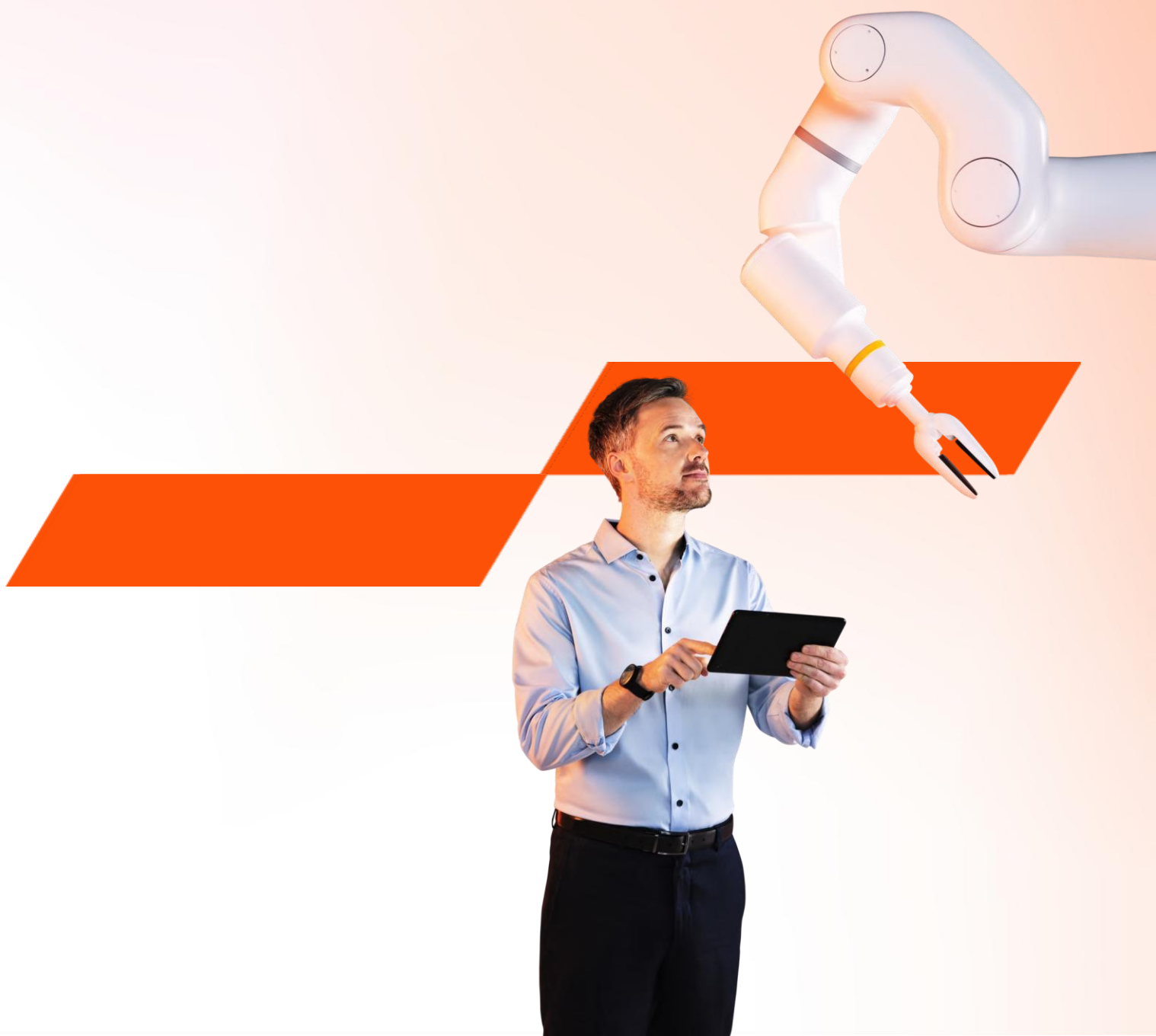


Farm mechanisation

The path towards a future-ready India





Message from Ministry of Agriculture & Farmers' Welfare

शिवराज सिंह चौहान
SHIVRAJ SINGH CHOUHAN

D.O. No. 1166 /AM



कृषि एवं किसान कल्याण और
ग्रामीण विकास मंत्री
भारत सरकार
कृषि भवन, नई दिल्ली
Minister of Agriculture & Farmers Welfare
and Rural Development
Government of India
Krishi Bhawan, New Delhi



MESSAGE

India is a country of small and marginal farmers, and our mechanisation journey must be shaped around their needs. The Government of India is committed to promoting technologies that are economically accessible, energy-efficient, climate-smart, and suited to diverse agro-ecological conditions. Through initiatives such as Custom Hiring Centres, digital rental platforms, FPO-led equipment services, precision mechanisation, and support for indigenous manufacturing, we are ensuring that every farmer—regardless of land size—can benefit from modern agricultural tools and practices.

As the country is moving towards achieving the goal of “Viksit Bharat” by the year 2047, it is important to have an inclusive and futuristic road map for agriculture sector. Farm machinery sector has to play a critical role in agricultural production, modernization of farms and increasing the incomes of smallholder farmers.

I am delighted that this Farm Machinery and Mechanisation Report, reflects India’s collective effort to modernise its agriculture, strengthen farmer livelihoods, and build a more resilient and sustainable food system. This report arrives at an important moment. Rising labour costs, climate variability, and the need for higher resource-use efficiency require a new generation of innovative machinery solutions, including drones, smart sprayers, residue management equipment, electric tractors, and sensors for precision agriculture.

Strengthened collaboration between research institutions, industry, startups, farmers’ organisations, and state governments will be vital to accelerate adoption and build a globally competitive mechanisation ecosystem. As we advance toward Atmanirbhar Bharat, I firmly believe that India can emerge not only as a highly mechanised agriculture economy but also as a global leader in the design and manufacture of affordable farm machinery.

I appreciate the efforts in drafting this knowledge paper and bringing the important recommendations related to Future Ready Farm Mechanization for a “Viksit Bharat”. Together, let us put our best efforts in taking the country toward achieving the goal of “Viksit Bharat” by 2047.


(Shivraj Singh Chouhan)

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Foreword



Jyoti Vij

Director General, FICCI

Agriculture remains the backbone of India's rural economy, sustaining livelihoods for nearly half of the population and ensuring national food and nutritional security. Although the sector's share in GDP is naturally evolving in line with India's economic growth, its strategic importance to national development and rural prosperity remains stronger than ever. As the nation advances toward its vision of Viksit Bharat@2047, strengthening agricultural productivity and resilience becomes central to achieving broader economic aspirations. India's ambition to become a \$30 trillion economy with a per capita GDP of \$18,072 by 2047 will require a decisive shift from a middle-income to a high-income economy—an evolution in which agricultural transformation, particularly through mechanisation, will play a critical role.

This report provides a clear and timely assessment of India's farm mechanisation landscape and outlines practical pathways to achieve our national targets for 2030 and 2047. It underscores the need for innovation-driven growth, strengthened public-private partnerships, and supportive policy frameworks that enable every farmer to benefit from mechanisation, regardless of scale.

FICCI remains committed to advancing dialogue, collaboration, and ecosystem development to accelerate India's agricultural transformation. I am confident that this report will serve as a valuable reference for policymakers, industry leaders, and the farming community as we collectively work towards a more productive, competitive, and future-ready agriculture sector.

Message from PwC



Shashi Kant Singh

Partner – Agriculture, Food, and Agribusiness

Today, we stand at a crucial juncture in the country's growth journey, and the agricultural and allied sector lies at the core. The sector not only feeds a huge population but also provides livelihood and employment opportunities to more than 46% of the country's workforce. Steady growth over the past decade has enabled poverty reduction in many states; however, large portions of the country are yet to harness the potential of agriculture.¹

As we work towards achieving 'Viksit Bharat' by 2047, a vibrant, deeply rooted agriculture ecosystem is a prerequisite. A strong agricultural ecosystem not only guarantees food and nutritional security for a population of more than 1.6 billion, but also ensures a surplus. This is a compelling factor for industrialisation of agriculture, demand generation, exports, and creation of large-scale livelihood opportunities.

While the sector remains the focal point defining the country's growth, a gradual systemic and structural shift is also under way. Emerging global issues and challenges related to climate change, sustainable agriculture practices, variable cropping patterns, and degradation of natural resources demand a long-term sustained response in order to nurture and strengthen the agriculture ecosystem.

In the current situation, the role of farm mechanisation has become pivotal. In the last five years, mechanisation in the country has been on a sustainable growth path, building up on favourable policy support and initiatives. But adoption, especially with small and marginal farmers, still poses a challenge. Currently, the average farm power availability in the country is around 3.126 kW/ha, which is slated to reach 4 kW/ha by 2030. Similarly, the country's farm mechanisation level in the country stands at around 47% level (as on 2024), with a target of achieving 75% mechanisation by 2047.² Training and capacity-building initiatives, customised solutions with user and crop centricity, and effective technology adoption will act as key levers for realising these targets.

Farm mechanisation in India is not merely a machine-based intervention, but a leap forward that will enable farmers to raise their income, reduce drudgery, and ensure the active participation of women in agriculture. Together, this will help the country nurture a resilient agriculture ecosystem that contributes substantially towards the realisation of the 'Viksit Bharat' vision.

1. indiabudget.gov.in

2. https://sansad.in/getFile/loksabhaquestions/annex/184/AU429_rEjFhq.pdf?source=pqals



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01 Executive summary

In recent years, the declining share of the agriculture sector in national GDPs has become a growing concern. Nonetheless, the sector continues to play a crucial role in sustaining rural economies, particularly across developing countries.

In India, the agriculture and allied sectors have long served as the backbone of the national economy, playing a vital role in generating employment. As of FY 2024, the sector contributes approximately 16% to India's GDP and provides employment to nearly 46.5% of the total population.³ Sustained growth averaging 7% per annum over the past decade has contributed to poverty reduction in several regions. However, large portions of the country have yet to fully harness the potential of their agricultural resources.

Achieving India's vision of Viksit Bharat by 2047 requires inclusive and mechanised agricultural growth. By then, India will mark the centenary of its independence, with the population projected to reach 1.61 billion, alongside an anticipated 2.44% annual increase in food demand.^{4,5} To attain a \$30 trillion economy by 2047 with a per capita GDP of \$18,072, India must transition from a middle-income to a high-income economy.⁶

However, the agriculture sector currently faces crucial challenges and various pressures. Despite its foundational role in employment generation and food production, India's agricultural productivity remains constrained by several structural issues. Among the most critical is the low level of farm mechanisation, which limits efficiency and output. Over 86% of Indian farmers are classified as small and marginal, making it difficult to adopt and utilise future-ready farm mechanisation.⁷

As of 2024, India's average farm power availability stands at approximately 3.126 kW/ha (2024), significantly lower than that of Japan (8.75 kW/ha) and China (5.7 kW/ha).⁸ The national target aims to raise this figure to 4 kW/ha by 2030. Similarly, India's current mechanisation level of 47% trails behind that of countries with developed agricultural economies.⁹ Strategic measures are therefore required to achieve 75% farm mechanisation by 2047.¹⁰

By fostering an enabling ecosystem that supports small and marginal farmers with farm mechanisation, the country can unlock its full potential in the agriculture sector and achieve both national and international benchmarks in the production and productivity of major crops. This will also reduce drudgery and align with national goals such as nutrition for all. Such an approach will also contribute to a sustainable, future-ready agricultural sector.

In recent times, data-driven and technology-enabled farm mechanisation has taken the lead in the country. For instance, the adoption of drones for precise applications, such as spraying and farm monitoring, has gained momentum. Shared ownership models, in contrast to individual equipment ownership, have proven effective in promoting inclusion, dignity, recognition, and gender empowerment and youth participation within the evolving agricultural ecosystem.

Thus, farm mechanisation in India is not merely a machine-based intervention but also an entire pathway towards an inclusive, responsive, sustainable, and future-centric agriculture ecosystem, allowing the country to act locally while remaining competitive globally.

3. <https://dge.gov.in/dge/labour-and-employment-statistics>, <https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS>

4. https://www.thehindu.com/news/national/lancet-study-predicts-earlier-peak-for-indian-population/article32095120.ece#google_vignette

5. https://www.niti.gov.in/sites/default/files/2024-02/Working%20Group%20Report%20on%20Demand%20%26%20Supply%20Final_V9.pdf

6. <https://economictimes.indiatimes.com/news/economy/policy/india-needs-to-strive-to-be-30-tn-economy-with-per-capita-income-of-18000-niti-document/articleshow/112082897.cms?from=mdr>

7. <https://dge.gov.in/dge/labour-and-employment-statistics>

8. https://www.nabard.org/auth/writereaddata/tender/pub_3110250527591873.pdf

9. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2146927>

10. https://sansad.in/getFile/loksabhaquestions/annex/184/AU429_rEjFhq.pdf?source=pqals

02 Farm mechanisation landscape

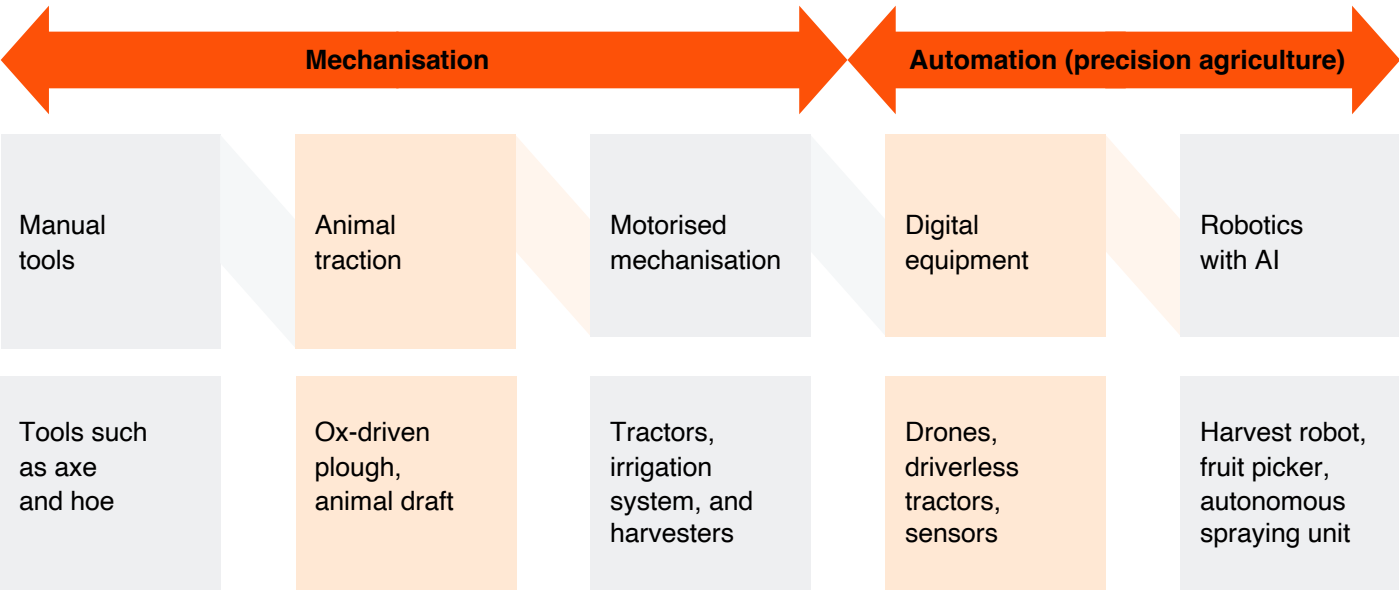
Globally, agriculture remains one of the most significant sectors, providing both food and employment. Approximately, 26% of the global workforce is engaged in agricultural activities, while 46.5% of India’s workforce engages in agriculture.¹¹ As the global population reached 8.14 billion in 2024, growing at a compound annual growth rate (CAGR) of 15% since 1960,¹² challenges surrounding food security have increased significantly. Furthermore, the world is expected to witness an escalating demand for nutritious food in the near future, limitation in agricultural land availability, shortage in natural resources, and the various impacts of climate change on the environment. To mitigate these risks, nations worldwide have adopted corrective measures—ranging from the introduction of high yielding seed varieties for yield intensification, chemical fertilisers, and improved irrigation systems, to advancements in motorised mechanisation, automation, precision farming.

Farm mechanisation has been recognised worldwide as an important agricultural transformational agent. Its adoption has helped developed countries such as the United States and European countries in reaching a mechanisation level of more than 90%, followed by Russia at 85% and Brazil at 75%. China, a global leader in food production, has focused on agricultural mechanisation since the 1970s and achieved remarkable progress, with an overall mechanisation level of 60%.¹³

In contrast, India’s overall mechanisation level remains at 45%, which is below the desired level of mechanisation to reach the optimum level of agricultural productivity.¹⁴ Recognising this, the Government of India has implemented multiple policy initiatives to accelerate the adoption of farm mechanisation in the country. Farm mechanisation is a central solution to many of the challenges the country faces.

The need for improving the farm mechanisation levels for driving yield intensification and improving cropping intensity persists. Farm mechanisation has become central to enhancing operational efficiency and boosting agricultural productivity to increase overall food production levels in the country and increase farmers’ income. It has emerged as a critical input to achieve and ensure food security to reduce the country’s dependence on agricultural imports and transform the agricultural landscape towards becoming truly ‘Atmanirbhar’. In addition, to create a ‘future-ready’ agricultural ecosystem, the latest technological advancements in agricultural digital automation are being adopted, including driverless tractors and implementation of robotics in agriculture, such as harvest robots and autonomous spraying robots for precision agriculture.

Evolution of mechanisation and automation



Source: Food and Agriculture Organization of the United Nations

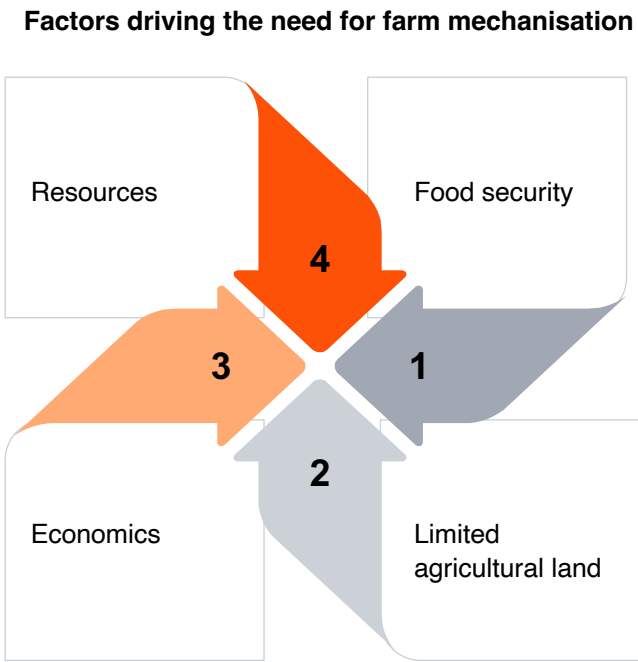
11. <https://dge.gov.in/dge/labour-and-employment-statistics>,
12. <https://data.worldbank.org/indicator/SP.POP.TOTL>
13. <https://sansad.in/getFile/annex/259/AU1938.pdf?source=pqars>
14. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2146927>

2.1 Need for farm mechanisation

2.1.1 Food security

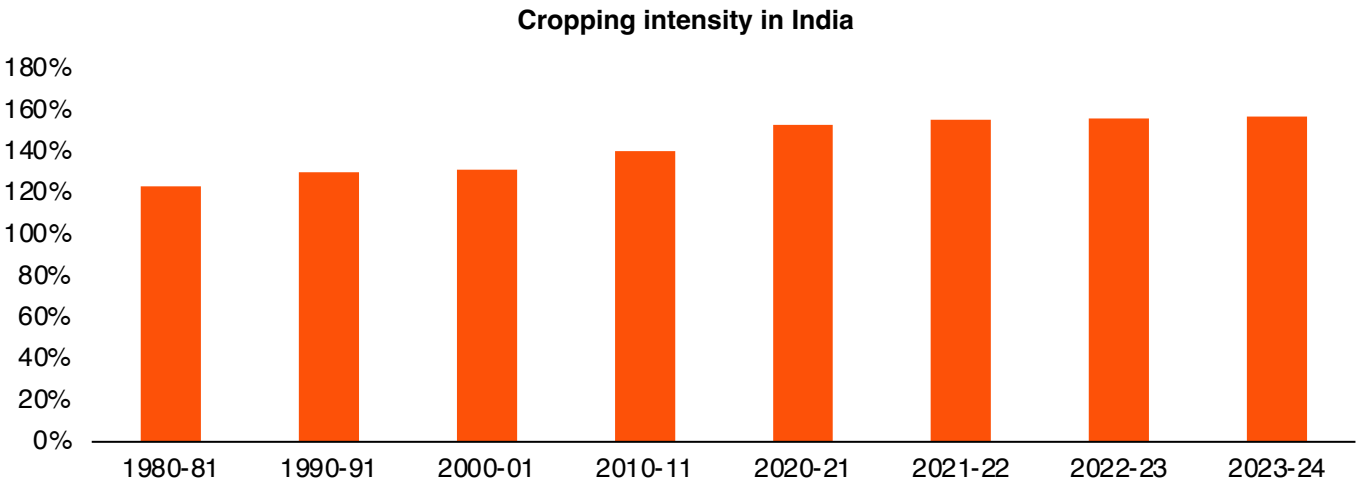
2.1.1.1 Enhances agricultural productivity

Previous studies have suggested that farm mechanisation boosts agricultural productivity and production per unit area by enhancing the operational efficiency. Mechanisation allows farmers to undertake systematic, timely, and high-quality cultivation, including seedbed preparation, uniform seed plantation, and timely harvest, which supports successive crops multiple cropping cycles. Consequently, it encourages the expansion of net sown area, thereby increasing agricultural productivity per unit area, which ultimately boosts overall agricultural production.



2.1.1.2 Propels cropping intensity

Cropping intensity in India has mostly remained stagnant, averaging around 143% over the past 45 years. This highlights the need for farm mechanisation, which can accelerate cropping intensity and boost agricultural production in the country. Mechanisation will enable farmers in timely sowing and harvesting given the narrow window between successive crops to cultivate across multiple seasons.



Source: Department of Agriculture & Farmers Welfare

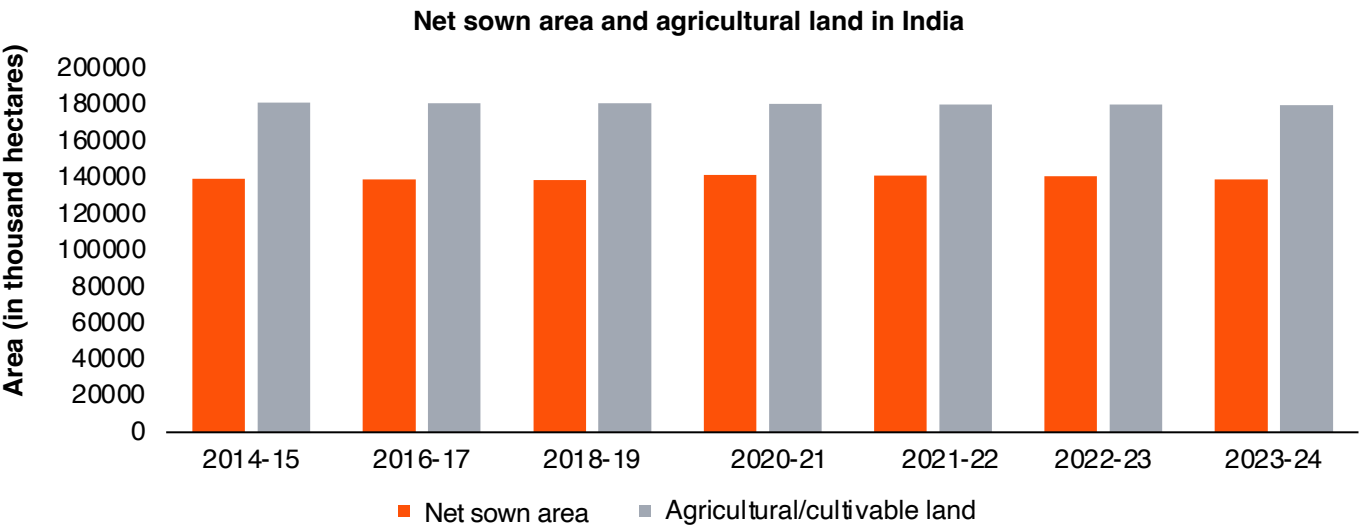
2.1.1.3 Increases production to meet increasing demand

Intensifying population pressure necessitates an increase in agricultural production to meet the increasing demand. Yield intensification can be achieved either through high-yielding varieties of seeds or by enhancing the operational efficiency of agricultural processes. However, usage of high-yielding seeds does not improve the operational efficiency of agricultural activities. Thus, farm mechanisation can address this limitation by allowing efficient and timely farming operations, thereby increasing productivity per unit area.

2.1.2 Limited agriculture land

2.1.2.1 Stagnant net sown area and cultivable land

In India, the net sown area has largely remained stagnant relative to the total agricultural/cultivable land at an average of 1,39,876 thousand ha and 1,80,396 thousand ha in the last 10 years, respectively. Hence, farmers must adopt modern agricultural practices to utilise the limited available resources efficiently and achieve higher productivity and agricultural production.



Source: Department of Agriculture & Farmer Welfare

2.1.2.2 Need to maintain a balance between agriculture and forest cover to mitigate the adverse impacts of global warming

The world is currently experiencing a radical shift due to climate change, making adequate forest cover essential to maintain environmental balance. However, the limited availability of agricultural land may create pressure to encroach upon forest areas to expand agricultural production. Farm mechanisation can ensure operational efficiency, thereby expanding agricultural production per unit area and thus help avoid encroachment of forest area for agricultural purposes.

2.1.3 Economics

2.1.3.1 Food production at competitive rates

Farm mechanisation has an incremental effect on the scale of agriculture and a net positive impact on economies of scale. Increased agricultural production leads to lower production costs, higher profit margins, and improved income and returns for farms. In India, small and marginal farms constitute the majority and account for nearly 86% of the country's agricultural workforce.¹⁵ Thus, farm mechanisation plays a vital role in improving the income generating potential and livelihood of these small and marginal farmers.

2.1.3.2 Reduce import dependencies

Farm mechanisation is crucial to food security, as it can help reduce import dependencies by making the nation self-sufficient in food production. By improving operational efficiency, farm mechanisation contributes to increased agricultural productivity and facilitates multiple cropping, thereby increasing the overall cropping intensity in the country. Consequently, it plays a vital role in achieving self-sufficiency in food production and in reducing the import dependencies of agricultural commodities. Between 2019-20, the import of agriculture commodities amounted to \$19.91 billion, underscoring the urgent need to boost production and become self-sufficient.¹⁶

2.1.4 Resources

2.1.4.1 Rainfed agricultural practices

In India's subcontinent, the agricultural irrigation is mostly dominated by rainfed irrigation. It accounts for 55% of the net sown area and caters to 61% of India's farmer population.¹⁷ Hence, available rainwater must be utilised in the most efficient and feasible manner; however, this remains a complex challenge, as rainfall is often brief, often unpredictable, posing risks of dry spells and potential crop damage due to water stress. Farm mechanisation can enhance operational efficiency by facilitating timely completion of agricultural operations, such as sowing and harvesting, thereby ensuring the use of available soil moisture and promoting effective water and soil management.

2.1.4.2 Agricultural labour force

India's agricultural labour force has increased from 44% in 2017-18 to 46.5% in 2020-21. The rate of female workers in the agricultural sector has increased from 57% in 2017-18 to 62% in 2020-21, whereas that of male workers has declined from 40.2% in 2017-18 to 39.8% in 2020-21.¹⁸ This indicates the displacement of the male agricultural labour force to other sectors. The World Bank estimates that the agricultural workforce would drop to 25.7% by 2050, ushering the need to enhance the country's level of farm mechanisation.¹⁹ Mechanisation can support the rising female agricultural workforce in the most labour-intensive task with intensive agricultural activity and reverse the effect of decreasing trend of male agricultural workers, boost production per unit area, and create avenues for increased income level to sustain the financial needs of the rising agricultural farmers in the country. It will also create and enhance the skill set of agricultural labour force, making them future ready to sustain and cater to the increased demands in the future.²⁰

2.1.4.3 Reducing drudgery

Reducing drudgery has become increasingly important in view of the recent trend showing an increase in female labour force in agriculture. Drudgery may be a major cause of accidents, injuries, and fatigue during agricultural operations such as threshing, load carrying, and harvesting. To increase the cropping intensity to boost production per unit area and meet the rising food demand of the increasing population, farm mechanisation is essential to increase the farm power availability, which is only 3.126 kW/ha as of 2024, and support the existing labour force in efficiently managing agricultural operations.²¹

15. <https://dge.gov.in/dge/labour-and-employment-statistics>

16. <https://www.pib.gov.in/Pressreleaseshare.aspx?PRID=1705518>

17. [https://agriwelfare.gov.in/Documents/121233187_rapfinaldraft%20\(1\)_repaired.pdf](https://agriwelfare.gov.in/Documents/121233187_rapfinaldraft%20(1)_repaired.pdf)

18. <https://dge.gov.in/dge/labour-and-employment-statistics>

19. <https://www.pib.gov.in/Pressreleaseshare.aspx?PRID=1518097>

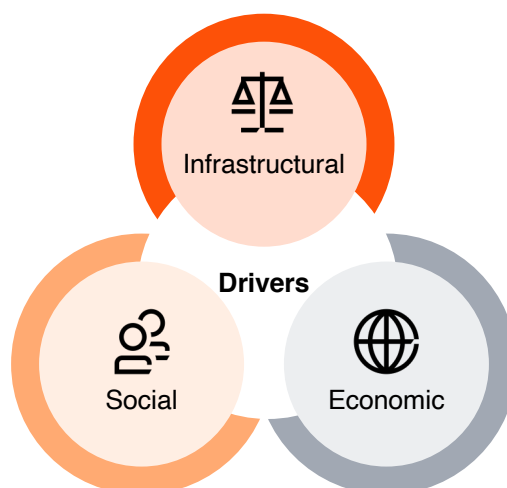
20. Ibid.

21. https://sansad.in/getFile/loksabhaquestions/annex/184/AU4030_u5gVDd.pdf?source=pqals

2.2. Drivers of farm mechanisation

The adoption of farm mechanisation by various countries may depend on different factors such as socio-economic conditions, geographical conditions, access to credit, type of crop, and irrigation facilities. As per the estimates of 2020-21, the overall operation wise average mechanisation levels across crop were 70% for seed-bed preparation, 40% for sowing/planting/transplanting, 33% for weeding and inter-culture, and 34% for harvesting and threshing, resulting in an overall average mechanisation level of 45%, which is well below developed countries such as US, China and European countries.²² The drivers that force change (adoption of farm mechanisation) within the agricultural ecosystem may be categorised broadly into three important groups, namely infrastructural, social, and economic.

Three key drivers for adoption of farm mechanisation



2.2.1. Infrastructural

2.2.1.1. Government policies and schemes

Government policies and schemes are one of the most important drivers of farm mechanisation worldwide. Conducive government schemes and subsidies promote the accelerated adoption of mechanisation in agricultural practices such as centrally sponsored scheme Sub-Mission on Agricultural Mechanization (SMAM) wherein financial assistance is provided to purchase agricultural machinery and equipment.

2.2.1.2. Access to credit

Affordable and accessible credit line for procuring agricultural equipment is a major driver behind the incremental level of mechanisation worldwide, given that small and marginal farmers face major challenges of affordability in purchasing farm equipment. The priority sector lending target, set at 40% of the adjusted net bank credit (ANBC) total lending portfolio for commercial banks, includes credit for agricultural finance and farm equipment. This provides the necessary credit cushion for agricultural farmers in the country.

2.2.1.3. Custom hiring centres

Custom hiring centres and farm machinery banks will enable agricultural farmers to hire high-cost agricultural machinery such as combine harvesters and paddy transplanters and promote its use extensively at reduced operational expenses than individual ownership.

2.2.2. Social

2.2.2.1. Changes in agriculture workforce

Recent trends in agricultural workforce suggest an increase in female participation in agriculture, alongside a marginal decline in the number of male agricultural workers. However, the overall agricultural workforce is projected to decrease in the future due to the gradual shift of labour from agriculture to other sectors. This transitional shift in agricultural workforce would drive the need for mechanisation for ensuring robust productivity and ensuring production to meet the increasing demands due to population growth.

22. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2146927>

2.2.2.2. Drudgery reduction

Agriculture is inherently a labour-intensive work, and drudgery is one of the main reasons of low productivity and delayed farming activities due to intense, repetitive, time-consuming, and fatigue-causing agricultural work. Farm mechanisation can reduce drudgery by mechanising the labour-intensive manual work such as land preparation, harvesting, threshing, and so on. Hence, the need to reduce drudgery would drive mechanisation in order to sustain the growing female workforce and ensure optimum agricultural productivity and food production.

2.2.2.3. New generation of farmers

Young people who are presently involved in agriculture or are venturing into agriculture as a profession are more likely to adopt mechanisation at a much faster pace owing to increased awareness and more acceptability towards the latest technological developments. Their inherent desire to develop their skills and stay informed about recent advancements in agricultural practices—to increase productivity, scale up production for higher profits, and secure sustainable livelihoods—would drive the adoption of modern techniques such as farm mechanisation and precision farming technologies.

2.2.3. Economic

2.2.3.1. Higher farmer income

India's agricultural farmers are mostly characterised by small and marginal farmers having less than 2 hectares of land and account for approximately 86% of total farmers in India.²³ This necessitates increasing production per unit area and farmers' overall income to sustain the livelihood of small and marginal farmers. The need for higher income would drive mechanisation as it would ensure increased productivity and overall agricultural production.

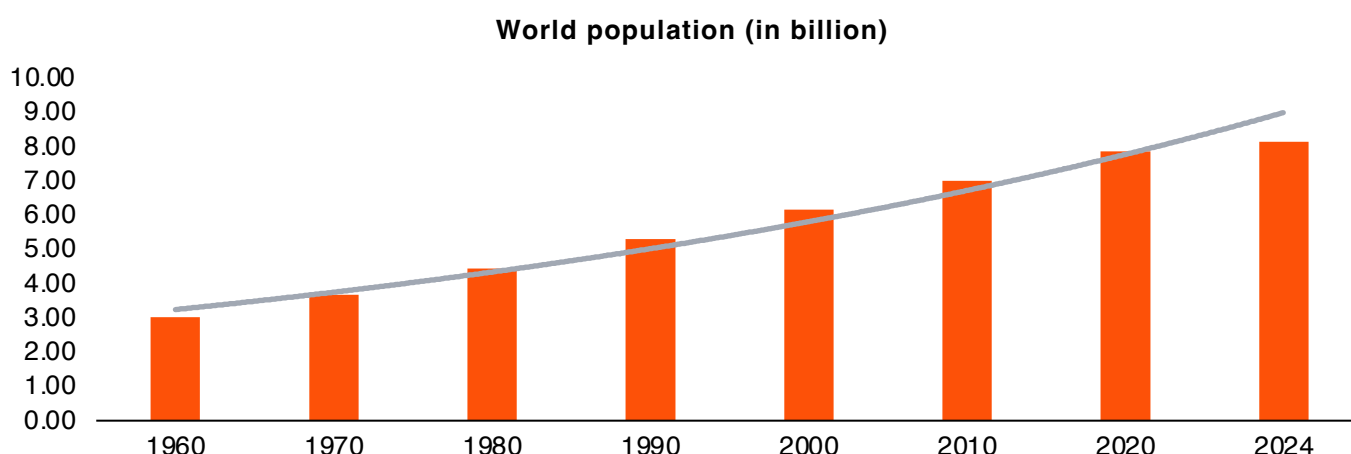
2.2.3.2. Cost efficiency

Cost efficiency is vital to ensure higher margins for farmers; however, the use of manual labour in agricultural activity is often expensive and increases the overall cost of production. Cost efficiency would likely drive mechanisation to achieve economies of scale by scaling up production per unit area and overall agricultural production.

2.3. Global outlook on farm mechanisation

2.3.1. Rising world population

The world is witnessing a continuous rise in population, from 3.02 billion in 1960 to 8.14 billion in the last 60 years.²⁴ Food security is emerging as a major challenge many nations will face in the near future, making it critical to mitigate this risk and to achieve self-sufficiency in food production to meet the need of the ever-growing population. Farm mechanisation improves operational efficiency, thus increasing agricultural productivity and agricultural production per unit area, which is essential to ensure food security.



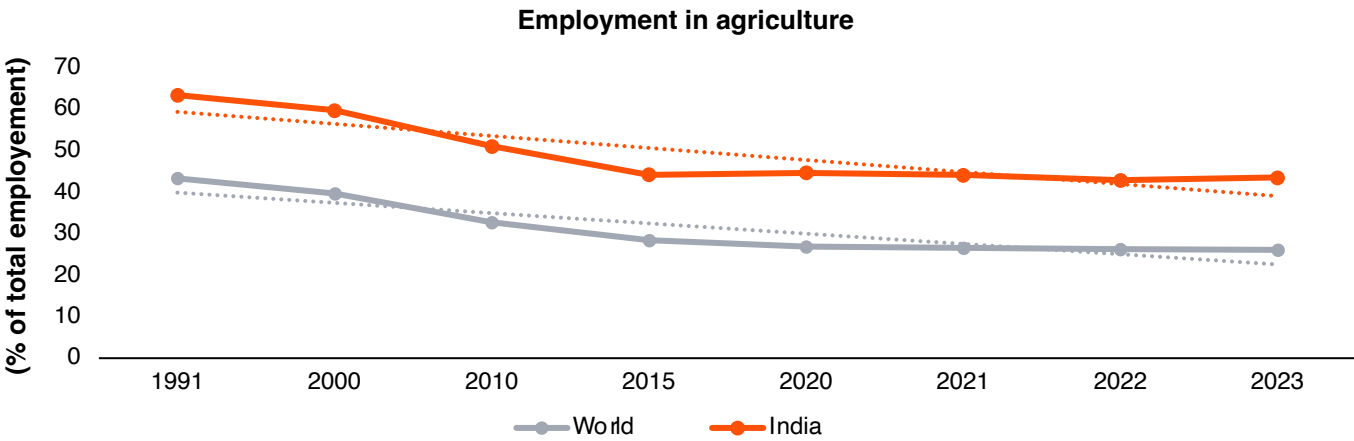
Source: World Bank

23. <https://naas.org.in/spapers/Strategy%20Paper%20No.%2018.pdf>

24. <https://data.worldbank.org/indicator/SP.POP.TOTL>

2.3.2. Employment in the agricultural sector

Agriculture sector is one of the largest employers worldwide. However, we have been witnessing a shrinking agricultural workforce globally for the last few decades. In 1991, agriculture contributed approximately 43% to the total employment globally, which has reduced to 26% in 2023. India is also on the same trajectory, as seen in the global agricultural employment trend. In the last few decades, employment in agriculture has decreased by nearly 31% from 63% in 1991 to 44% in 2023. The decline is largely attributed to the emergence of other sectors supporting the economy and is the major cause of this displacement of agricultural workers. Adoption of farm mechanisation is highly imperative in the present context to sustain agricultural productivity and increase food production.²⁵

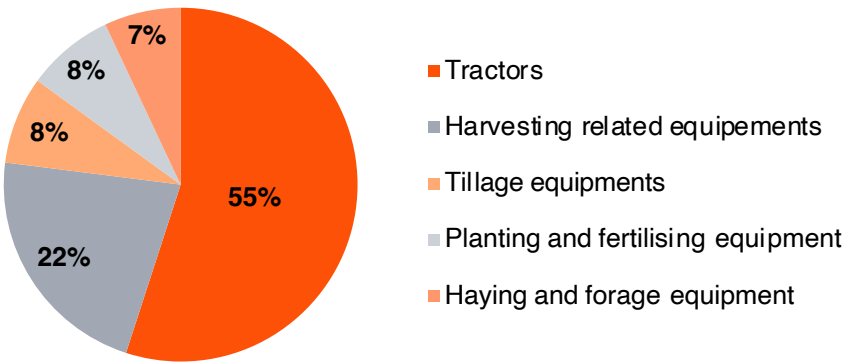


Source: World Bank

2.3.3. Global market size

The global agricultural machinery market size is continuously expanding with an incremental trajectory. It is dominated by tractors, which account for the highest share in market size, followed by harvesting-related equipment, tillage equipment, planting equipment, and haying and forage equipment. The high growth observed in Asia-Pacific is predominantly due to the market scope, which is still at a developing stage. In contrast, most developed markets are largely mechanised with a mechanisation level of above 90%.²⁶

Global market share of farm equipment



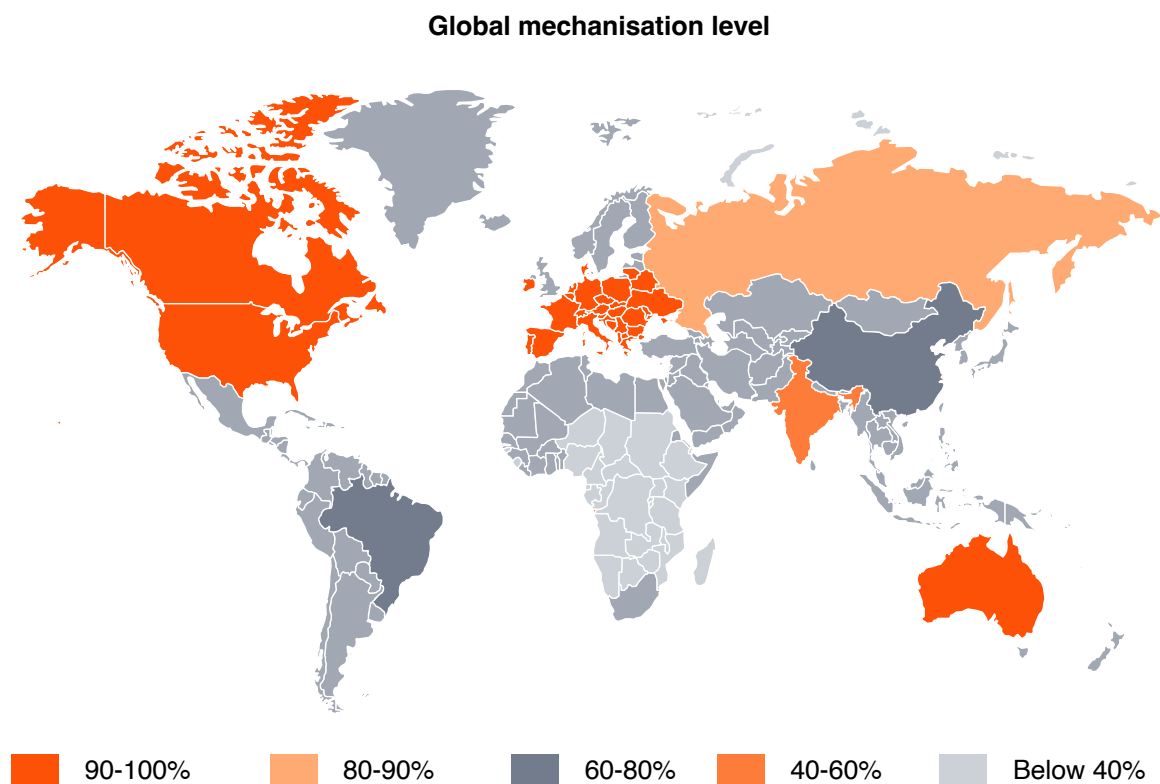
Source: PwC

25. <https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS>

26. <https://www.pwc.in/assets/pdfs/consulting/management-consulting/farm-mechanisation-catalyst-sustainable-agricultural-growth.pdf>

2.3.4. Level of mechanisation

The level of farm mechanisation in North American and European countries ranges between 90%– 100%. Developing nations such as Sub-Saharan Africa, China, and India have a significant scope for growth in mechanisation, which can drive global agricultural food production.²⁷



Source: PwC

2.4. Farm mechanisation in the Indian context

The adoption rate of farm mechanisation worldwide is region specific and largely depends on social and economic conditions and land availability. In India, agriculture is predominantly driven by small and marginal farmers with less than 2 hectares of land, who account for approximately 86% of all farmers. Mechanisation adoption is further affected by geographical factors, crop types, and sources of irrigation, among other factors.

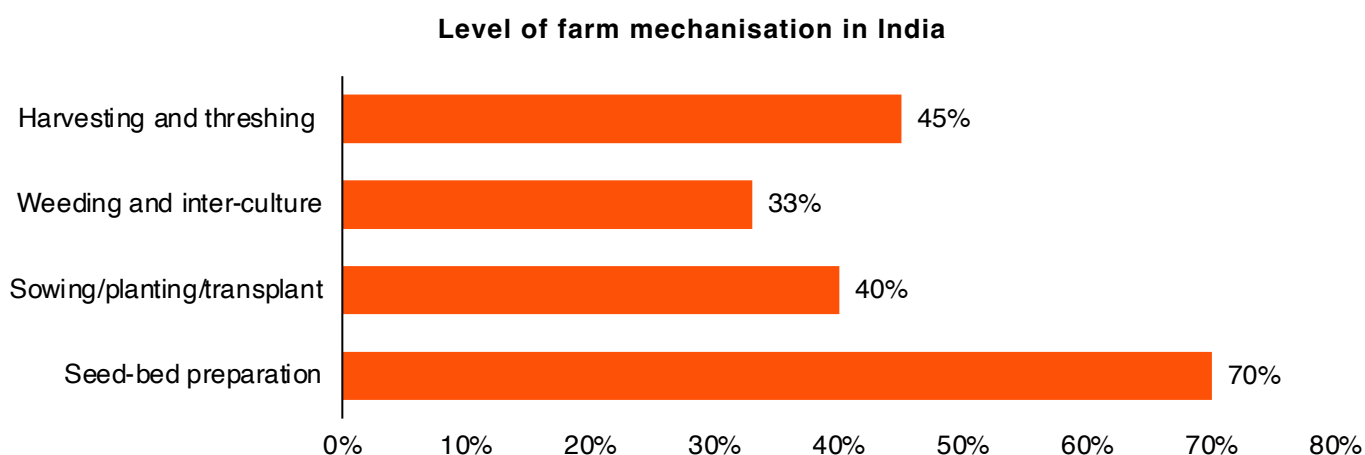


²⁷<https://www.pwc.in/assets/pdfs/consulting/management-consulting/farm-mechanisation-catalyst-sustainable-agricultural-growth.pdf>

2.4.1. Level of mechanisation

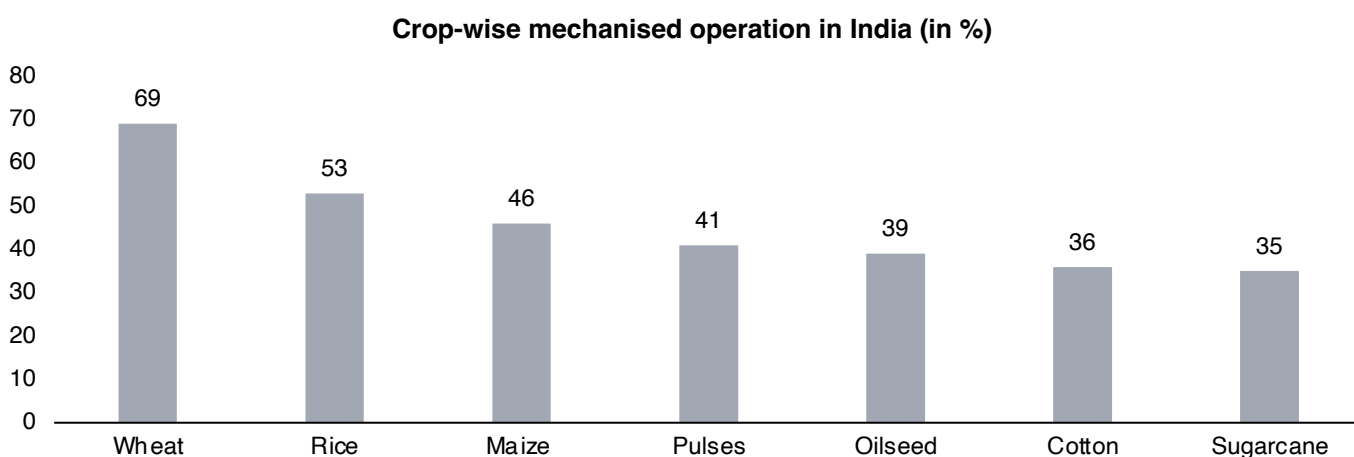
Farm mechanisation in India can mostly be credited to the wide application of tractors on India's farms. India has also emerged as one of the largest tractors producing nation and accounts for approximately one-third of the total global tractor production. However, the mechanisation level at other stages of agricultural process is low within the range of 35%–45%.

The level of mechanisation for seed-bed preparation is the highest in India, majorly on account of use of tractors in the process. However, strong thrust and support is required to promote the use of mechanised tools and equipment in other stages, such as sowing, weeding, and harvesting. Additionally, the standing committee on Agriculture, Animal Husbandry and Food Processing (2022-23) has emphasised the need to achieve a mechanisation level of 75% by 2047.²⁸



Source: PIB

Below is an indicative graph showcasing crop-wise mechanisation level (in %) which highlights the need for an increased level of mechanisation amongst crop categories.²⁹



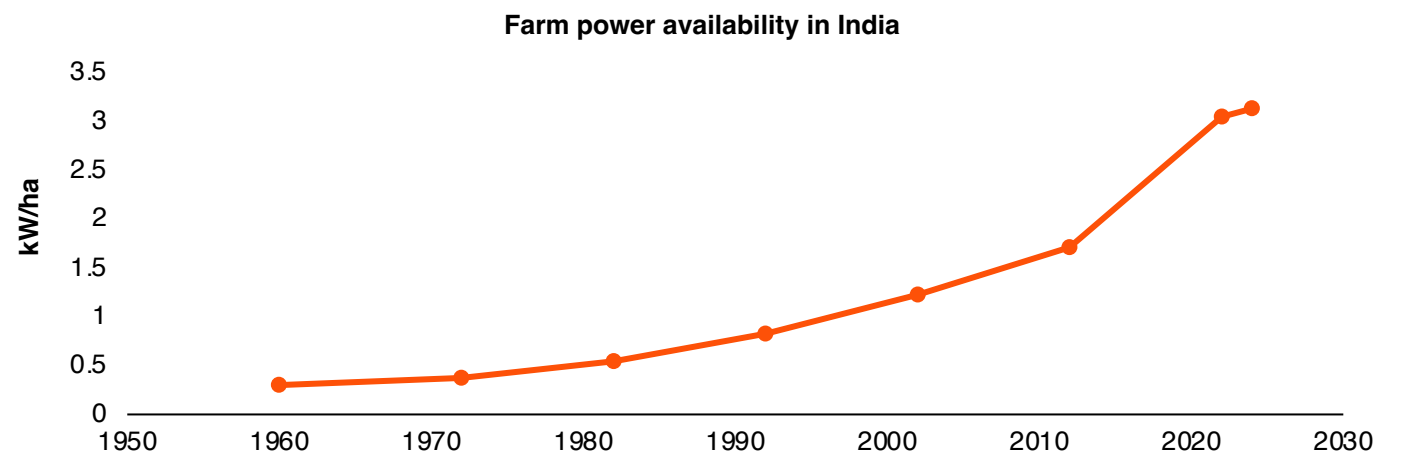
Source: PwC

28. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2146927>

29. <https://www.pwc.in/assets/pdfs/consulting/management-consulting/farm-mechanisation-catalyst-sustainable-agricultural-growth.pdf>

2.4.2. Farm power

The average farm power availability in the country is roughly 3.126 kW/ha (2024). This is well below developed countries such as Japan and China whose net farm power is at approximately 8.75 kW/ha and 5.7 kW/ha, respectively.³⁰ Despite the increase in farm power availability from 0.30 kW/ha since 1960, it escalated at a much slower pace. As per the Department of Agriculture & Farmers Welfare, at least 4kW/ha is required by the end of 2030 to meet the increasing demand of food grain in India.³¹ The distribution of farm power is not consistent. The wide gap is evident from a comparison between the average farm power in Punjab (6 kW/ha) and that in Mizoram (0.7 kW/ha).³²



Source: NABARD

India's aspiration for the future

4 kW/ha
Farm power by 2030

75%
Level of mechanisation by 2047

Source: Digital Sansad

30. <https://naas.org.in/spapers/Strategy%20Paper%20No.%2018.pdf>
31. <https://agriwelfare.gov.in/en/MechanizationDiv>
32. <https://www.pwc.in/assets/pdfs/consulting/management-consulting/farm-mechanisation-catalyst-sustainable-agricultural-growth.pdf>

03 Interventions in farm mechanisation

India’s agriculture sector has come a long way, showing remarkable growth and transformation over the years.

	Decade	Average growth (%)	Notable years and context	Key drivers
1	1980–89	~3.3%	Comeback post-1987 drought. Experienced strong growth in 1988–89	Green Revolution. Intervention in oilseeds and sugarcane
2	1990–99	~3.2%	Moderate growth with sharp dips in 1991–92 and 1997–98	Impact of economic reforms. intervention in sectors such as livestock and horticulture
3	2000–09	~3.0%	Droughts in 2002–03 and 2009–10, recovery in 2003–04 and 2010–11	Initiation of National Food Security Mission (NFSM) and NREGA
4	2010–19	~3.6%	Strong years: 2010–11, 2016–17. Relatively low growth in 2014–15 and 2018–19	Integrated impact of mechanisation, e-NAM, crop insurance, and allied sectors such as fisheries and dairy
5	2020–25	~3.4%	COVID impact and moderate recovery in 2024–25	Focus on technology and sustainability

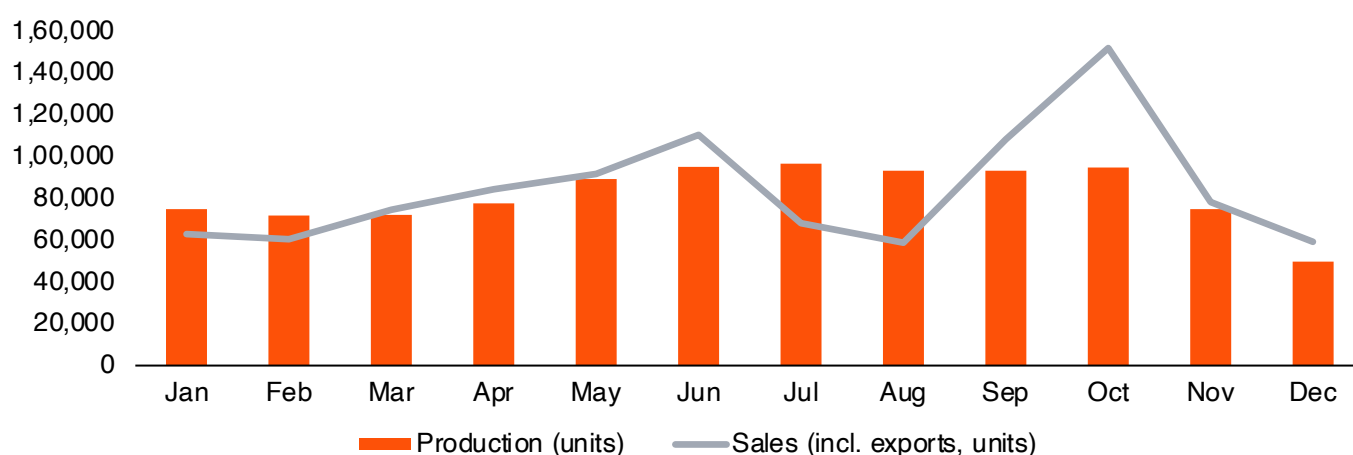
Source: PwC analysis



Farm mechanisation is no longer a choice but has evolved as a necessity to sustain the growth engine of agriculture and the country whilst ensuring food security. Although it has become one of the most crucial and important factors to achieve the global standard of production, it is also critical to enhance farmer-field engagement (cropping intensity).

In 2024, the country produced nearly 982,146 tractors, and the consumption was around 10,07,900 units (including exports). Tractors are one of the most utilised farm-implements across regions but with varied cropping practices and land holding in the country, the role of other implements becomes crucial. The emerging challenges of labour availability, rising cost of cultivation, and climate change have made farm mechanisation an urgent requirement. Farm implements apart from tractors such as harvesters, planters, sprayers, weeders, threshers, and driers have been instrumental in transforming the farm mechanisation ecosystem. Modern farm implements backed with technology such as automated drip/sprinkler irrigation systems and drones for customised spraying and monitoring of crops have been successful in implementing responsible cropping practices and supporting in harnessing the potential without impacting environment.

Tractor production and sales—2024 (consolidated monthly totals)



Source: Tractor and Mechanization Association

3.1. Government's interventions

Currently, the agriculture sector faces numerous structural and unique challenges which require multidimensional approaches. As the most important stakeholder in the promotion of different schemes and interventions for the sustainable growth of the agriculture sector, the role of Government machinery is crucial in the propagation of future-ready farm mechanisation which will be affordable, inclusive, sustainable, and scalable. This is not only crucial for boosting production and productivity but also for driving the agricultural sector towards digital transformation and climate resilience.

3.1.1 Policy architecture and flagship schemes

3.1.1.1. SMAM

The Central Government scheme was initiated in between 2014–15, with the primary objective of supporting mechanisation in the agriculture sector. SMAM supports machinery purchase subsidies, Custom Hiring Centres (CHCs), testing and evaluation, demonstration and training, and strengthening of testing infrastructure at the state level. The scheme is being implemented through state agriculture department/directorates.

3.1.1.2. Crop Residue Management (CRM) Scheme

The CRM Scheme is an ambitious government initiative. On the one hand, it highlights issues of burning crop residues, leading to environmental and health issues. On the other hand, it highlights the adoption of future-ready farm mechanisation. The scheme was initiated between 2018–19 and provides financial support to farmers and subsidies for establishing CHCs that allow community access to modern farm machinery. The scheme provides training and handholding support to farmers and other stakeholders.

3.2. Interventions by other stakeholders

The role of different stakeholders at different stages is crucial in the development and adaptation of future-ready farm mechanisation. Partnership and collaboration amongst different agencies are key in accelerating the adoption of new technological interventions at the field level.

1	Donors, multilateral and bilateral agencies	Support from these organisations focuses on creating programmes that are designed to create service models, inclusive and gender-sensitive access to farm tools, and integration of sustainability and environment with value addition.
2	NGOs, CSOs, and farmer producer organisations (FPOs)	These organisations/institutions play a crucial role in training/handholding farmers and also in creating village-level entrepreneurs (VLEs).
3	Private sector players/corporates	They are also crucial in arranging support such as after-sales services and other offerings such as technology-enabled customised services by start-ups and AgriTech platforms.

3.3. Best practices and case evidence

3.3.1. Global lessons

Numerous examples at the global level offer significant lessons that can be adapted at the national level to strengthen the eco-system for future-ready farm mechanisation. Technological advanced countries such as Japan, the United States, and the Netherlands have successfully adopted the models of smart farm mechanisation which integrates automation, precision agriculture, and customised digital technologies, resulting in enhanced production and productivity with sustained long-term positive impact.

Some of the successful global models which can be customised locally:



Use of robotics and customised autonomous tractors in Japan has successfully addressed labour shortages.



AI and IoT integration in the United States emphasises on data-driven decision-making.



Shared access to high-cost machinery is highly successful in European nations. Helps to reduce cost for small farmers.



Rental models for machines/farm tools are very popular in China, parts of Africa, and Asia.

3.3.2. National best practices

Across India, several best practices exist in implementing future-ready farm mechanisation models—for instance, CHCs.³³

1	CHCs	Government schemes such as CHCs across states have shown significant potential for adoption and replication. They have proved to be crucial in the use of modern farm machines/tools by different sections of farmers without heavy capital requirement.
2	CRM Scheme	It has successfully contributed to maintaining soil health and addressing environmental issues caused by stubble burning, particularly in states such as Punjab, Haryana, and the NCR.
3	Agri startups and innovation hubs	States such as Madhya Pradesh and Maharashtra have successfully introduced next-generation technology such as drones and IoT-enabled farm solutions. Southern states such as Andhra Pradesh, Telangana, and Tamil Nadu have introduced digital mechanisation platforms linking farmers with end solution providers.
4	Farm Machinery Training and Testing Institutes (FMTTIs)	Capacity building and handholding support to farmers have been successfully carried out in the country. This has been crucial in the adoption and propagation of future-ready farm mechanisation.

There are several other successful practices and models (e.g. Namo Drone Didi Scheme) across the country that demonstrate the importance of technology integration, policy support, and institutional innovation in creating scalable, inclusive, gender-sensitive, and sustainable pathways for a much-needed, future-ready mechanisation for the agriculture sector.

3.3.2.1. Namo Drone Didi Scheme

The Namo Drone Didi initiative by the Government of India is a unique, futuristic, and transformational scheme promoting technology-supported adoption of farm mechanisation. The initiative has emerged as a driver of women empowerment and has showcased the future of mechanisation in India. The scheme also promoted shared and rental models of farm mechanisation.^{34,35}

Across various states, several case studies highlight how women's self-help groups (SHGs) under the Deendayal Antyodaya Yojana–National Rural Livelihoods Mission (DAY-NRLM) have been provided with drone packages. These packages include Central Government subsidies, access to low-interest loans, certified training covering day-to-day operations and maintenance, and safety protocols, enabling them to effectively adopt and operate advanced farm mechanisation technologies.

Case 1

A homemaker from the state of Haryana, after being trained, is now recognised as Drone Didi. Apart from her regular chores, she now helps farmers in her nearby areas in spraying using drone services. In less than six months, her income reached around ₹50,000. She has also helped her fellow farmers in bringing down the cost of spraying.

Case 2

A SHG of nine members from Varanasi, Uttar Pradesh, launched drone services in their locality, covering approximately 2,500 acres. In less than a year, the SHG earned ₹3.38 lakh from these services.

33. CHC refers to custom hiring centre where farm equipment can be rented to farmers.

34. <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2149706#:~:text=Press%20Release:Press%20Information%20Bureau,is%20attached%20at%20Annexure%20%2DI>

35. <https://thebetterindia.com/451976/women-farmers-using-drones/>

04 Emerging needs and challenges

To achieve a future-ready agricultural landscape, India's government has recognised the need to mechanise its farms and achieve 75% level of mechanisation by 2047. Along this trajectory of farm mechanisation and developing an ecosystem of technology enabled agriculture, it will face multiple emerging and already existing challenges in the pursuit of achieving the desired level of mechanisation.

4.1. Role of financing

India's agricultural landscape is characterised by small and marginal holdings of less than 2 hectares, which account for approximately 86% of the total holdings. Moreover, the average size of holdings has declined to 1.08 ha in 2015–16 from 1.15 ha in 2010–11.³⁶ The decline in average size of holdings is likely to continue in the future given the country's continuous population growth. The low average landholding is a key reason for the low household income of farmers. Hence, affordability is a major challenge in the adoption of farm mechanisation.

Financing will play the most important role and act as a catalyst to boost demand for farm equipment. The gap between expenditure and income realisation after harvest is considerable and cyclical. A majority of small and marginal farmers lack sufficient buffer for investment in mechanisation. Hence, affordable and accessible finance at low rates will enable farmers to procure suitable farm equipment based on their farming needs.

Key highlights of agriculture finance in India

40%

RBI mandate for PSL
of ANBC

2nd

After China in
agriculture credit

2x times

Growth in agriculture credit
from 2010 to 2020

Source: RBI, FAO

The Reserve Bank of India's (RBI) priority sector lending (PSL) target of 40% of ANBC acts as a key enabler for providing loans to farmers through commercial banks.³⁷ These are offered as cash credit facilities (e.g. Kisan Credit Card) to meet cultivation and ancillary expenses and as term loans for purchasing farm equipment, along with overdraft facilities. Micro credit institutions have equally played an important role in providing credit for financing agricultural activities and livelihood support.

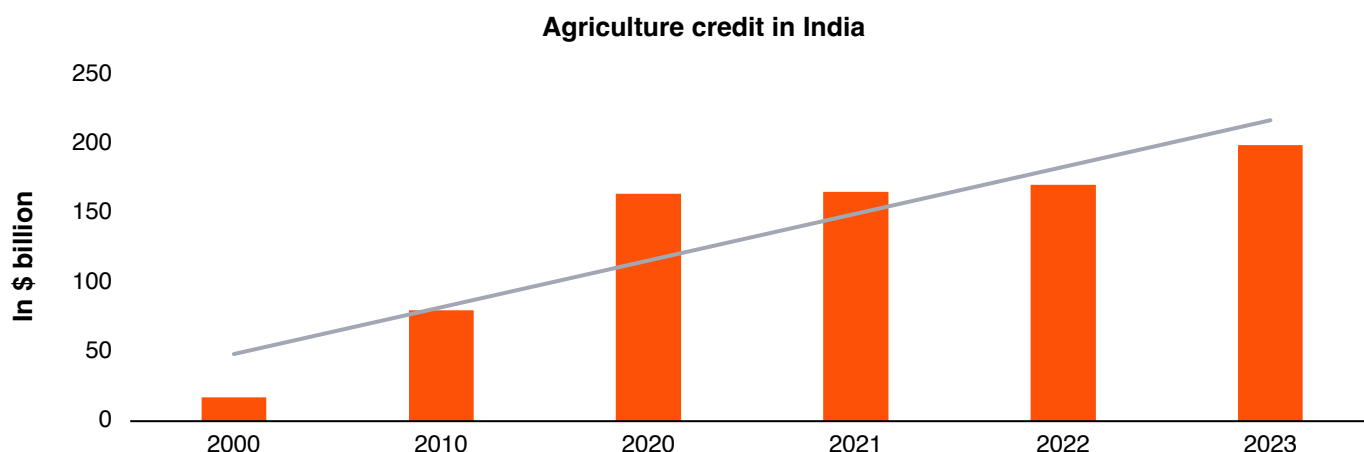
Subsidies play a crucial role in accelerating the adoption of farm mechanisation, given its capital-intensive nature and the limited financial capacity of small and marginal farmers. Specially curated schemes such as the SMAM have been effective in reaching underserved areas.

However, much effort is required to innovate and ensure easy financing for farm mechanisation. Innovative lending models must be institutionalised to increase the penetration of credit facilities targeted towards boosting farm mechanisation in the country.

36. <https://naas.org.in/spapers/Strategy%20Paper%20No.%2018.pdf>, <https://www.pib.gov.in/newsite/PrintRelease.aspx?relid=199780>

37. https://www.rbi.org.in/Scripts/BS_ViewMasDirections.aspx?id=12799#7

India has witnessed a major thrust towards agricultural credit and is the second largest lender after China in Asia.³⁸ It has more than doubled since 2010 from \$80.13 billion to \$164 billion in 2020, and is increasing with an upward trajectory.³⁹



Source: FAO

4.2. Changing gender dynamics

India is witnessing a gradual shift in male-dominated agricultural practices, accompanied by the migration of male agricultural workforce to other sectors. This change is reflected in the increase in female agricultural workforce and decrease in male agricultural workers with an overall increase in total agricultural workforce. The incremental boost in the total agricultural workforce is driven by the increase in female agricultural workers.

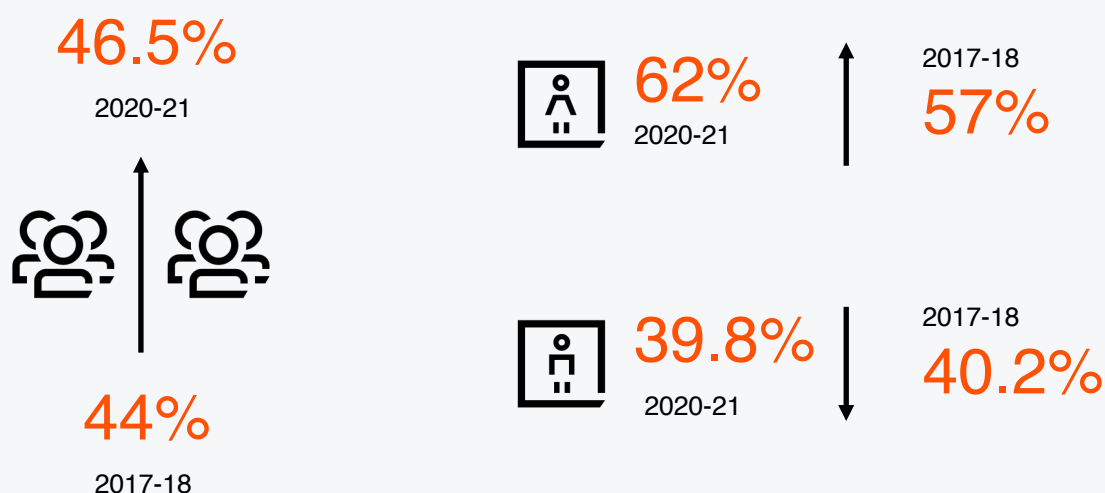
The need to empower female agricultural workers to take on greater decision-making roles must be prioritised to sustain growth and momentum in agricultural production. Customisation of agricultural machinery to make it more convenient for female agricultural workers shall further drive the adoption amongst the female workers. Female agricultural workers may face significant challenges in accessing finance due to land ownership rights, which are predominantly held by male farmers.



38. <https://openknowledge.fao.org/server/api/core/bitstreams/2f5b6de0-6668-4fcc-b837-48a038ae8751/content>

39. <https://www.fao.org/faostat/en/#data/IC>

Changing gender dynamics in Indian agriculture



Source: Directorate General of Employment (DGE)

Women are significantly involved in activities such as sowing, weeding, harvesting, and post-harvest processing. However, several socio-cultural challenges can be encountered in the development process such as women farmers operating a tractor. Hence, education will play a major role during this transitional phase and would drive acceptability.

4.3. Awareness and training

Adopting modern mechanisation and technology demands enhanced skills, mutual trust, and awareness amongst farmers. A clear understanding of the benefits and cost advantages of mechanisation is essential for effective uptake. However, barriers to widespread adoption amongst farmers include the lack of exposure to new technology and shortage of skilled workforce, operators, and trainers.



05 Future-ready farm mechanisation in India

5.1 Why future-ready farm mechanisation is required

A growing need for future-ready farm mechanisation persists worldwide. In recent years, shifts in skill-based labour market have significantly affected agriculture operations. The shift from subsistence farming to commercial/profit-making agriculture demands concentrated efforts to maximise the cropping intensity, diversify cropping patterns, and adopt cost-efficient cultivation practices. It also calls for strategies to address global issues such as climate change and promote responsible cropping practices to ensure long-term sustainability.

Key facilitating scenario

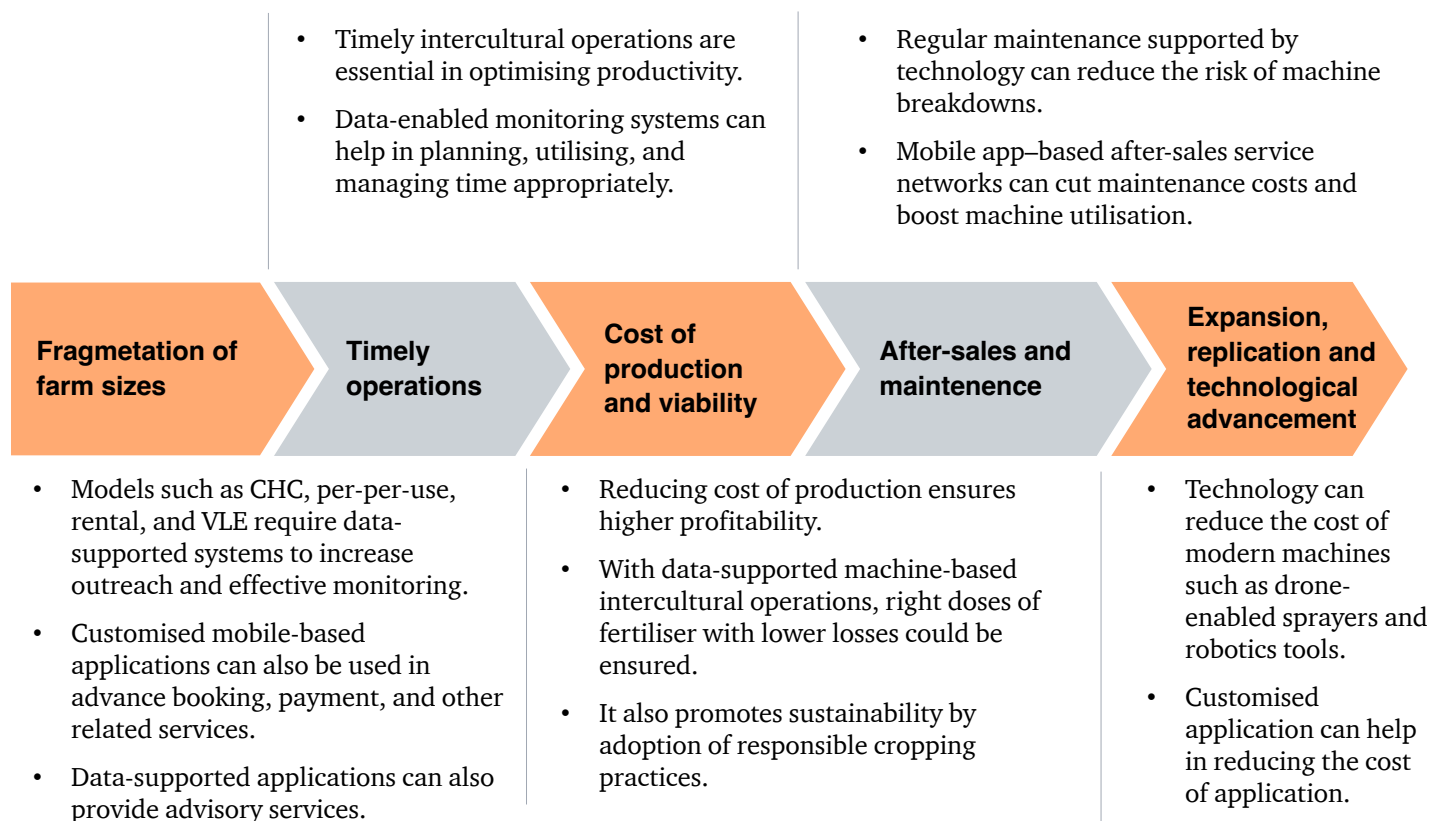
01 Rising production cost due to unavailability of timely labour • Unavailability of skilled manpower • Uneven distribution of agricultural labour across regions	02 Need for increasing cropping intensity • With the growing population, the country needs more agriculture production. • To achieve the global standard of productivity, timely and precise intercultural operations are necessary.	03 Shifting from subsistence to commercial agriculture	04 Globally challenging situations such as climate change and urgent food demands
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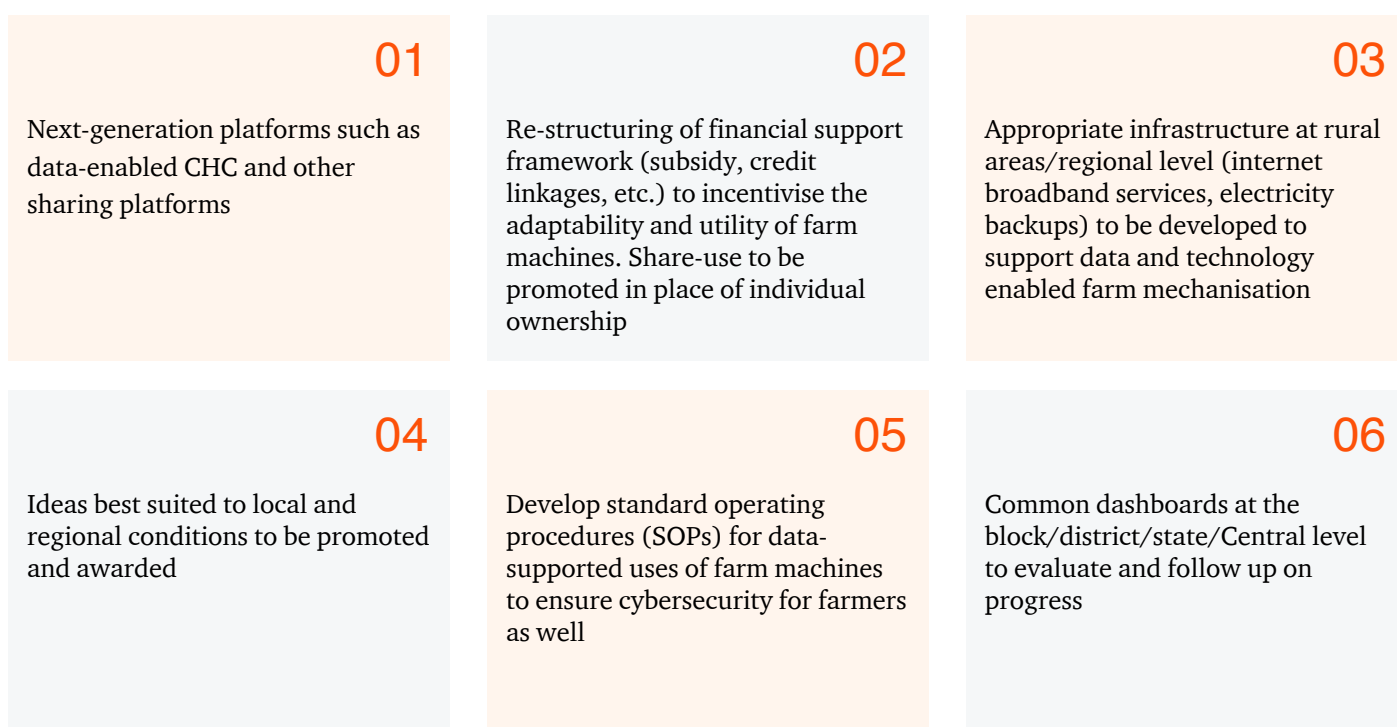
5.2. Data/technology-driven farm mechanisation

Future-ready farm mechanisation in India extends beyond increasing density and deployment of farm machines. It emphasises how to improve the adaptability and utilisation of farm machines and how to incentivise different models that will benefit small and marginal farmers across regions. Data-driven and customised approaches could make significant impact. Currently, a significant difference exists in the reach of mechanisation across regions/states. Given that the majority of farmers belong to the small and marginal category, with comparatively small farm sizes, adaptability remains an issue. Nonetheless, these challenges can be addressed with precise data-supported monitoring and forecasting-based models.

5.2.1. Why data and technological integration is the key to next-generation, future-ready farm mechanisation in India



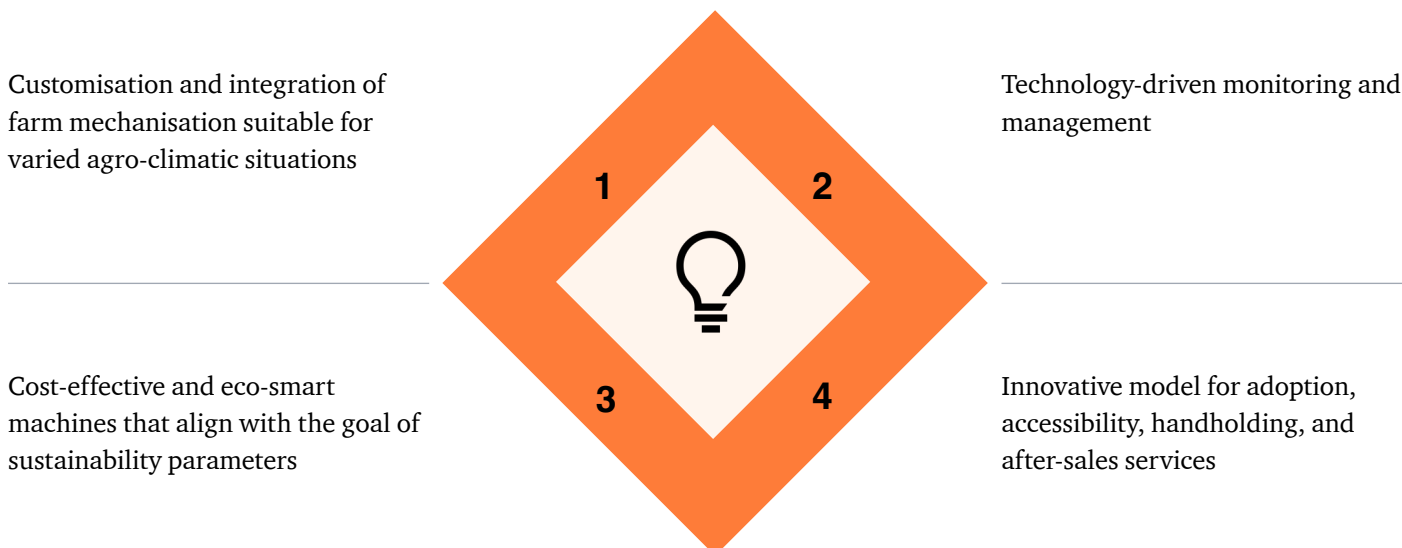
5.2.2. Suggested data and technology-enabled roadmaps for future-ready mechanisation



5.3. Strategies for scaling up farm mechanisation

With food and nutrition sufficiency at the core, and to achieve sustainable long-term impactful agriculture growth, future-ready farm mechanisation has evolved from being a choice to a necessity. Scaling up such mechanisation in the country requires a multitude of strategies. Most strategies must integrate various approaches that combine government policies, financial and institutional support, technological handholding, training and capacity building, and customised packages for adoption.

The adoption of any strategy will largely depend on four key factors.



5.3.1. Role of financing, subsidies, and training

5.3.1.1. Financing

Affordable and timely financial support has a major role in the penetration and adoption of farm mechanisation in the country. The SMAM reported that despite the subsidy arrangement by the government, farmers continue to struggle in arranging finances.⁴⁰

Key strategic point

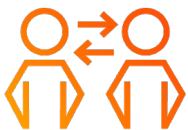
Customised financing models - Models based on current needs and utilisations - Long-term-lease-based financing models - Financial assistance/linkages to service-based models, profit-sharing models, etc. - Inclusion of add-on services, such as insurance and cost of spare parts, and proposal of integrated loan packages	Role of institutions - Establishing partnerships with financial institutions (NBFCs/banks) and farm mechanisation manufacturers - Establishing partnership with farmers' collectives such as FPO, PO, and SHGs, and farm machine manufacturers to address the actual requirements of farmers - Customising the payment tenure of loans depending on the harvest season of different crops
Inclusion of risk factors - Inclusion of risk factors such as crop loss and machine breakdowns - Insurance for farmers and machinery to be made an integral component	Re-strategising the subsidy component - Subsidy to be integrated with credit linkages - Adoption and utility of farm machines to be integrated with subsidy - Fixing a specific time or minimum cropping season for releasing the full 100% subsidy

40. farmech.dac.gov.in

5.3.1.2. Subsidies

Government subsidies are a key catalyst in accelerating and maintaining the pace of future-ready farm mechanisation. In India, where a majority of farmers are small and marginal (around 86%), inclusive farm mechanisation must be promoted to help farmers overcome challenges in terms of affordability. Farm mechanisation is a capital-intensive activity requiring prior investment, which is often beyond the means of small and marginal farmers.

Key strategic point



Small and marginal farmer centric strategies

- Customised subsidy components
- In place of individual ownership, subsidy to be redesigned to incentivise shared use models, rental models, and tool banking models.



Incentivisation and replication of successful models

- Subsidies can be linked with the replication of successful models.
- Entrepreneurship could be incentivised and linked with subsidies as well.



Customised design to increase adaptability and usage

- Customised subsidy component to prioritise quality over quantity
- Customised subsidy for types of farm machines

5.3.1.3. Training, handholding, and capacity building

Training, demonstration, and capacity-building support to various stakeholders are the backbone for designing any strategy aimed at scaling up future-ready farm mechanisation in India. Although access to affordable farm machinery is important, adoption and utilisation completely depend on the skills and capacities of farmers. However, exposure to modern farm equipment, particularly to small and marginal farmers, remains limited. Targeted skilling, handholding, and capacity building through different approaches ensure real utilisation of farm tools and conversion of investment into tangible productivity enhancements.

Government and private institutions such as Krishi Vigyan Kendras (KVKs), State Agricultural Universities, dealers, and service providers, can be crucial in handling the customised training and handholding interventions. Modern technologies such as e-learning modules, customised mobile applications, virtual sessions, and demonstration sessions can be integrated to further strengthen the training and handholding intervention.

Key strategic point

01

Expansion and strengthening of the network of training centres related to testing, demonstration, operation, safety measurements, etc., of farm machines at the regional and local level

02

Subsidies and financing to be linked to skill upgrade, with support tied to certification

03

Digital and remote platforms to be leveraged to extend services to remote and hard-to-reach areas

04

Specially curated training modules to be developed to ensure the skilling of all stakeholders, including VLEs, service enablers, machine operators, technicians, and other key participants

5.3.2. Collaboration between stakeholders (government, private sector, NGOs, CSR donors)

Strategies for scaling up future-ready farm mechanisation require multi-dimensional approaches and concentrated efforts. To increase mechanised operations in various crops across regions and states, a coordinated effort from all stakeholders is necessary.

The 3Cs—collaboration, convergence, and creation—are important strategies to impact cost, quality, and content. Future-ready farm mechanisation is not only a vision for technology and data co-ordination, but also a commitment to system-oriented transformational approaches.



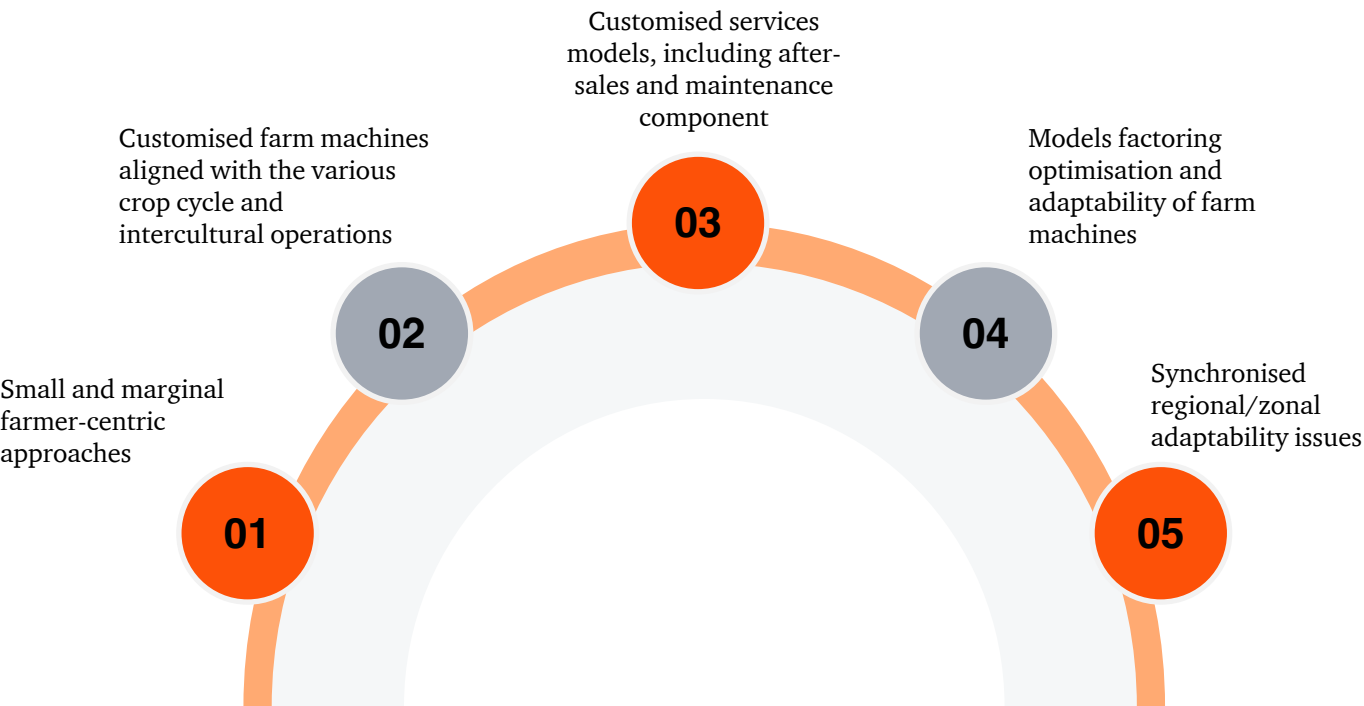
Key strategic point: Coordination mechanisms and roadmap

Monitoring and steering committee at the state and Central level (government + private players + farm equipment industry) + banks/NBFCs + farmer collectives + CSOs/NGOs/CSR	Shared platforms to provide access to data on machine utilisation, financing and subsidies, service mechanisms, adaptability, and capacity-building records
Platform for conducting research and demonstration in collaboration (government and private research institutions + industry houses + NGOs/CSOs/CSR)	Platform for designing common risk-mitigation arrangements

5.3.3. Customised farm equipment/tools/machines for a future-ready agriculture ecosystem in India

With efforts from different stakeholders, the country is advancing towards increasing the adoption of future-ready farm mechanisation. However, several challenges remain, including the diverse farm sizes across regions. India has diversity in farm size, cropping patterns, availability of skill base, and agro-climatic situations. Thus, a single design or prototype is not fit for the entire country.

5.3.3.1. Farm equipment/tools/machines: Customisation based on the size of farm and utility as per crop



5.3.3.2. Service and business-based solutions

01

Pay-per-use business models can be replicated.

02

The concept of VLEs can be adopted.

03

A tools and equipment bank could be established, utilising champion farmers and youth as key facilitators.

04

A technology-supported platform can be developed for tracking, monitoring, and service delivery.

05

Cluster-based farming approaches have been successful across regions.

5.3.3.3. After-sales services and timely doorstep maintenance

Timely and quality after-sales services must be maintained.

Youths and women could be trained, promoted, and supported.

A cadre of such trained persons could be part of strategies.



Timely maintenance not only extends the lifespan of machines but also helps prevent losses caused by breakdowns.

Timely availability of spare parts is also part of after-sales services.

5.4. Outreach and effectiveness

Small and marginal farmer-centric approach	• Subsidies to focus on small and marginal farmers • Youth and women: skilled as service providers
Multi-tier intervention roadmap	• Customisation of packages with farm equipment specifications, service delivery models, financing modalities, etc. • Graduation approaches for different sets of beneficiaries
Credit and financing linkages models	• Shared utilisation over individual ownership • Customised credit products model with add-on packages like insurance
Training, handholding, exposure, and farm demonstration methods	• Customised training modules, technology-driven demonstrations, and region-specific training centres • Mobile training units with experts
Shared platform for different stakeholders	• Monitoring and steering committee at the state and Central levels • Shared platforms for data access, R&D, and collaborations

Conclusion

In India, agriculture remains the largest sector in terms of employment generation. As the country pursues sustainable growth to achieve the goal of becoming a developed nation by its 100th year of independence in 2047, setting a clear vision for this sector is both crucial and challenging. Over the next quarter century, the population of the country is projected to reach approximately 1.61 billion. Simultaneously, the country is expected to witness an annual increase in food demand by 2.3–2.4%, underscoring the need for strategic interventions in agriculture.

To achieve the Government's target of a \$30 trillion economy with a per capita GDP of \$18,072, the country must advance from being a middle-income to a high-income economy. Out of the 17 Sustainable Development Goals (SDGs), 6 are linked with the agriculture sector, making it more challenging and critical. By 2047, the sector is all set for a complete transformation led by technology-enabled, future-ready approaches.

In the path towards a future-ready farm mechanisation, the country has already established tested and successful policy frameworks such as SMAM and widespread workable models such as CHCs, VLFMBs, FPOs, and VLEs, supported by a robust ecosystem. To achieve a technology-enabled, prosperous farming future, the core focus must be shifted from highly subsidised distribution models to a demand-driven customised approach. This approach must focus on creating demand (felt needs), providing customised technology-enabled services, fostering entrepreneur-led after-sales and support systems, leveraging data-driven monitoring approaches, and establishing output-linked credit linkages. The shift will also prioritise gender inclusivity and empower the youth to become the drivers of next-generation, technology-enabled farming, resulting in sustenance, optimised production and productivity, inclusivity, greater resilience, and enhanced family well-being.

The most important driver to accelerate the adoption of farm mechanisation in India will be a shift from individual ownership to 'pay-per-use models'.

Individual ownership model Works efficiently in case of big farms and commercial farming system	Pay-and-use models/shared models/CHC model Much more viable and adaptable for small and marginal farmers having small farm holding
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