, adoption naturally remains limited.

A sixth challenge is the inadequate repair, maintenance, and support infrastructure in many rural areas. Even when machinery is purchased or rented, farmers need access to spare parts, technical servicing, trained operators, and reliable fuel supply. Without such support systems, breakdowns can delay operations and increase cost. This is especially critical because many agricultural activities are highly time-sensitive; a delay of even a few days in sowing or harvesting can reduce yields or cause crop loss. Mechanization therefore depends not only on the machine itself, but on the broader ecosystem around it. While policy documents focus strongly on machinery promotion, implementation effectiveness often depends on this rural support infrastructure, which remains uneven in many areas.

Another challenge, often discussed less openly, is the lack of disaggregated and updated data on farm machinery use. NITI Aayog's working group report specifically points out the non-availability of disaggregated data for farm machinery as a concern that makes precise projections difficult. (niti.gov.in) This is an important methodological challenge because policy planning becomes weaker when state-wise, crop-wise, or machinery-wise data are incomplete or inconsistent. Better data are needed not only for research, but also for designing region-specific interventions, monitoring mechanization gaps, and assessing whether subsidy or CHC programs are truly reaching the intended beneficiaries.

A further issue is the social and institutional gap in awareness and adoption. Even where machinery is available, some farmers may lack adequate information about machine utility, subsidy procedures, maintenance requirements, or rental options. Mechanization adoption is therefore shaped not only by income, but also by extension support, local demonstration, and trust in the technology. This is one reason why mechanization promotion in selected villages and farmer outreach programs remain important in policy design. (agriwelfare.gov.in) Without proper awareness, even well-designed mechanization policies may remain underutilized.

Finally, farm mechanization in India must also confront the challenge of balancing productivity with sustainability and inclusiveness. FAO's broader work on mechanization warns that mechanization is indispensable for production, but if poorly managed it can also create environmental concerns such as soil degradation, inefficient energy use, and unsustainable cultivation practices. In the Indian context, this means that the future of mechanization should not be assessed only in terms of more machines, but also in terms of appropriate technology, resource efficiency, and access for smallholders. Mechanization that is costly, unsuitable, or ecologically mismanaged may not produce long-term agricultural benefits.

Overall, the challenges in farm mechanization in India can be summarized as a combination of structural constraints, affordability barriers, access limitations, infrastructure weaknesses, and planning gaps. These problems do not negate the importance of mechanization; rather, they show that India's mechanization strategy must be more adaptive and inclusive. The future success of farm mechanization in India will depend not only on increasing machine numbers, but on ensuring that machines are affordable, suitable, accessible, and supported by strong local service ecosystems.

Table 3: Major Challenges in Farm Mechanization in India

Challenge	Nature of the Problem	Impact on Mechanization
Small and fragmented landholdings	Majority of farmers operate very small plots	Reduces economic viability of machine ownership
High machinery cost	Expensive purchase, fuel, repair, and maintenance	Limits adoption by small and marginal farmers
Regional disparities	Low mechanization in less developed/rainfed regions	Creates uneven agricultural productivity
Limited CHC reach	Custom hiring services not equally available everywhere	Restricts timely access to machinery
Unsuitable machinery	Large machines often not fit for small/irregular plots	Lowers adoption in fragmented farms
Weak support infrastructure	Lack of repair, spare parts, and operators	Reduces reliability of machine use
Lack of disaggregated data	Incomplete state/crop-level machinery information	Weakens policy planning and targeting
Low awareness/extension gaps	Limited knowledge of benefits and subsidy procedures	Slows adoption and utilization

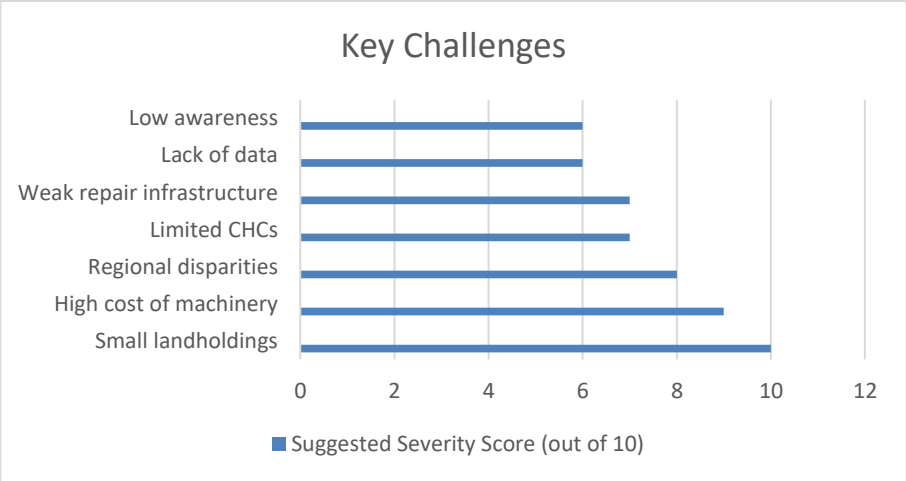

Figure 6: Key Challenges in Farm Mechanization in India

Source: Press Information Bureau

Government Initiatives and Policy Support

The Government of India has actively promoted farm mechanization through policy, subsidy, and access-based interventions, especially under the Sub-Mission on Agricultural Mechanization (SMAM). SMAM aims to improve access to modern farm equipment through training, testing, demonstrations, direct financial assistance for machinery purchase, and support for Custom Hiring Centres (CHCs) and Farm Machinery Banks. The official SMAM guidelines specifically include assistance for location- and crop-specific machinery, support for small and marginal farmers in low-mechanized regions, and the establishment of hi-tech equipment hubs for shared use. Recent annual reporting by the Department of Agriculture & Farmers Welfare also continues to treat agricultural mechanization as a key pillar of productivity enhancement and modernization.

Policy thinking has increasingly shifted from ownership-led mechanization toward access-led mechanization, which better suits India's smallholder-dominated farm structure. NITI Aayog's recent agriculture sector report highlights that leveraging CHCs can expand access to clean mechanization for smallholders while also improving productivity and efficiency. (NITI Aayog) In addition, policy reports emphasize training, testing institutions, and targeted support for under-mechanized areas, indicating that

mechanization is being treated not only as a technology issue but also as an inclusion and service-delivery issue. Overall, government initiatives show that India's mechanization policy is becoming broader, more decentralized, and better aligned with the realities of small and marginal farmers.

Conclusion

Farm mechanization in India has advanced significantly over the decades and now represents an essential component of agricultural modernization. Secondary evidence shows clear improvement in mechanization indicators such as farm power availability, along with strong policy commitment to expand machinery access and improve productivity. However, the overall level of mechanization in India remains moderate, and the benefits are distributed unevenly across regions and farm sizes. The dominance of small and marginal holdings, high machinery costs, uneven service access, and weak support infrastructure continue to limit wider adoption.

The analysis suggests that the future of farm mechanization in India will depend less on increasing ownership alone and more on strengthening inclusive access systems such as CHCs, machinery banks, and service-based models. For a country where most farmers operate on small and fragmented plots, timely access to suitable machinery is more practical than universal ownership. Therefore, sustainable progress in mechanization will require region-specific planning, affordable technology, stronger rural repair ecosystems, and better disaggregated data for policy targeting. In conclusion, India's mechanization journey is progressing, but its long-term success will depend on making mechanization not only more widespread, but also more affordable, accessible, and equitable.

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