

Farm mechanisation: Ensuring a sustainable rise in farm productivity and income

pwc

FICCI

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Government of India

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MESSAGE

The Government has introduced several schemes and policies that support greater mechanization of Indian Agriculture. The Sub Mission on Agricultural Mechanization (SMAM) is an important initiative of the Government, in this direction.

The focus on farm mechanization is driven by the need for enhancing agriculture productivity and availability of food grains; increasing agriculture exports and facilitating judicious use of scarce natural resources and farm inputs. Keeping this in view, an ambitious target of increasing the availability of farm power from 2.02 kW per ha (2016-17) to 4.0 kW per ha by the end of 2030 has been set.

Performance of the agricultural sector has significant impact on the sustainable growth of economy. It is an opportune time that India moves towards technology driven agriculture growth. I strongly believe that technologies for farm mechanization have a lot to contribute in the development and sustainability of agriculture sector.

I congratulate FICCI and PwC for coming up with the knowledge Report on farm machinery sector. I with this report help in opening up another facet to the emergent knowledge base of farm mechanization sector.

(Parshottam Rupala)

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& FARMERS WELFARE
GOVERNMENT OF INDIA

MESSAGE

There is a widespread realization that farm mechanization is indispensable for increasing yield. To realize the Government vision of doubling farmer's income by 2022, farming system need to be adequately mechanized and customized for Indian scenario. The challenge lies not only in leveraging farm mechanization for enhancing agricultural productivity, but also to identify ways to include a large community of small and marginal farmers for adopting mechanized farming.

Government of India has been encouraging mechanization through various policy interventions. However, greater impetus is needed to develop need-based and regionally differentiated farm machinery for country.

I believe, technological innovation in farm equipment sector is one lever that can catapult Indian Agriculture to next level.

I congratulate FICCI and PwC for coming out with knowledge report on **"Farm mechanization in India: Ensuring sustainable rise in farm productivity and income"**. I hope this report works as a strong point of reference for all stakeholders in the farm mechanization sector.

(Kailash Choudhary)

Dated 26.11.2019
New Delhi

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MESSAGE

Though India is one of the world's largest agricultural economies, its agribusiness is characterized by a multitude of fragmented supply chains. Agriculture in India is spread across 6,00,000 villages. Therefore, constant application of latest ideas to provide customized solutions to diverse needs of farming community is required.

Enhancing farm mechanization is a key step towards better rural prosperity. While Indian tractor market is highly organized and among the largest in world, the farm equipment market needs to diversify and move beyond tractorization. Agricultural mechanization is today a critical sector given the constrains of availability of shortage of labor during peak season. Special attention should be paid to develop the technologies / equipment for small and marginal farmers especially for planting and harvesting operations.

There is ample evidence that suggests that productivity improves dramatically with usage of more farm power. **I congratulate FICCI and PwC for coming up with the knowledge Report on farm machinery sector.** I am sure this report will address some of the key interventions necessary to take Indian farm machinery sector to next level.

(T. MOHAPATRA)

Dated the 27th November, 2019
New Delhi



Dilip Chenoy
Secretary General
FICCI

Message from FICCI

Farm mechanisation plays a key role in sustaining agricultural growth. The global farm machinery market has reached a valuation of USD 200 billion in FY19 and is expected to grow at a compound annual growth rate (CAGR) of 9% from FY19 to FY25. Globally, Europe, Asia-Pacific and North America are the top-performing regions for the agriculture and farm mechanisation sectors.

Governments across the world are trying to focus on increasing food productivity. The demand for agricultural equipment with modern technology is expected to rise, as machinery with better technology will act as a catalyst to increase agricultural yield. The farm equipment market in India is estimated to be worth USD 3 billion in FY19 and expected to reach USD 18 billion by FY25 – growing at a CAGR of 6% between FY19 and FY25.

By creating an enabling policy environment and implementing the necessary interventions for strengthening the farm mechanisation sector, the Government of India (GoI) is committed to not only helping farmers in improving their socio-economic conditions by increasing farm income, but also boosting the overall development of the agriculture sector through technology-based mechanised solutions. We hope this report will encourage more discussion around policy developments in the farm mechanisation sector.



Alessandro Malavolti
President
FederUnacoma, Italy

Message from FederUnacoma

In the last few years, agricultural mechanisation in India has become one of the most significant events from a socio-economic perspective. The impressive increase in the volume of tractor sales – which is four times higher than that recorded by the European and US markets – represents a decisive factor. Mechanisation brings in an increase in agricultural productivity, rational use of resources, reduction in working time, and improvement of life conditions of the rural population. This shift must be directed, integrated into a development policy, and turned into a functional development model exactly in the way GoI and its institutions are doing. In fact, mechanisation can be effective only if its implementation is planned according to the specific demands of agriculture and monitored according to the results achieved in various contexts. This approach is not obvious, as the history of agricultural mechanisation is often characterised by dynamic phases, during which the distribution of means takes places in a way that is spontaneous and not always rational.

In Italy, as well as in other countries in which the process of mechanisation of agriculture began way back in the 1960s, the purchase of machinery by agricultural enterprises almost occurred by chance, with demand oriented towards high-power machines and oversized equipment. Though such mechanisation enabled farmers to quickly familiarise themselves with a wide range of technologies, it also caused diseconomies, a negative environmental impact and poor flexibility to adapt mechanical components to new crop trends and shifting market demands.

In contrast, mechanisation which is structured according to the specific demands of agricultural enterprises and is compliant with a specific development model produces both economic and environmental benefits. Within these strategic choices, a leading role is played by knowledge of both the agricultural and farm mechanisation sectors.

The study conducted by FICCI and PwC India, and presented during EIMA Agrimach 2019, presents useful insights into the state of agriculture and mechanisation in India. These insights can be used to evaluate the progress of technological development in the agriculture sector and effectively implement development policies in the sector.



Ashok Varma
Partner, Government Reforms and Infrastructure Development (GRID)
PwC India

Message from PwC

India's agriculture sector accounts for around 15.9% of the country's USD 2.7 trillion economy and 49% of total employment. The structural changes in the economy have resulted in the movement of labour from agriculture into other sectors. The need to make agriculture technology driven and less labour-intensive is more urgent than ever. This seems to be the only way to achieve higher per unit productivity and sustainable agricultural growth.

Domestic sales of tractors have increased from 3 lakh units in FY9 to 7.8 lakh units in FY19, registering an impressive CAGR of 10%. Traditionally, tractors and tractor-led devices have dominated farm equipment use, largely helping in land preparation, sowing and other activities which require mobility. In the recent past, easier availability of other specialised equipment for post-sowing and harvesting activities is transforming the way an average farmer works. The service models piloted across the country are gradually helping farmers to access machinery without owning it. Digital technology is expected to play a much larger role in agriculture in the coming years.

We anticipate innovations that will lead to the development of new equipment and services which address typical challenges like small landholding and low investment appetite.

The farm machinery industry is poised at an inflection point from where it is set to move into a high-growth period and expected to transform the way an average Indian farmer works in the farm. However, the pace of this transformation would depend on how all stakeholders (e.g. farmers, machinery manufacturers and the government) work together to provide an appropriate policy framework, schemes, financing mechanism and technology that is suited for diverse climatic and environmental conditions.

This knowledge report proposes a few strategic intervention areas which would help India to achieve the stated mechanisation objectives in the near future. We hope this report will be useful to stimulate new ideas and help in opening up another facet of the expanding knowledge base of the farm machinery sector.



T R Kesavan
Chairman, FICCI National Agriculture Committee and Group President, Tractors and Farm Equipment Limited (TAFE)

Message from FICCI

Optimum input-use efficiency and sustainable productivity increase are key challenges faced by the Indian agriculture sector. The degree of mechanisation and investment in new technologies has a big role in resolving these two challenges. Studies reveal that adoption of appropriate mechanisation of farm operations can increase food production and farm productivity by 10–15% and cropping intensity by 5%–20%.

In emerging economies like China and India, there has been a rising trend of farm workers migrating from agriculture to other industries, leading to high labour shortages in the agriculture sector, especially during labour-intensive operations. Therefore, India is at a point where it needs to not only find ways to promote precision farming through automation and mechanisation but also ensure effective adoption of technology. Going ahead, we need to find diligent ways to promote the 'right technology' through an acceptable 'model for maximising adoption'.

Agriculture does not suffer from a lack of ideas or government initiatives. There is a need to bring in convergence, work together and develop future interventions in farming that have a positive impact on retained income of farmers as well as farm productivity.

This knowledge report is timely as it consolidates relevant facts and contains a wealth of information and analysis on the farm mechanisation sector. I am certain the report will be of interest to policymakers, industry players and academia.



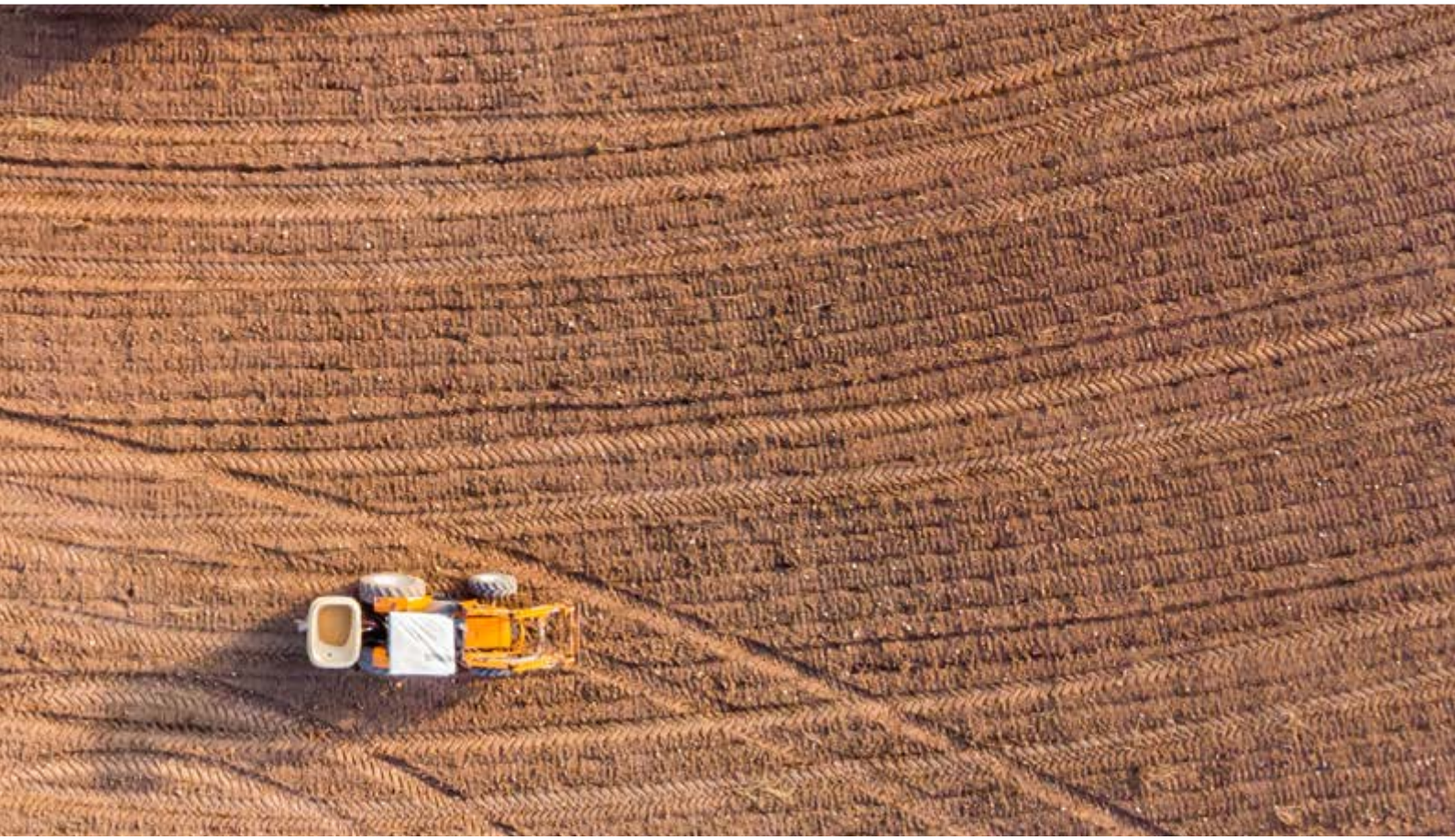


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A. Executive summary

Over few past decades, agriculture has evolved into a highly diverse and complex sector globally, with operational units ranging from small and sustenance-based farm holdings to large corporate farm holdings. Farm input and output products are sold not only in local markets, but also across the world through sophisticated and modern value chains. Beyond the traditional role of providing mankind with food, farmers are now important custodians of the natural environment and have become producers of fuel and fibre as well.

With the rise in population, food insecurity and malnutrition have been posing serious challenges at the global level, especially in developing economies. At the current and forecasted growth rate pattern, **the world's population is projected to reach near 10 billion by 2050.**[1] The declining contribution of agriculture to GDP and employment are additional concerns. Although agricultural investments and technological innovations have boosted productivity levels considerably, the growth of yields has not been adequate enough to meet these emerging challenges and future requirements.

In India, the contribution of the agriculture sector is vital for the economy. On the one hand, it has promoted the service and manufacturing sectors along with meeting the food and nutritional demands of the ever-rising population, and on the other hand, it has contributed to macroeconomic stability. Through the adoption of improved inputs such as high-yielding varieties (HYVs) and inorganic fertilisers during the Green Revolution, the sector attained self-sufficiency. Since then, the sector has seen phenomenal growth and now boasts a significant global presence in terms of production of major food commodities like rice, wheat, milk, sugarcane, fruits and vegetables. Nationally, the agri and allied sector contributes around **15.9%** to the GDP and employs **more than half** of the workforce.[2] Despite these remarkable achievements, the growing population in India and related constraints continue to exert significant pressure on agricultural land and call for increased mechanisation.

Farm mechanisation in India is in the initial stages, with the mechanisation level ranging from **40–45%,** which is very low compared to that in developed economies, where mechanisation has reached **beyond 90%.**[3] India's farm equipment market is 7% of the global market, with **more than 80%** of the value contribution coming from tractors. Even though the growth of mechanisation has been slow, the overall foodgrain production in India grew from **over 50 million tonnes in 1950–51 to 283 million** tonnes in 2018–19. The adoption rates of farm equipment have increased as indicated by the sales of tractors sale and the rise in farm power availability (FPA) in the recent past. Domestic sales of tractors have increased **from 3 lakh units in FY09 to 7.8 lakh units in FY19,** registering a phenomenal **CAGR of 10%.**[4] In addition to the impressive domestic sales volumes, India has exported **92,095 units** of tractors during FY19. Average FPA in India has also risen from **1.1 kW/ha in 1995–96 to 2.02 kW/ha in 2017–18.** India is also one of the largest manufacturers of equipment such as tractors, harvesters and tillers.

In addition to **agricultural, social and economic growth drivers** of mechanisation, macroeconomic and intrinsic factors such as the **growing population and demand, urbanisation, surge in agri exports such as tractors, improved flow of agricultural credit, labour migration and shortages** are also necessitating the adoption of mechanised solutions in Indian agriculture for long-term and sustainable growth. With the rise in pollution and huge nutritional losses through crop residue burning, mechanised solutions like the super **straw management system (SMS)**[5] and promoting Custom Hiring Centres **(CHCs) around stubble management** are other important drivers fuelling sectoral growth. Technology integration by **farm mechanisation start-ups,** especially based on the farming as a service (FAAS) model, is gaining significant momentum these days. With a high emphasis on **precision agriculture** in India, a majority of agriculture equipment manufacturers are now focused on integrating multiple technologies such as robotics, Global Positioning System (GPS) and navigation systems to enhance the effectiveness of their equipment and gain a competitive advantage.

Among the enabling policy initiatives, the Government of India (GoI) has executed various schemes and policies supporting greater

1 The future of food and agriculture: Trends and challenges, FAO 2017

2 Planning Commission and National Sample Survey Organization (NSSO)

3 World Bank Open Data 2019, FederUnacoma, PwC analysis

4 Industry reports, Tractor Manufacturers Association 2019, PwC analysis

5 Guidelines (Amended) of Straw Management Scheme



mechanisation of Indian agriculture, in the light of its commitment to transform the agriculture sector and **double farmers' income by 2022–23. The Sub Mission on Agricultural Mechanization (SMAM)** is a significant initiative by GoI in this direction. The focus on farm mechanisation is driven by the need for enhancing agriculture productivity and availability of food grains, increasing agriculture exports, mitigating labour shortage, and facilitating judicious use of scarce natural resources and farm inputs. Keeping this in view, an ambitious target of increasing the availability of farm power from **2.02 kW/ha (2016–17) to 4.0 kW/ha by the end of 2030[6] has been set.**

Though there are significant opportunities and drivers of farm mechanisation in India, **fragmented landholdings, supply-demand mismatch, limited access to finance and institutional credit, a subsidy-driven market, poor implementation mix in GoI support programmes, inefficiencies associated with subsidy disbursal and skill gaps** are some of the challenges the sector faces. To address these gaps, **efficient scheme implementation and an improved delivery mechanism, forging Public Private Partnerships (PPP) models, ensuring future-ready farm mechanisation, skill upgrade and improved access to finance** are the necessary interventions. These measures can be implemented in the short- and medium-term future to ensure a sustainable rise in productivity and boost farm income.

6 Comprehensive Policy Recommendations, Report of the Committee on Doubling Farmers' Income, MoA&FW, September 2018

B. Need for mechanising farm operations in Indian agriculture: Setting the context

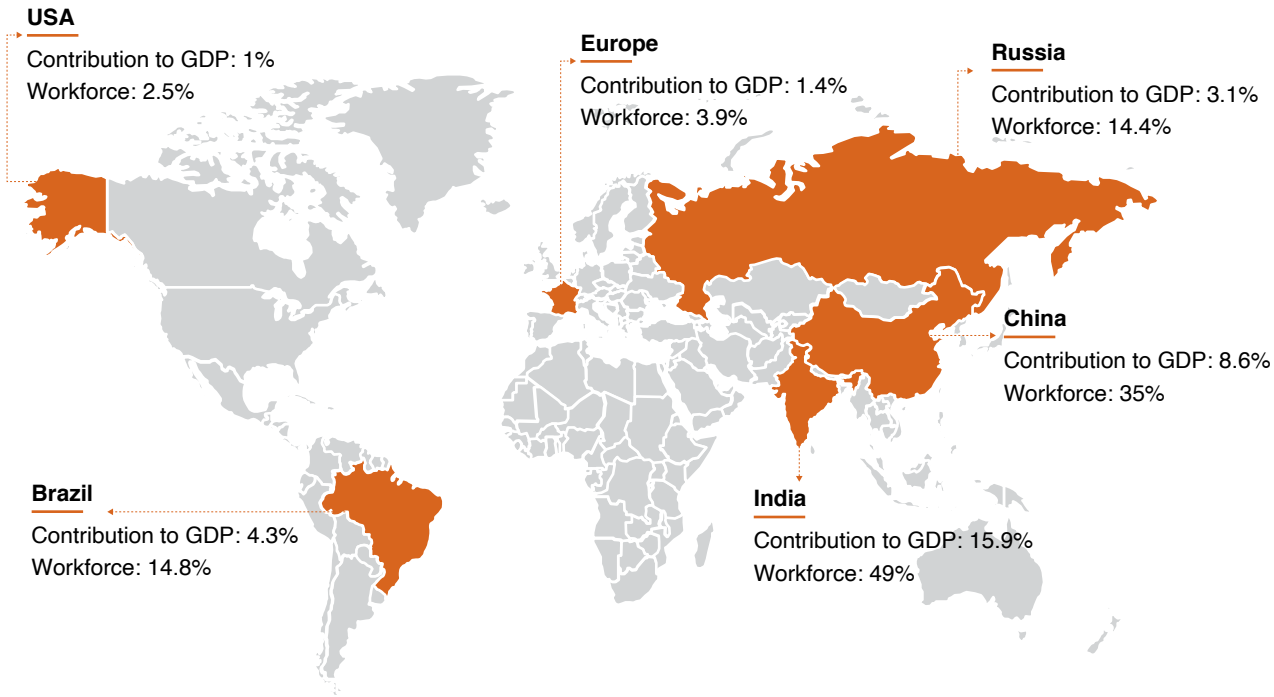
The global economy continues to face challenges such as escalation of US-China trade relations, macroeconomic stress in Turkey and Argentina, and normalisation of monetary policies with financial tightening in advanced economies. The International Monetary Fund (IMF) forecast a global economic growth rate of 3.3 % in FY20, as against the rate of 3.6 % achieved in FY19, with emerging economies facing a major downward growth trend.[7]

By 2030, the world's population[8] is forecasted to reach 8.5 billion and around 9.7 billion by 2030, which makes it crucial to find solutions to fulfil future food, feed and biofuel requirements.[9] In the near future, most of the additional demand for food is expected to be from the regions experiencing high population growth, particularly India, the Middle East, North Africa and Sub-Saharan Africa.

Role of agriculture in shaping the global economy

The agricultural sector not only contributes towards securing livelihoods of large populations of developing countries but also helps to sustain economic growth in developed economies.

Comparative analysis of share of agriculture in GDP and percentage of workforce employed in the agriculture sector across the world



Source: World Bank data, PwC analysis, and Mechanisation – Key to higher productivity to double farmers' income, 2017, FICCI

- The agriculture sector's contribution to the GDP of developing nations like India remains significant in comparison to that of developed nations. Also, the percentage workforce engaged in agriculture is **very high** in developing economies **(49% in India)** as compared to that in developed nations like the **USA, where it is only 2.5%.**[10]
- Globally, the industry and service sectors together contribute **more than 95% of the world's GDP.**[11]

7 Industry reports and PwC analysis

8 The future of food and agriculture: Trends and challenges, FAO 2017

9 World population projected to reach 9.7bn by 2050, UN report

10 Industry reports and PwC analysis

11 USDA – Foreign Agricultural Service data, 2017

It is important to note that while on the one hand, the world's agricultural production is forecasted to grow by 15% in the coming decade (from FY19 to FY28), on the other, no increase in the global agricultural land use is expected. The expected increase in crop production can mainly be credited to technological innovations and developments resulting in enhanced yields and better production intensity.

Agricultural investment orientation ratio (AIOR):[12] An imperative for sustainable growth

Regardless of the low share of the agriculture sector in GDP, developed economies have made considerable investments in the sector for sustainable growth compared to their developing counterparts.

In order to measure the share of investment in agriculture against the GDP share of the sector, an index called **AIOR**[13] has been adopted globally. In the last two decades, the AIOR for developed and high-income countries has consistently been above 1, whereas for developing economies, this ratio is far lower at approximately 0.4.

Driving demand and growth in agriculture

In general, agricultural products are used as food, feed, fuel and raw materials for industrial applications.

Utilisation of key agricultural products and demand drivers



Agricultural products

- **Food**
  - Crop
  - Livestock
  - Fish
- **Feed**
- **Biofuels**
- **Others (fibres)**

Key demand drivers:

- Population
- Per capita income
- Market prices
- Consumer preferences
- Change in production systems
- Fuel demand
- Economic and trade-related activities
- Technology integration and automation
- Policy factors

Source: OECD–FAO Agricultural Outlook 2019-2028

A study by the FAO indicates that to meet the sectoral demand in 2050, the agriculture sector needs to increase production of food, feed and biofuel by almost 50% from that in 2012.[14] Currently, demand is being driven by a bunch of common factors such as population dynamics, disposable income, prices and consumer preferences. In addition to these basic drivers, for non-food uses such as feed, fuel and other industrial applications, a number of specific factors can be identified. For example, feed demand is derived from a combination of the food demand for products of animal origin and the respective livestock production systems. The demand for agricultural products is also subject to broader policies that shape disposable incomes.

Rise in per unit productivity: The need of the hour

Increasing resource use efficiency is essential for realising the ever-increasing food demand. However, due to lack of adequate input usage, productivity has suffered and thus not been able to keep pace with global requirements. The Global Agricultural Productivity Index™ (GAP Index™) 2018[15] indicates that for five consecutive years, growth in agricultural productivity has not advanced enough to sustain the demand of almost 10 billion people (by 2050) in terms of food, feed, fuel and fibre.

12 The future of food and agriculture: Trends and challenges, FAO 2017

13 www.fao.org/about/meetings/future-of-food/key-documents/the-future-of-food-and-agriculture-alternative-pathways-to-2050/en

14 The future of food and agriculture- Trends and challenges, FAO 2017

15 Sowing the policy seeds of a flourishing agriculture sector, PwC 2019

Apart from productivity growth constraints, booming urbanisation and the increasing population pose a different set of challenges. It has been forecasted that by 2050, more than two-thirds of the world population will be urban.[16] Also, there **has been a shift in workforce preferences from pure farm-oriented activities to associated sectors, largely due to the commercialisation of the agricultural sector. Rise in technology integration and a greater emphasis on precision agriculture are other key factors changing the employment dynamics of the global agriculture sector.** These factors certainly underline the need for a sustainable rise in per unit productivity from an existing piece of farm land.

Both developed and developing economies will play an equally important role in addressing the above sectoral shifts and concern areas. At the same time, evidence suggests that the true potential of agriculture in developing economies has not yet been realised, especially in regions where small and marginal landholders predominate. In this scenario, India could have a leading role in the subcontinent by developing economically viable and scalable solutions to ensure a sustainable rise in per unit productivity.



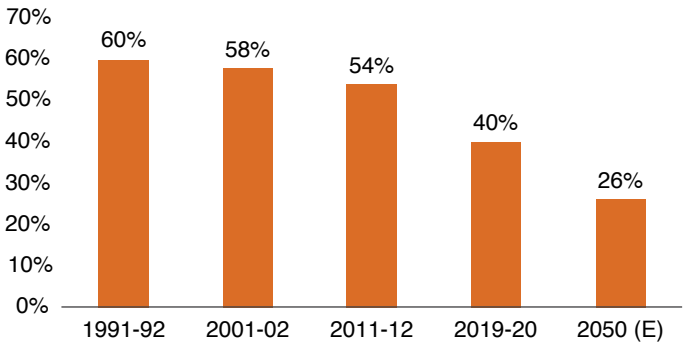
Mechanisation: Ensuring a sustainable rise in per unit productivity in India

During FY15–19, India's real GDP growth has averaged 7.5%, the highest among the major economies of the world. After registering GDP growth of 7% till FY18, the GDP growth dropped to 6.8% in FY19 due to an economic slowdown in the last 2 quarters. A recent global economic outlook pegged India's gross domestic product (GDP) growth at 6.6% for FY20.[17]

Around 58% of India's population primarily depends on agriculture for its livelihood. The agriculture sector accounts for a 15.9% share of India's USD 2.7 trillion economy and 49% of the total employment (2018–19).[18] Even with a lower rate of technology adoption, total foodgrain production in India rose from over 50 million tonnes in 1950–51 to 283 million tonnes in 2018–19.

Though India has seen high levels of production of foodgrains as well as other cash crops, there have been symptoms of stagnation in the per unit productivity in the recent past due to systemic constraints and other factors such as lack of farm manpower, , urbanisation, migration of farm labourers to the non-farm sector, and reduced livestock rearing on farms. These shifts in the sector emphasise the need for technological interventions for ushering in the next revolution. Moreover, the population pressure for increased production is compounded by the shrinking amount of arable land due to diversification of farmland into non-farm usage. Enhancing productivity through technological intervention needs a time-bound policy as well as implementation-level support.

Trend in shift of agricultural workers (% of total labour force) in India from 1991–2050 (estimated)



PwC analysis, World Bank estimates, Planning Commission, NSSO

A gradual diminishing pattern has been observed in percentage of agricultural workers to the total workforce in the country and it is projected to reach 25.7 percent by 2050 creating a critical shortage of farm labour.

Compelling results from many studies indicate that FPA and agricultural productivity are positively correlated.[19] Availability of farm power depends directly on the quantity of farm machinery with a higher weightage on tractors, power tillers, electric motors and diesel engines. In this scenario, farm mechanisation emerges as an important technological intervention for giving the desired productivity push to the country's agricultural sector. Moreover, leveraging mechanisation by means of custom hiring services (CHSs) helps not only in increasing agricultural productivity but also identifying ways of increasing the acceptance and adoption of mechanised farming by a larger group of small and marginal farmers.

16 World Bank data, 2018

17 Industry reports and PwC analysis

18 Report on Policies and Action Plan for a Secure and Sustainable Agriculture, GoI, August 2019

19 UNESCAP CSAM policy brief, June 2014

C. Current status of the farm mechanisation sector and trends

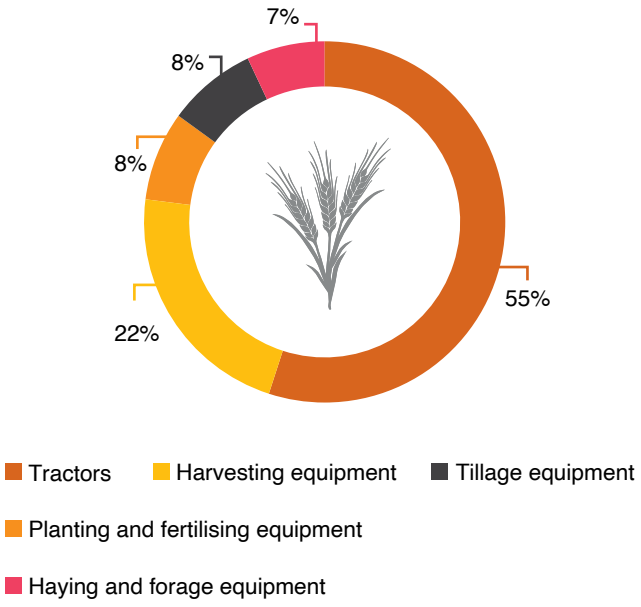
Global outlook

This section looks at the global farm equipment market, with a special emphasis on the tractor market and global trade of farm equipment.

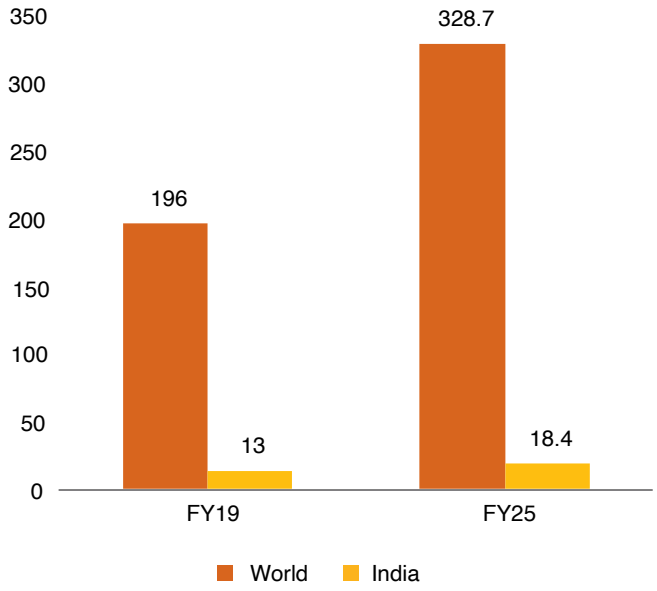
Global farm equipment market

The world's agriculture and farm machinery market is worth around **USD 200 billion in FY19,** with a predicted **compounded annual growth rate (CAGR) of 9% from FY19 to FY25. Europe, Asia-Pacific and North America** are the key performing regions of the agricultural and farm machinery market.[20] As a key contributor to farm machinery, Europe holds **30% of the market share globally.** The Indian farm equipment sector is forecasted to grow at **a CAGR of 6% from FY19 to FY25.**

Market segmentation of global farm equipment market (%)



Current and forecasted market size of global and Indian farm equipment market at 9% CAGR and 6% CAGR respectively (in USD billion)



Source: Mechanization: Key to higher productivity to double farmers' income, FICCI 2017, Imarc Research 2019, Industry reports and PwC analysis

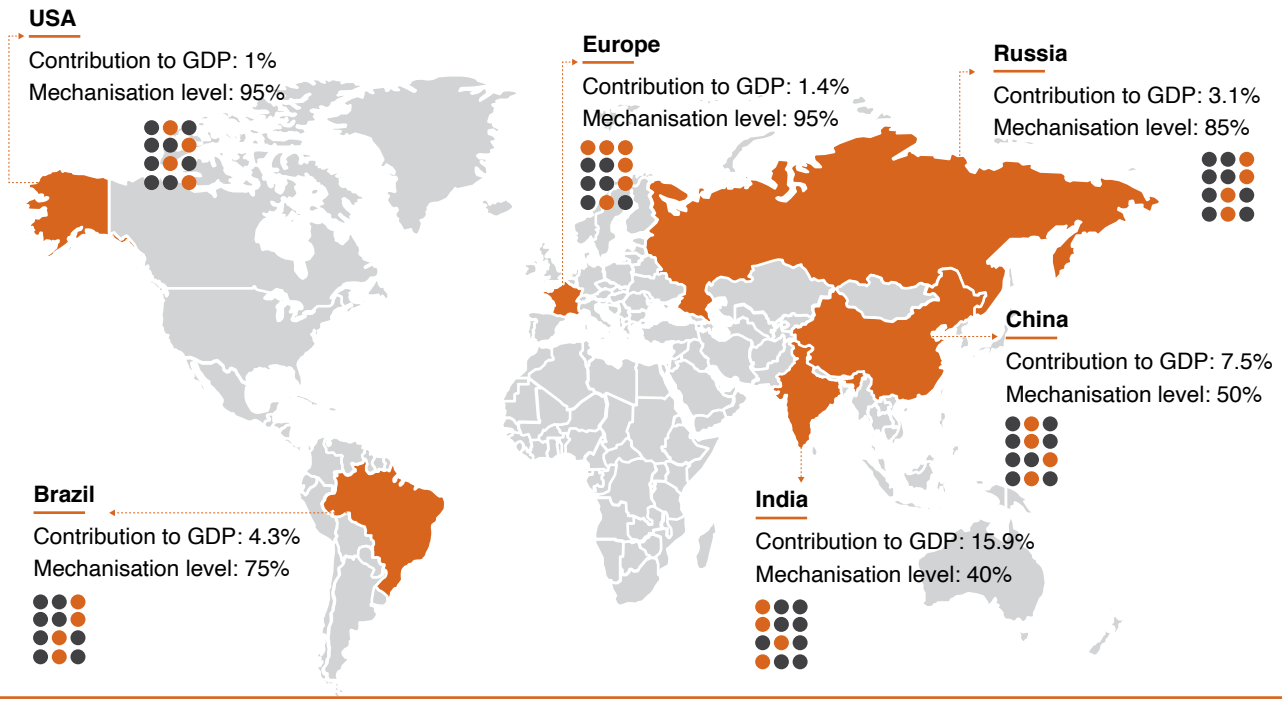
- The global market is forecasted to experience substantial growth from FY 2019 to FY 2025, resulting from the intensive inclusion of innovative and advanced technologies in the farm machinery sector. For example, a number of manufacturing companies (of farm machinery) are focused on incorporating trending and innovative technologies (such as GPS, robotic systems, navigation systems) in their farm equipment to increase productivity. Another contributing factor towards the expected growth is the support from governments in developing countries, in the form of subsidies, low rates, etc., for adopting farm mechanisation.
- The growing demand for farm tractors and harvesting machinery will promote global market growth.
- After tractors, the contribution of harvesting machinery in the global market is very prominent, with a 22% share and year-on-year growth in the segment. A major share of the demand is from the **Asia-Pacific region, especially China and India.** This demand can be attributed to the growing population in this region, resulting in rising food consumption.
- Tillage, sowing/planting and fertilising machinery account for 15% of the overall market, and are similarly forecasted to record reasonable growth in the near future.

20 Mechanization: Key to higher productivity to double farmer's income, FICCI 2017; industry reports and PwC analysis

Globally, governments are focused on enhancing the food productivity. Therefore, the demand for agriculture machinery equipped with modern technology is expected to rise as this machinery will drive yield enhancement.

The relation between mechanisation level, its key features and the contribution of agriculture to GDP across key regions and countries of the world has been assessed below.

Current status of mechanisation vis-à-vis contribution of agriculture to GDP



Legend:		
	Type of farm	Small I Medium I Large
	Machinery power preferred (HP)	Low I Medium I High
	Type range of farm machinery used	Very few I Moderate I Too many
	Adoption of precision agriculture	Low I Medium I High

Source: World Bank Open data 2019, FederUnacoma, PwC analysis

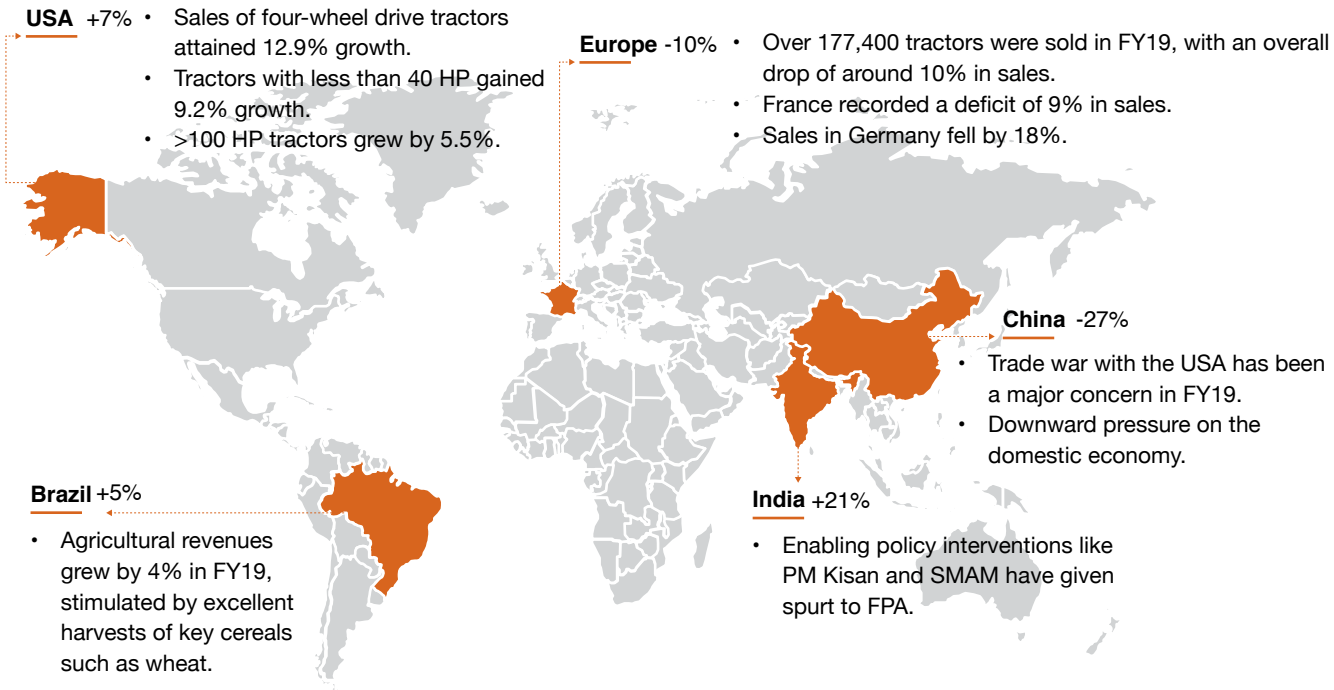
- The agriculture share to GDP in developed economies is **minimal/low,** whereas in developing countries like India, the agriculture sector makes a significant contribution to GDP.
- Level of mechanisation and adoption of precision agriculture are **higher in developed economies, especially the USA.**
- **Europe records over-mechanization with a fairly large number of machines per ha.** Further, agricultural farm sizes range from smaller ones in elevated areas to quite large farms in plains.
- The **USA is marked by fully mechanised farms and shows a trend towards farm machinery with higher horsepower.** Further, efforts are being made to move towards precision agriculture and smart farming.
- Except China and India, high machinery power is preferred across other nations due to a larger average farm size and high usage of precision farm equipment.

With the rise in uncertainties around both food supply and demand at the global level due to the unexpected impact of climate change, trade tensions, declining food availability and fuel reserves, and increasing population in developing countries, the role of both developed and developing economies would be equally crucial. In this context, smallholders of developing nations could offer potential solutions to these problems through increased production and overall gains from their harvest outputs. **Mechanisation could play an important role through evolving ways of increasing per unit productivity and derisking the constraints associated with small and fragmented landholdings.**

World tractor market

At 55%, tractors constitute the largest share of the global farm equipment market. In FY19, global tractor sales stood at **2.16 million units.** After a record growth rate of **13% in FY18,** the global market showed stagnation and achieved only **0.4% growth in FY19 amid a global slowdown.**

Key features and growth rate of tractor industry worldwide in FY19



Source: Mechanizing the world, FederUnacoma (2019)

The USA has shown significant growth over time in adoption of farm machinery, especially tractors. With **+7% growth in tractor sales in FY19,** the country has already attained **more than 95%** mechanisation.

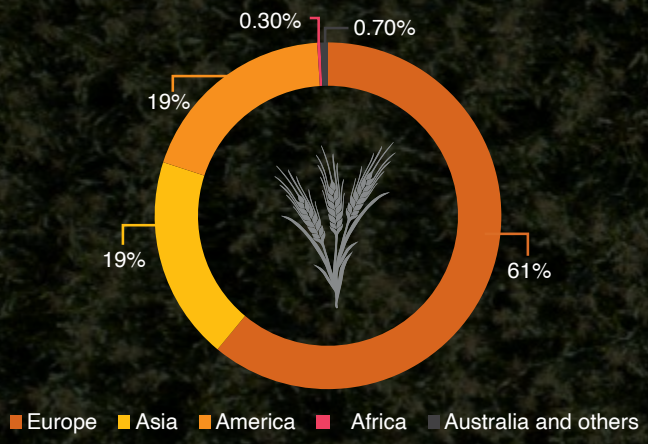
China witnessed a slowdown in sales of tractors in **FY19 compared to FY18 due to global trade tensions and domestic economic pressure. With swelling corn reserves and a shifting focus on oilseed plantations in China,** the mechanisation level may certainly change in the next few years.

The Indian tractor market is the largest globally and showed the best performance (+21%) in FY19. However, the level of mechanisation in India is still qualitatively low. Enabling policy interventions like a greater focus on irrigation, and a push to Direct Benefit Transfer (DBT) through Pradhan Mantri Kisan Samman Nidhi (PM-Kisan) have provided considerable momentum to the sector.

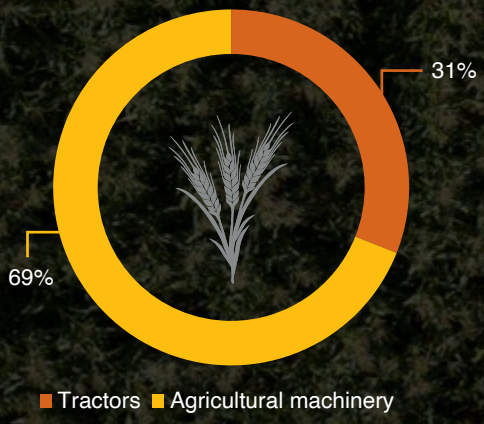
Global trade of farm equipment

Amid tightened regulations and trade tensions, in FY19, global exports of tractors and agricultural machinery stood at over **USD 64 billion. Further, 62% of total exports come from the European continent,** and almost all from the European Union countries. **Asia and the Americas rank second,** with shares of 18.9% and 18.7% of the total respectively.

Global exports (region wise) of farm equipment in FY19



Global exports of farming equipment in FY19



Source: Mechanizing the world, FederUnacoma, 2019

With reference to the type of machines exported internationally, in FY19, tractors accounted for **31% of the total exports and agricultural machinery, for 69%.** In 2008, tractors represented 38% of the total farm equipment exports, and agricultural machinery represented 62%. The increase in global exports of agricultural machinery, along with the decreasing share of tractors, strongly suggests that there has been a significant shift from **'tractorisation' to 'mechanisation'** globally.

National scenario

Market size and segmentation

India's farm equipment market is presently estimated at **USD 13 billion in FY19** and is likely to grow at a CAGR of 6%, reaching **USD 18 billion by 2025.** The overall mechanisation level of Indian farms stands at **40%,** although that varies greatly from region to region.

Farm equipment industry in India and its characteristic features

Mechanisation drivers

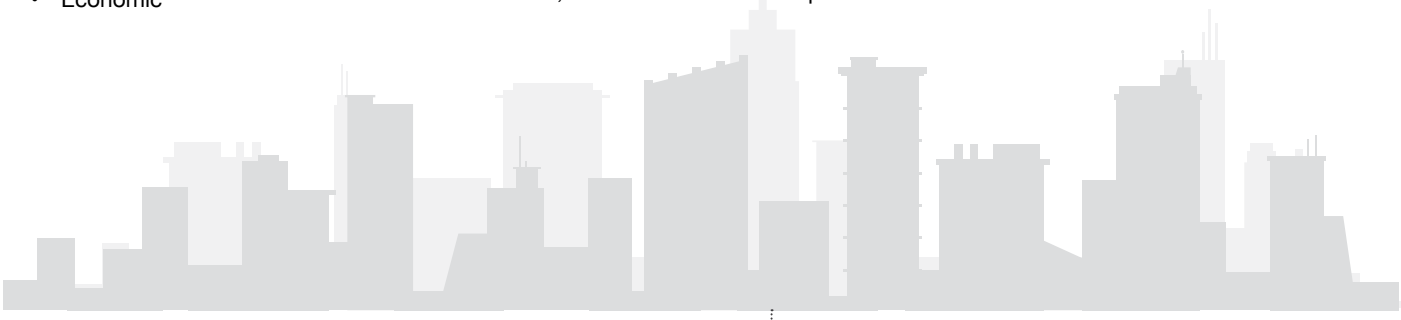
- Agronomic
- Social
- Economic

Agri-equipment industry

- USD 13 billion in size
- Dominated by 1,500 micro units, 2,500 SSIs, 250 medium-sized companies

Market leadership: Indian tractor industry

- Largest in the world (1/3 of global production



Macro outlook

- Scattered landholdings with predominance of small and medium farmers
- Low mechanisation rate vs high percentage of population engaged

Industry outlook

- Organised market size (8 lakh tractors)
- Highly unorganised market of threshers

Source: Industry reports and PwC analysis

The farm machinery market in India has a variety of products to offer, covering a multitude of operations and activities throughout the agricultural value chain. This machinery replaces traditional farming methods which are predominantly dependent on human and animate labour.



Agriculture value chain and types of equipment required

Seedbed preparation	Sowing and planting	Weeding, inter-cultivation, plant protection	Harvesting and threshing	Post-harvest and agro-processing
• Tractors • Levellers • Plough • Dozers	• Drill • Seeder • Planter • Dibbler	• Harrow • Tiller • Sprayer • Duster	• Harvester • Thresher • Digger • Reaper	• Seed extractor • Dehusker • Huller • Cleaner • Grader

Current level of farm mechanisation in India for several agricultural activities

Operation	Mechanisation level in terms of percentage (overall: 40%)
Land preparation	40
Seeding/planting	30
Plant protection	34
Irrigation	34
Harvesting	65

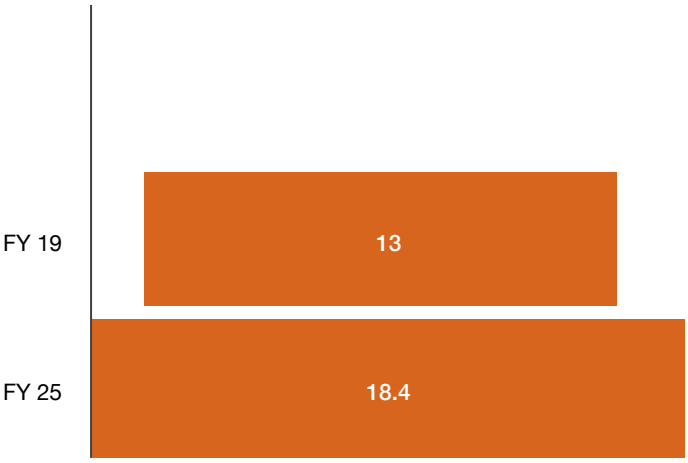
Observations:

- Except for harvesting of wheat and paddy, none of the operations are mechanised more than 50%.
- Even in critical phases such as sowing/seeding, mechanisation is a meagre 30% only.

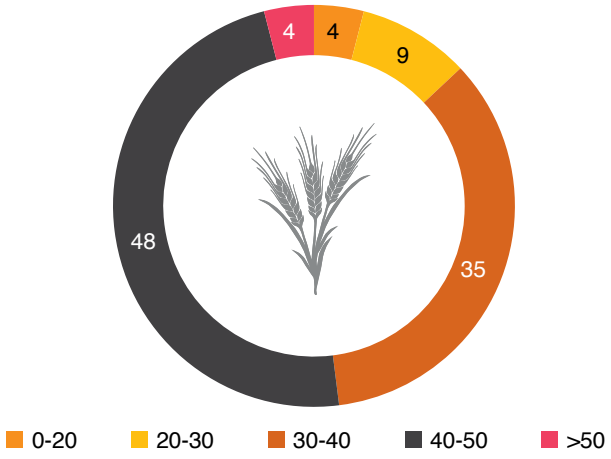
Source: UNESCAP CSAM website and 2nd Regional Forum on Sustainable Agriculture Mechanization, Indonesia, 2014

The farm machinery market is forecasted to progress at a CAGR of 6% from FY19 to FY25.

Farm equipment industry size in India in FY19 and forecast for FY22



Segmentation of market share of tractors based on HP capacity for India (FY17)



Source: Imarc Research Report Feb 2019, Industry reports, Interaction with industry experts and PwC analysis

Based on tractor power segmentation, 83% of the market share of tractors in India is represented by 30–50 HP tractors.

Farm machinery in India is either manufactured domestically or imported from the manufacturing country. The predominant farm machineries in the country are tractors, threshers, combine harvesters, rotavators, power tillers, and multi-crop planters.

Farm equipment category	Market size (in USD billion)	Farm equipment	Market share (%)	Current status
Tractors	10.5	Tractors	81.4	• Tractors have the biggest share of India's farm machinery market, contributing 80% of the total farm machinery sold in the country. • Accounting for almost one-third of the world's total tractor production, India is the largest tractor manufacturer globally. • The increasing rate of mechanisation has resulted in an increase in tractor sales. Moreover, tractors and tractor-operated machinery are significant products in the organised market. • Presently, overall sales of tractors in FY 2019 were 878,476 units, with exports accounting for10.5% of sales, i.e. 92,095 units.
Non-tractors	2.5	Thresher	2.5	• Within the non-tractor category, threshers, rotavators, harrows and cultivators, puddlers, cage wheels, seed cum fertiliser drills, weeders, power tillers, etc., are commonly used equipment.
		Rotavator	3.7	
		Power tillers	1.4	
		Others	11	

Crop-wise and region-wise adoption of mechanisation

Farm mechanisation encompasses use of technology and machinery to improve production, productivity and profitability. Currently, India's level of mechanisation is at 40% compared to 90% across the developed nations.

Moreover, the mechanisation level in India varies across crops and different crop stages as well:

Major crops	Seedbed preparation	Sowing/planting/transplanting	Weed and pest control	Harvesting
Paddy	85	5	80	70
Wheat	90	80	70	80
Potato	90	80	80	70
Cotton	90	50	50	0
Maize	90	80	70	50
Gram	90	50	60	30
Sorghum	80	30	60	20
Millets	80	30	60	20
Oilseeds	80	30	60	20

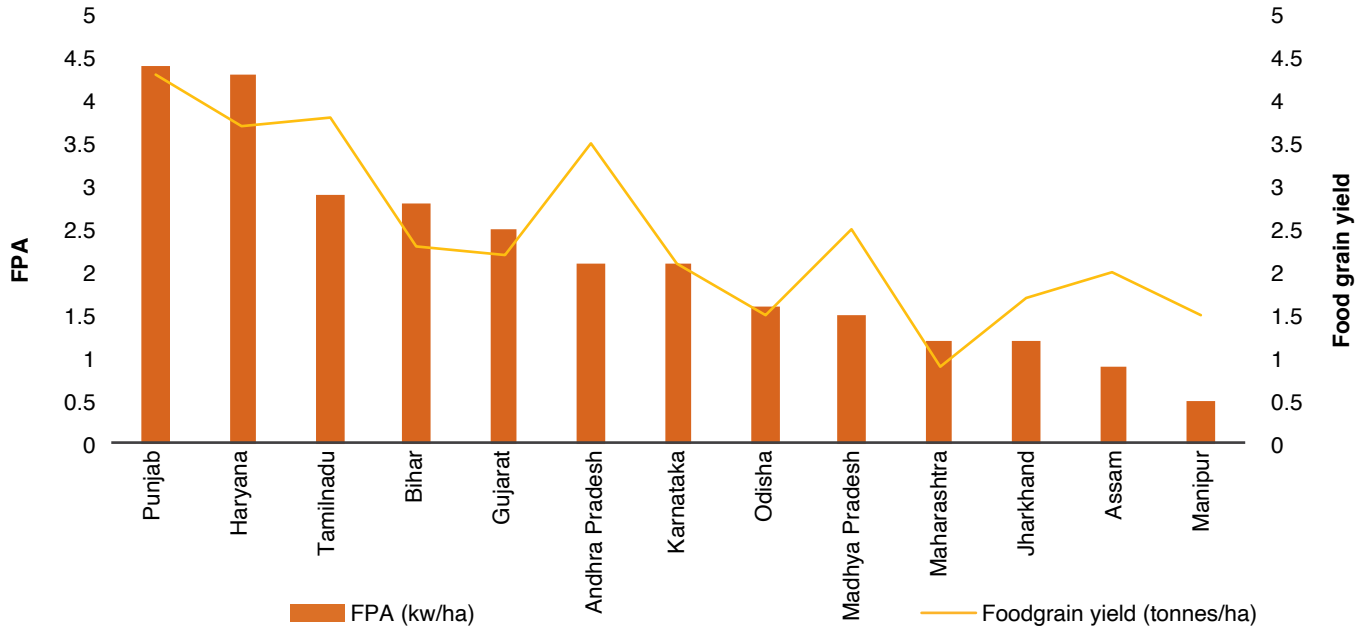
High Moderate Low



Mechanisation is significantly **low in paddy sowing/ planting and harvesting of cotton, sorghum, millets and oilseeds.** Land preparation or seedbed preparation across all the major crops is highly mechanised.

With regard to region-wise adoption, due to differences in FPA, level of mechanisation differs. Northwestern states of the country, such as **Haryana, Punjab and Uttar Pradesh (especially western states), have a higher level of mechanisation compared to their eastern counterparts.** The level of mechanisation has also been influenced by **regional farmer prosperity, which is a function of irrigation status, soil type, landholding pattern, cropping pattern and farm income.** Support from state governments towards promoting mechanisation has also been a differentiator.

Farm power availability vis-à-vis foodgrain yield of key states in India (FY17)



Source: Final Report on Monitoring, Evaluation and Impact assessment of SMAM, M&T Division, MoA&FW, May 2018

- In India, mechanisation level is measured in terms of FPA and FPA has a direct correlation with foodgrain yield.
- Northern states like Haryana and Punjab have a considerably higher FPA than the national average (2.02 kW/ha), whereas northeastern states have a very low FPA.

Landholding pattern and size are equally important factors while mechanising farms; the smaller the land size, the more difficult it gets to mechanise. Landholdings in eastern parts of the country are extremely small in size, and this becomes a major impediment for successful mechanisation.

On the basis of cropping patterns and region-specific mechanisation needs, we have divided India into four major regions:

Region	Major crops	Key mechanisation needs
Southern India	Paddy, groundnut	• Popularising **the direct seeding method for paddy** in dry upland and lowland areas with drum seeders • Promoting entrepreneurial **self-help groups (SHGs)** to operate power-driven transplanters on a custom hiring basis • Encouraging enterprising farmers to **develop and operate large-scale nursery farms** commercially • Promoting **agricultural tools and equipment which specifically cater to women farmers/labour** • Massive first-hand demonstration-based adoption campaigns/programmes for **mechanisation and other focused Training of Trainers (ToT) programmes** in mission mode
Eastern India and northeastern states	Rice, wheat, vegetables	• **Promoting high-capacity equipment custom hiring** to enable small, marginal and medium farmers to benefit from mechanisation • **Mechanising vegetable crop production** by identifying/designing and introducing appropriate equipment from seedbed preparation to harvesting. • Create and encourage **in-situ post-harvest value addition technologies and activities** to lessen losses, generate employment opportunities and ensure better returns for farmers • Involve agricultural implement manufacturers and develop **smaller hand-based tools,** including **gender-friendly equipment** • Prioritising adoption of rotavators, precision drill promotion and adoption of conservation tillage equipment (roto drills, Zero till [ZT] drills, till-plant machines, strip till drills, raised bed planters, etc.) for achieving efficient and economic tilling, sowing, planting and transplanting operations • For floriculture, ornamental and landscape horticulture, promoting power-based and modern manual gardening tools and equipment • Encouraging development and adoption of equipment for organic farming activities.
Western India	Soybean, cotton, sugarcane, wheat	• Inter-cultural farming operations require development of **high-clearance tractors having narrow tyres.** • In order to economise the water requirement in farming, **precise land levelling, sprinkler usage and drip irrigation method** to be promoted.

Region	Major crops	Key mechanisation needs
		• **Mechanisation requirement exists for planting, harvesting and managing sugarcane waste.** • There exists ample **scope of mechanisation in planting, intercultural and harvesting operations for the cotton crop.** • There is a need for **mechanising vegetable and fruit farming** across Maharashtra. **CHCs** have effectively increased the mechanisation level and farmers' access to farm machinery in the state. CHC programmes need to be further scaled up to increase the level of mechanisation in the state. • Threshing of crops such as safflower, pigeon pea and sunflower should be promoted. In the coming years, promoting **high-capacity, energy-efficient and multi-crop threshers** should be prioritised.
North India	Rice, wheat	• Diversification options (such as oilseeds, fruits and vegetables, maize, etc.) for areas under paddy need to be promoted due to a fast-depleting water table and deteriorating soil fertility. Further, **precision equipment and machinery for inputs are required to be prioritised** so as to reduce losses and to make farming operations cost effective. • There is need to promote CHCs and farm machinery banks around in- situ management of crop residue in **Punjab, Haryana and Western UP.** • Developing and promoting **power-operated weeders** • Developing **adequate equipment for harvesting and silage making**

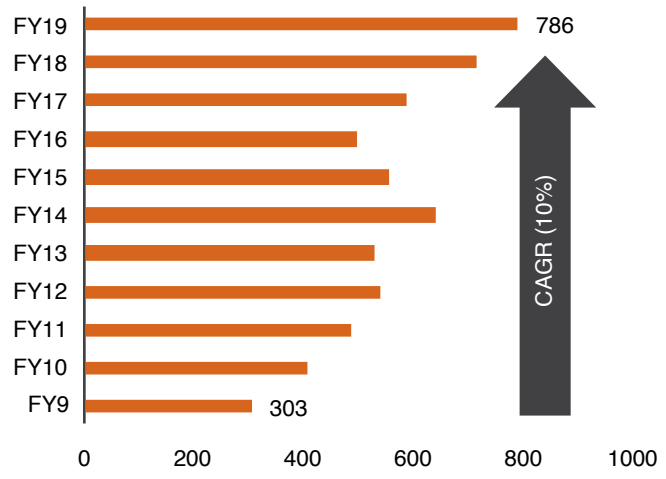
Manufacturing, sales and distribution of farm equipment

The major forces driving the adoption of mechanisation technology are manufacturing and captive production, sale size and after-sales services accompanied by incentive schemes/policies offered by the government.

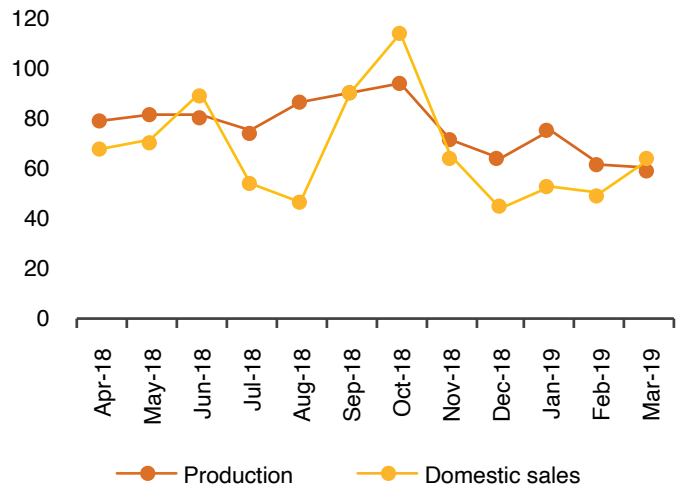
Production and domestic sales volume of tractors in India in FY19

As assessment of periodic trends as well as the intra-year trend of nationwide sales of tractors is presented below.

Trend of domestic sales of tractors from FY9 to FY19 (in thousands)



Monthly production and domestic sales of tractors in FY 19 (in thousands)



Source: Industry reports, Tractor Manufacturers Association 2019, PwC analysis

- The volume of tractor sales has significantly increased in the last 10 years and has reached 786,381 in FY19. The sales volume has grown at an impressive CAGR of 10%.
- Production and domestic sales volumes of tractors were on par in FY19. Sales volumes peaked in October, and a dip was observed in December and August.
- In addition to impressive domestic sales volumes, India also exported 92,095 units of tractors in FY19.

Manufacturing of farm equipment

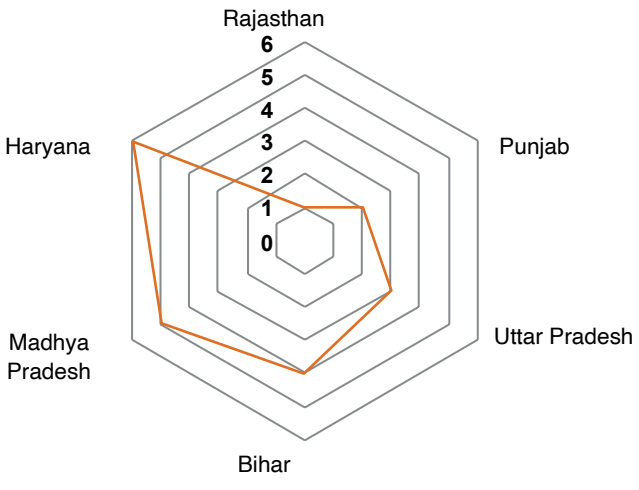
Farm equipment manufacturers in the country can be classified into three broad categories:

Manufacturer category	Number of units	Specific features
Village-level craftsman	>100,000	• This category of manufacturers is the key supply, repair and maintenance source of agricultural hand tools at the village level. • A multitude of farming tools such as local ploughs, sowing devices, spades, sickles, levellers, hand mills, grinding wheels, milk churning tools, carts, water-lifting devices, sieves and storage structures are provided by these artisans.
Small-scale industries	2,500	• This category provides more upgraded farm equipment than the previous category, including cultivators, seed grills, ploughs, disc ploughs, reaper harvesters, combine harvesters, plant protection equipment, graders, soil working tools, oil expellers and mills. • Small-scale industries also produce equipment which is used by tractor and power tiller manufacturers.
Organised farm machinery industries	250	• This category of manufacturers supplies sophisticated and technologically advanced machinery for farming such as electric motors, diesel engines, irrigation pumps, sprayers, dusters, tractors, power tillers, dairy machinery and post-harvest processing machinery. • After-sales services are also ensured by these manufacturers to distributors. • They focus on product upgrade and process technologies through their own R&D efforts.

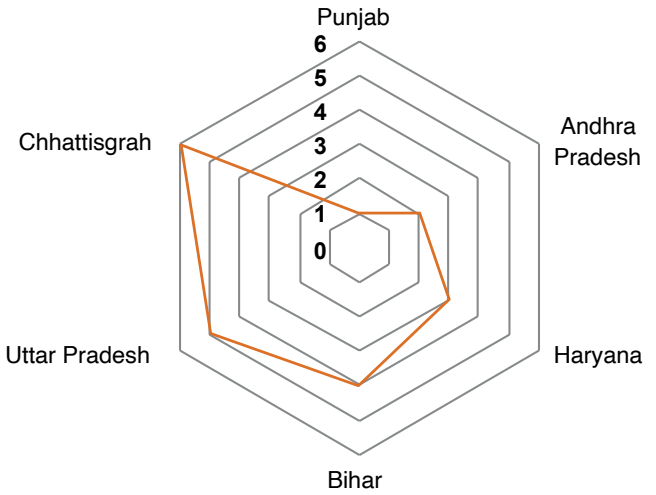
Manufacturing of farm equipment largely depends upon **assessment of demand pattern, factoring in region and time variables.** Assessment of the demand pattern of **combine harvesters** in India also serves as an important indicator of mechanisation needs across states. In the same context, a one-to one interaction[21] with select combine manufacturers in Punjab were made to understand the demand pattern and observations are presented herewith.

Demand pattern of combine harvesters for paddy and wheat

Demand for combines in wheat



Demand for combines in paddy

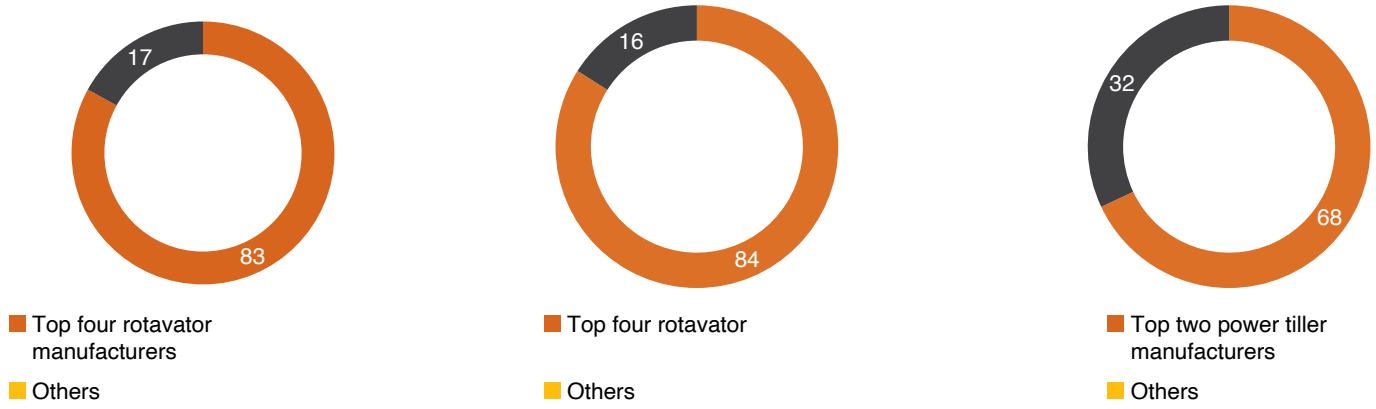


Source: Rating of states based on interaction with combine manufacturers in Punjab

- The highest demand for combine harvesters for wheat crop comes from Haryana, whereas for paddy, it comes from Haryana.
- Peak demand months for combine harvesters in India are November and March.

21 One to one interactions with select combine manufacturers in 2017 – 18, Excerpts of Roundtable discussions with farm mechanization players on Draft Policy for Strengthening Farm Mechanization in Bihar, FICCI, 2017, PwC analysis

Market landscape pertaining to farm equipment in India



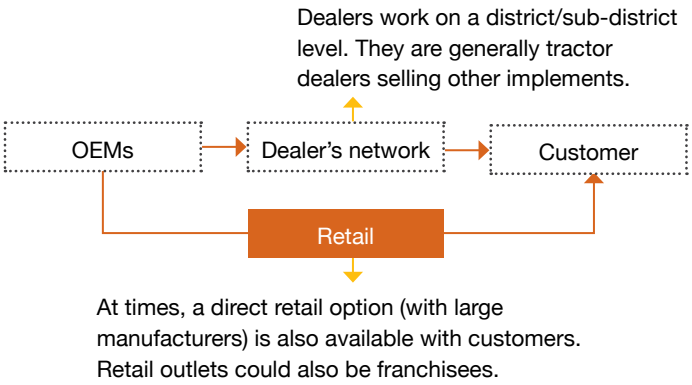
Source: Transforming Agriculture Through Mechanization, a knowledge paper on Indian farm equipment sector, 2015

With respect to the Indian farm machine market, a major portion of the market share is captured by three to four private sector farm machinery manufacturers. These companies not only cater to the domestic/national market but also export farm machinery to other nations such as the USA, China, the Middle East, Russia and Turkey.

For instance, taking into consideration the four main farm machines – **tractor, rotavator, power tiller and thresher –** it can be observed that the **top 4 manufacturers of these equipment in India contribute more than 80%** of the market share, leaving a minuscule percentage for small unorganised manufacturers.[22]

With respect to distribution channels for farm equipment in India, the key participants are the original equipment manufacturers **(OEMs), dealers, retailers and customers.** The OEMs directly cater to the customer at times. Otherwise, this distribution is fulfilled by a dealer who is a major distributor and is involved in selling other implements too. One such distribution network of farm equipment is illustrated in the figure alongside.

Distribution channels for farm equipment

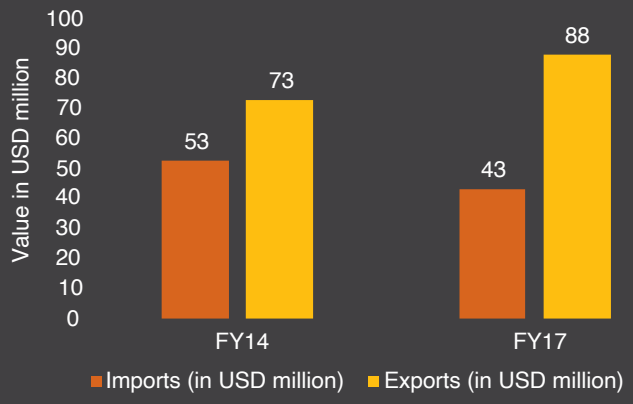


22 Transforming agriculture through mechanization, a knowledge paper on Indian farm equipment sector, FICCI 2015

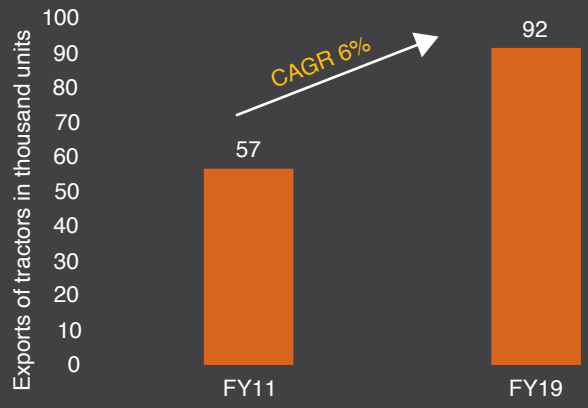
Trade scenario of farm equipment

India has not only proved to be an important market for farm equipment such as tractors domestically but has also developed as an exporter. The total trade value of the Indian farm equipment industry in **FY17 stood at USD 131 million.** Exports have doubled in value compared to imports.

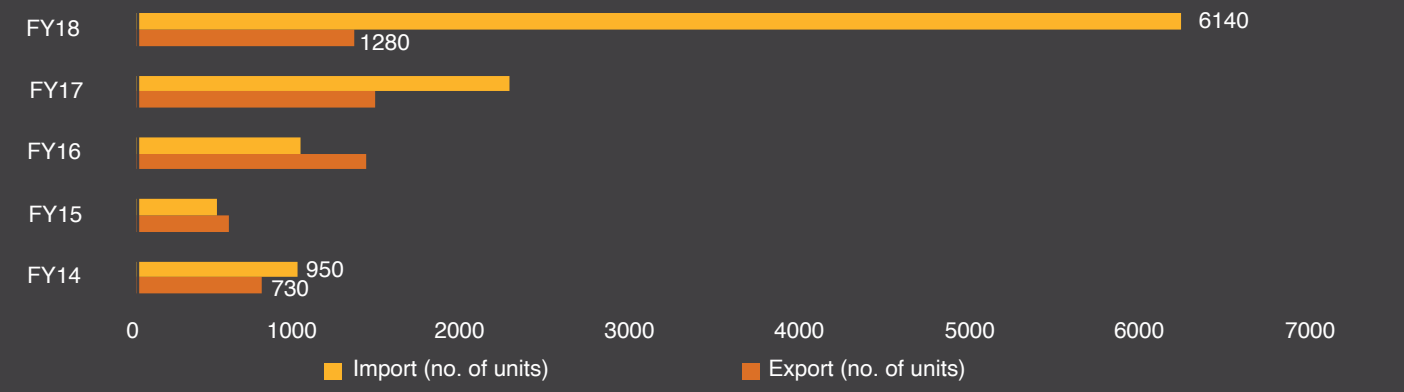
Trade scenario of agricultural machinery in India in FY17



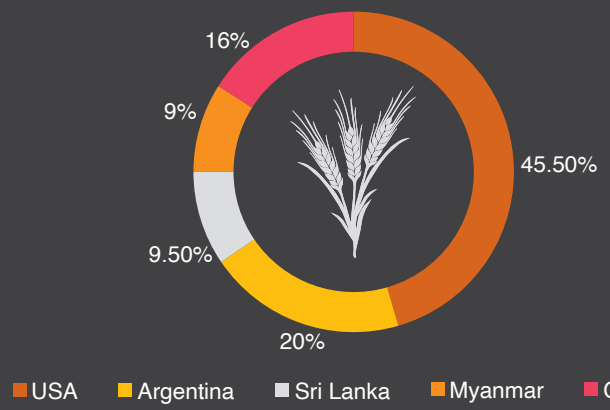
Export growth of tractors in India between FY11 and FY19



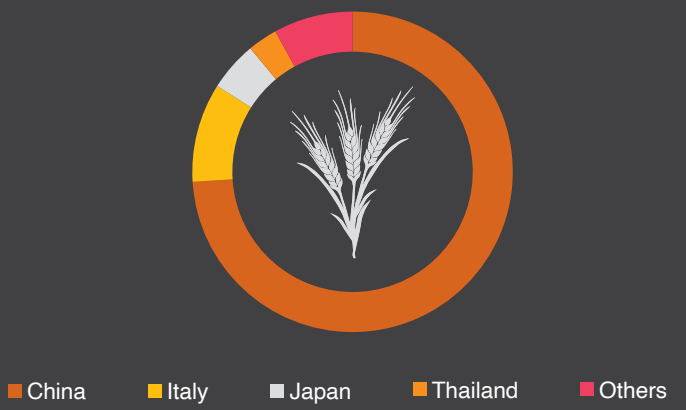
Trade scenario of combine harvestors from FY14 to FY18



Major export destinations for Indian farm equipment industry



Major countries from where India imports farm equipment



Source: Mechanization: Key to higher productivity to double farmers' income, FICCI 2017, Sectoral Paper on Farm mechanization- NABARD, Dec 2018, Industry reports and PwC analysis

- Despite a tightened regulatory environment and seasonal fluctuations, India has a trade surplus in agricultural equipment due to a consistent growth pattern in exports. Venturing into new markets and launching new product segment, new crop segments and market penetration strategies have been the key reasons behind this phenomenal growth.
- The USA continues to be the top exporting destination, whereas China has a major share among import destination nations.
- India exported **92,095 units of tractors in FY19 and has witnessed growth in exports at a CAGR of 6% in the last 8 years.**
- Exports of combine harvesters in terms of units have increased from **FY14 to FY18 at a CAGR of 15%, whereas imports have seen a huge jump at a CAGR of 60% during the same period.**

D. Drivers of farm mechanisation

Global drivers and emerging trends

This section looks at the global farm equipment market, with a special emphasis on the tractor market and global trade of farm equipment.

Global drivers for farm mechanisation

01 Global population

- Nearly 65 million people are expected to be added to the global population between 2016–2050, mostly from countries such as India, Pakistan, Congo, Ethiopia, Nigeria, Uganda.
- India, the second-most populated country in the world is expected to overtake China's population in the next decade.

02 Increase in demand for food, fibre and fuel

- The overall food demand is expected to increase in the range of 59% to 98% by 2050.
- To meet demand, agriculture in 2050 will need to produce almost 50% more food, feed and biofuel than it did in 2012.

03 Emerging trends in mechanisation

- Sales of two-wheel drive tractors witnessed 6.8% growth in the USA.
- With swelling reserves, China is shifting its cropping pattern from corn to oil palm plantations.
- Significant demand for harvesting equipment has been emanating from the Asia-Pacific, especially from China and India.

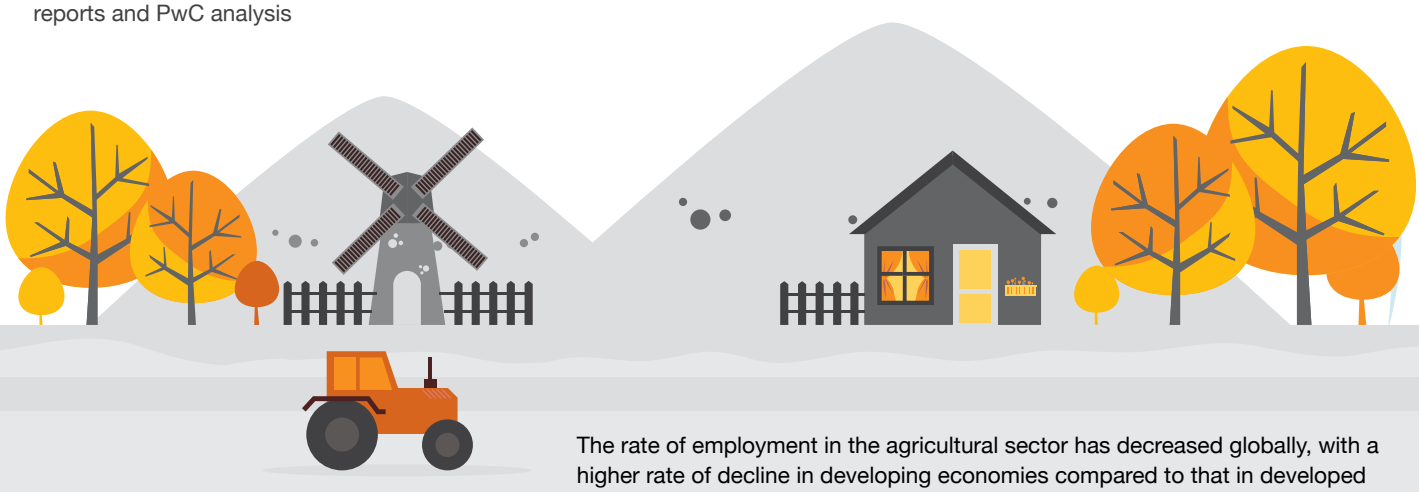
04 Labour shortages in developing nations

- There has been changing workforce preference from pure farm-oriented activities to allied sectors.
- There has been a consistent shortage in labour-intensive agricultural operations in India and China.

05 Precision agriculture

- In the USA and Europe, various farm machinery manufacturers are concentrating on integrating technologies such as navigation systems, GPS, and robotic systems into manufactured equipment to improve productivity.

Source: The future of food and agriculture – Trends and challenges, FAO 2017, Mechanizing the world FederUnacoma 2019, Industry reports and PwC analysis



The rate of employment in the agricultural sector has decreased globally, with a higher rate of decline in developing economies compared to that in developed nations. This change can be attributed to the commercialisation of the farming sector, i.e. a shift from purely farm-oriented activities to allied sectors. Allied sectors such as agroprocessing, equipment manufacturing, fertiliser plants, etc., appeal to a substantial share of the population from the purely farming sector.

Key global events and emerging trends in mechanisation

Developed countries like the **USA, European Countries and Russia have well-established markets for farm machinery, whereas the market is still developing in emerging economies like India and China. Enabling government policies and reforms are key drivers for improving farm mechanisation in these developing nations.** The following are the key global events and emerging trends in farm mechanisation, especially in the global tractor segment in FY19:

Country	Growth % age of tractor sales (+/-) in FY19	Key highlights of tractor segment in farm equipment sector
USA	+7%	• Despite the ongoing uncertainty linked to global trade and a weak agricultural economy, FY19 was a phenomenal year for tractor sales in the USA. • Sales of **four-wheel-drive tractors grew by 12.9% and sales of two-wheel-drive tractors saw growth of 6.8% in the year.** • In particular, tractors with less than **40 HP grew by 9.2%,** and those with power above 100 HP rose by 5.5%%.
India	+21%	• The **Indian tractor market is the largest in the world and showed the best performance in FY19 (+21%).** • The government's goal to double farmers' incomes by 2022 by focusing on irrigation, supply of seeds and quality fertilisers, and pushing DBT to the agricultural sector under the PM-KISAN scheme have provided significant spurt to the farm equipment sector in the country.
Brazil	+5%	• **Sales of tractors grew by 5.1% in FY19 and 10.9% growth is likely to be seen in FY20.** • **Soybean prices, exchange rates, availability of credit and the consequences of the trade war** between China and the USA will be the key factors influencing the farm equipment sector in Brazil.
China	-27%	• China has changed its agricultural structure, **reducing support for corn after the reserves swelled and trying to promote more plantations of oilseed, which it imports in large quantities.** • Furthermore, the trade war with the USA will also have impact tractor sales and, thus, mechanisation in country.
Europe	-10%	• In Europe, **over 177,400 tractors were sold in FY19, with an overall drop in sales of around 10%.** • France saw a deficit of 9%, with 24,700 units registered; Germany fell by 18% with 27,700 machines; and Spain saw a decrease of 5%, with 11,400 machines registered.
Turkey	-33%	• The Turkish economy experienced a significant slowdown in the second half of FY19, due to both currency tensions in August 2018 and the restrictive monetary policy adopted to contain inflation. • In FY19, it registered a **33% drop in sales of tractors and an even greater decline is shaping up for FY20, with sales in the first quarter having fallen by over 70%.**

The drivers, key events and emerging trends at the global level will have a visible impact on mechanisation in the future and, hence, on how the global agricultural economy shapes up. Specific drivers of mechanisation in India have been discussed in the next section.

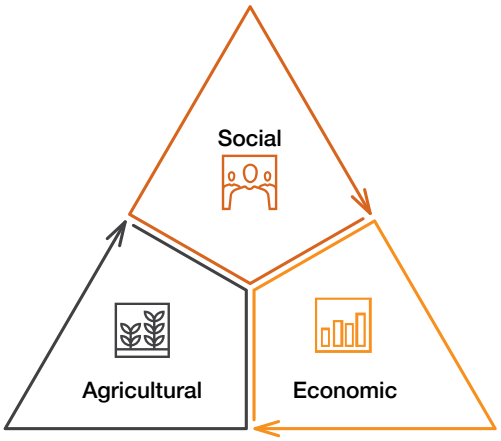
Driving indices at the national level – promoting mechanisation

Nationally, India has observed growth in farm machinery usage and a downward trend in animate power usage. In the previous section, it was established that mechanisation is a necessary technological intervention for bringing in the required productivity push.

Declining labour availability due to migration and increased involvement of women in the fields are some of the other drivers of farm mechanisation in India.

These additional drivers can be classified into three segments: social, agricultural and economic.

Mechanisation drivers in India



Key growth drivers of farm mechanisation in India

Drivers	Way in which they drive farm mechanisation
A. Social driving factors	
Increased participation of women	• Increased migration of men for better prospects in non-farm opportunities has rendered farming a responsibility for women, especially in poorer states. • Routine and physically demanding work such as weeding operation which is more difficult for women to perform, makes mechanisation a necessity.
Drudgery of farm activities	• Drudgery on animate and farm labourers in the field calls for mechanising farm operations. • Timely performance of farm activities and the small window available for conducting these operations compound the situation. • Activities such as paddy transplanting, dibbling and harvesting are not only labour-intensive but also back-breaking. Female labourers across the country undertake this work and there is a huge need and scope for reducing drudgery.
Status issues	• At times, the successive generations of a farming family refrain from agriculture because of the manual handling of operations. • Farm mechanisation can be an intervention to stop this important 'hand drain' from the farm to the non- farm sector.
B. Agricultural and agronomic driving factors	
Increasing cropping intensity	• Rising cropping intensity means more crops being cultivated in the same field, thus enhancing income per unit of land. • This reduces the time available between two crops and hence it becomes more important to carry out agricultural operations in a timely manner.
Increasing farm production	• States/countries utilising more mechanised sources of farm power have been found to have greater crop yields.
Enabling contract farming	• Increased participation of corporates that are entering into farming through contract farming agreements is leading to increased use of implements and machinery on the fields.
Contingency farming	• Farmers are vulnerable to extreme climatic conditions and vagaries of weather; in such a situation, mechanised farm operations help farmers mitigate/adapt to climate risk by carrying out farming operations in a short duration or suitable window.

Drivers	Way in which they drive farm mechanisation
C. Economic driving factors	
Cost and time efficiency	• Undoubtedly, mechanising operations results in time and cost savings, thus making farming activity more profitable.
Service/manufacturing sector growth	• There has been a significant shift in workers from farm to non-farm activities due to higher wages and increased requirement of workforce in the secondary and tertiary sectors. • The ratio of agricultural labour to India's overall workforce has reduced over the years and is likely to follow a similar trend in the near future. This inherently drives the need for mechanisation.

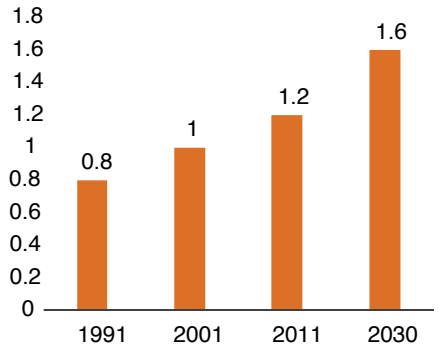
Source: PwC analysis

In addition to the agricultural, social and economic drivers, there are other macroeconomic and intrinsic factors which necessitate the adoption of mechanised solutions in Indian agriculture for long-term and sustainable growth. These factors are, by and large, applicable to almost all agro-climatic and cropping patterns in India. Some of these growth drivers have been elaborated below.

Growing population and demand

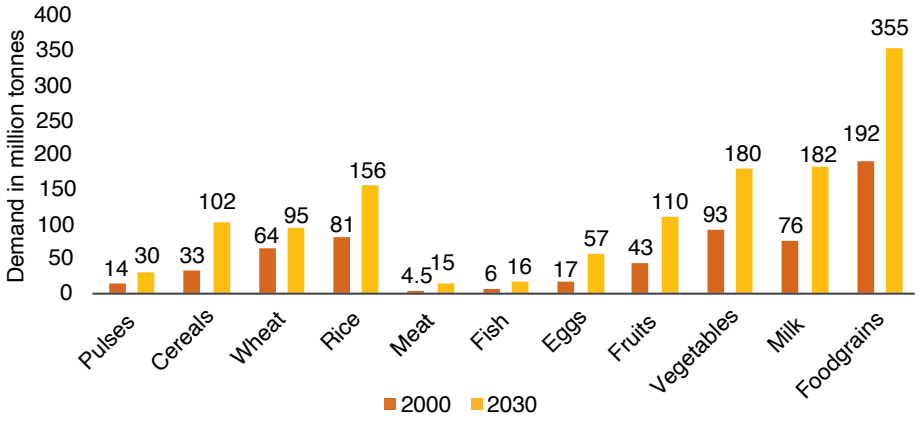
India has the second largest population in the world and accounts for 18% of the world's population. **It has been forecasted that by 2027, India will surpass China to become the world's most populous country.** [23]

Trend of India's population growth (in billions)



Source: UN estimates

Demand for key foodgrains in 2030



Source: ICAR Vision 2030

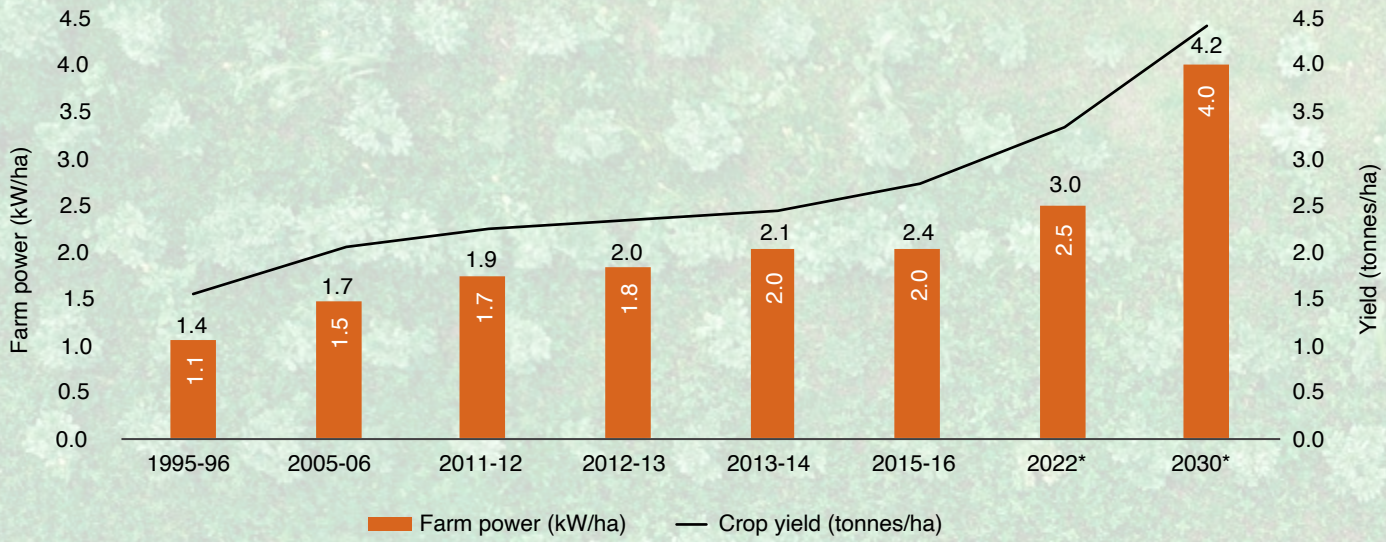
While India's population is forecasted to grow at a CAGR of 2%, the demand for key foodgrains will see a corresponding increase at a CAGR of 3%.

23 UN's department of Economic and social affairs (UN – DESA), 2018

Rise in foodgrain productivity

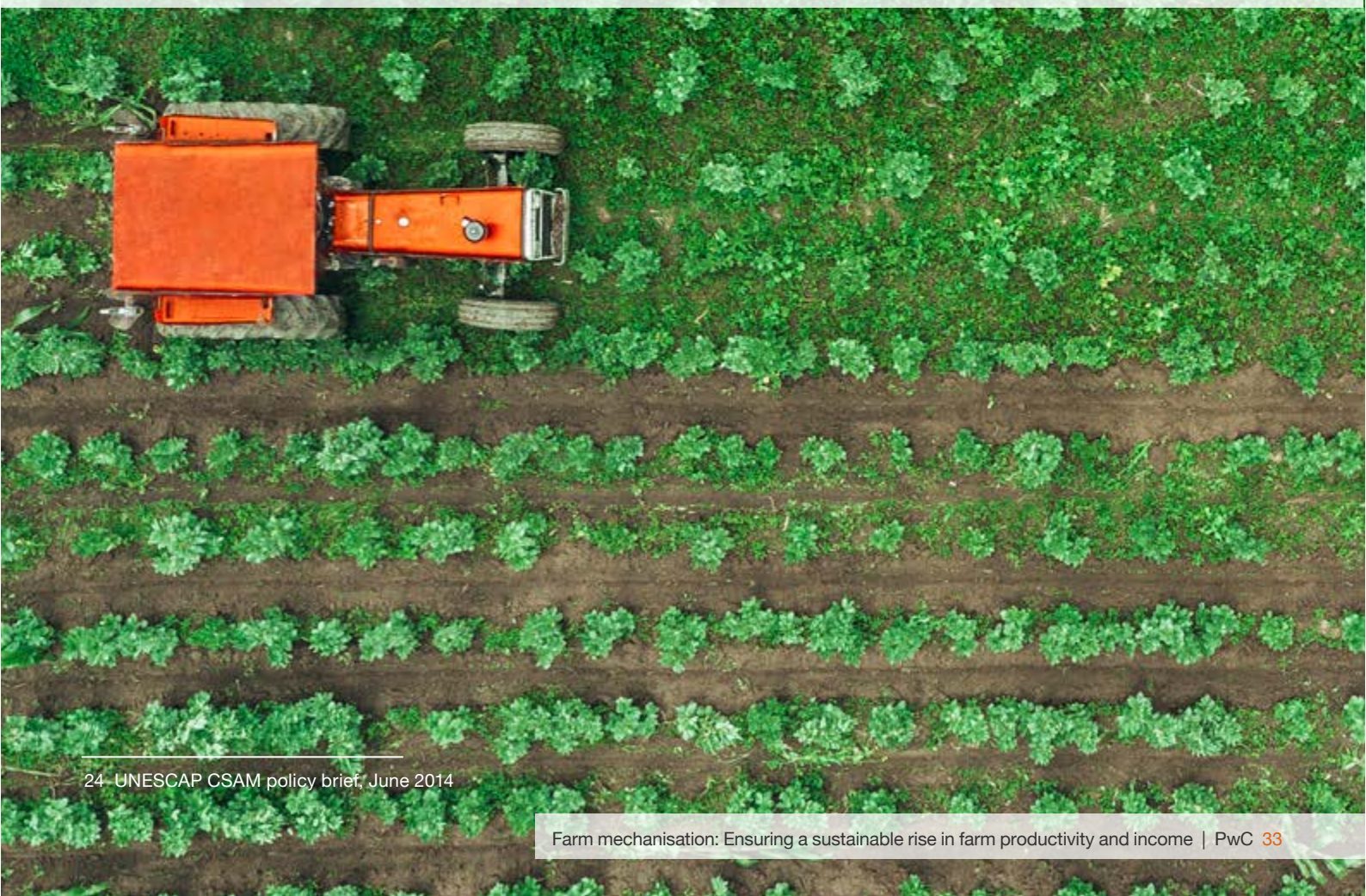
Research suggests that FPA and agricultural productivity are strongly and positively correlated.[24] In India, foodgrain productivity has seen a consistent upward trend since 1995–96, largely due to a rise in FPA. Farm power is a vital input for timely conducting various farming operations and processes related to agricultural production.

Correlation between farm power availability and crop yield in India



Source: FederUnacoma (2019), MoA&FW, Mechanisation and Technology Department *Targeted plan to achieve in 2030

Nationally, there has been **an increase in average FPA, from 1.1 w/ha in 1995–96 to 2.02 kW/ha in 2017–18. In order to achieve a foodgrain yield target of 4.2 tonnes/ha by the end of 2030, FPA needs to increase at a CAGR of 5% to achieve a target of 4.0 kW/ha.**

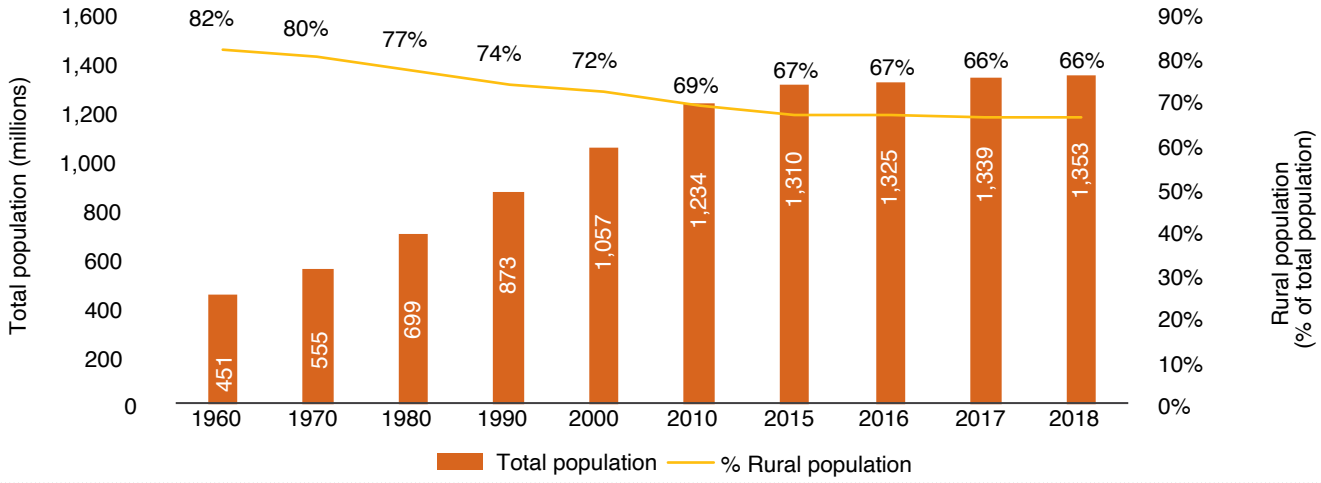


24. UNESCAP CSAM policy brief, June 2014

Urbanisation

Although India's total population has expanded in the last few decades, the population in rural India continues to witness a proportionate decline and **reached 66% in FY19.** The resulting labour shortage is one of the most critical drivers of mechanisation in country.

Comparison of India's total population with its rural population (1960 onwards)



Source: World Bank data, 2018

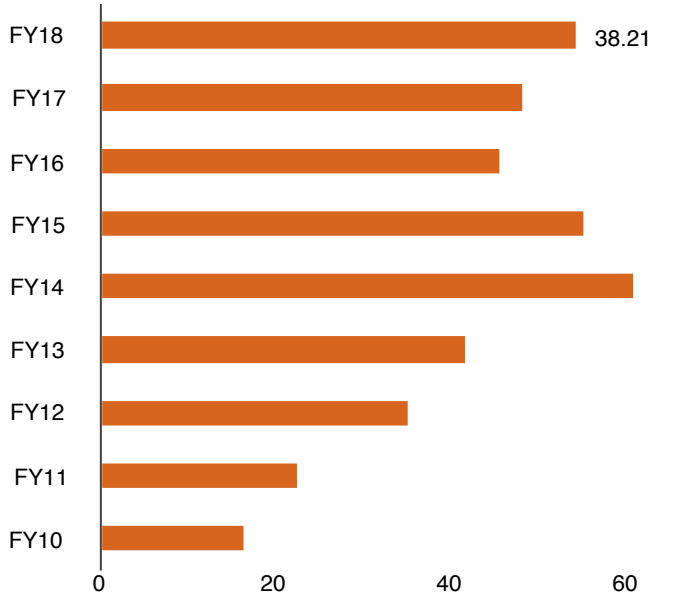
Surge in agri exports

India is one of the 15 leading exporter countries of agricultural products in the world. **Overall, agricultural exports from the country increased at a CAGR of 19% over FY10–18 to reach 38.21 billion USD in FY18.**

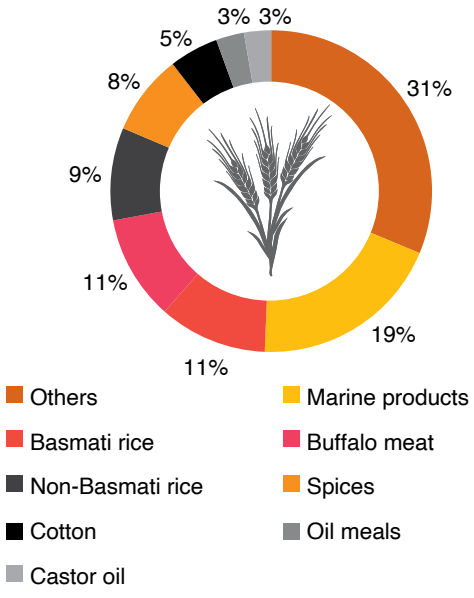
As per the Agriculture Export Policy, the Government of India **aims to achieve 60 billion USD in exports by 2022. Marine products,** buffalo meat and rice have the largest share in agricultural export items in terms of value. Other major export items **are spices, cotton, oil products, tea and coffee.**

Marine product exports reached 7.39 billion USD in FY18, followed by basmati rice at 4.16 billion USD and buffalo meat at 4.03 million USD. The increasing demand for agriculture exports will also enhance incomes in this sector, thereby enhancing service and product provision.

Surge in India's agricultural exports between FY10 and FY18



Source: Ministry of Commerce, WTO, Indian Budget 2016, Agricultural and Processed Food Products Export Development Authority (APEDA) and PwC analysis



Source: Ministry of Agriculture & Farmers' Welfare, APEDA

Demand for agricultural exports from India is expected to grow at a CAGR of 8.8%, i.e. from USD 32 billion in 2016 to USD 45 billion in 2020.[25] The external market demand will lead to a boom in the country's agriculture sector and in turn increase the demand for farming equipment.

25 Ministry of Commerce, World Trade Organization, IBEF

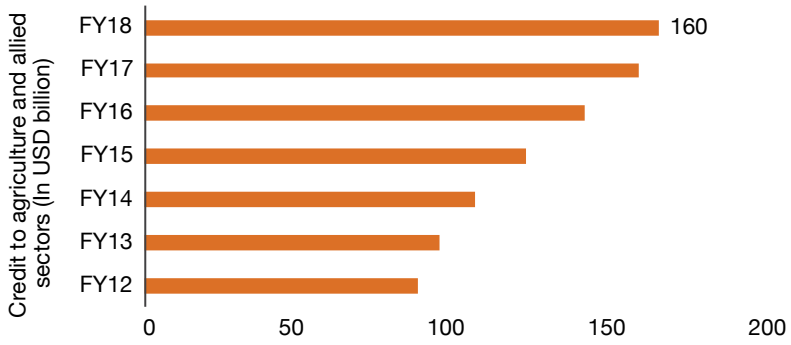
Rise in institutional credit to agriculture and allied sectors

Apart from the supply of quality agri inputs, infusion of capital plays an important role in the overall performance of the sector. Lack of easy and timely access to credit facilities (without any collaterals) is one of the critical challenges in formalised agri financing. In the informal credit system, it has been observed that farm input distributors usually charge higher interest rates than lenders.

There has been consistent support from the government to push **Kisan Credit Cards (KCC).** Moreover, agricultural loans have been categorised as priority sector lending and all banks are mandatorily required to lend to the agri sector. Such a pro-agriculture strategy has resulted in an overall increase in lending to the sector.

Rise in institutional credit between FY12 and FY18

- Credit availability to agriculture and allied activities has grown at a remarkable CAGR of 13% from FY12 to FY18.
- India's farm equipment sector assumes an important place in institutional credit to the agricultural and allied sector. The credit requirement of the farm mechanisation sector was INR 76,991.78 crore in FY 2018–19, which was 2.68% of the total priority sector lending.



Source: Ministry of Agriculture & Farmers' Welfare, RBI, National Sample Survey Organization (NSSO) and PwC analysis

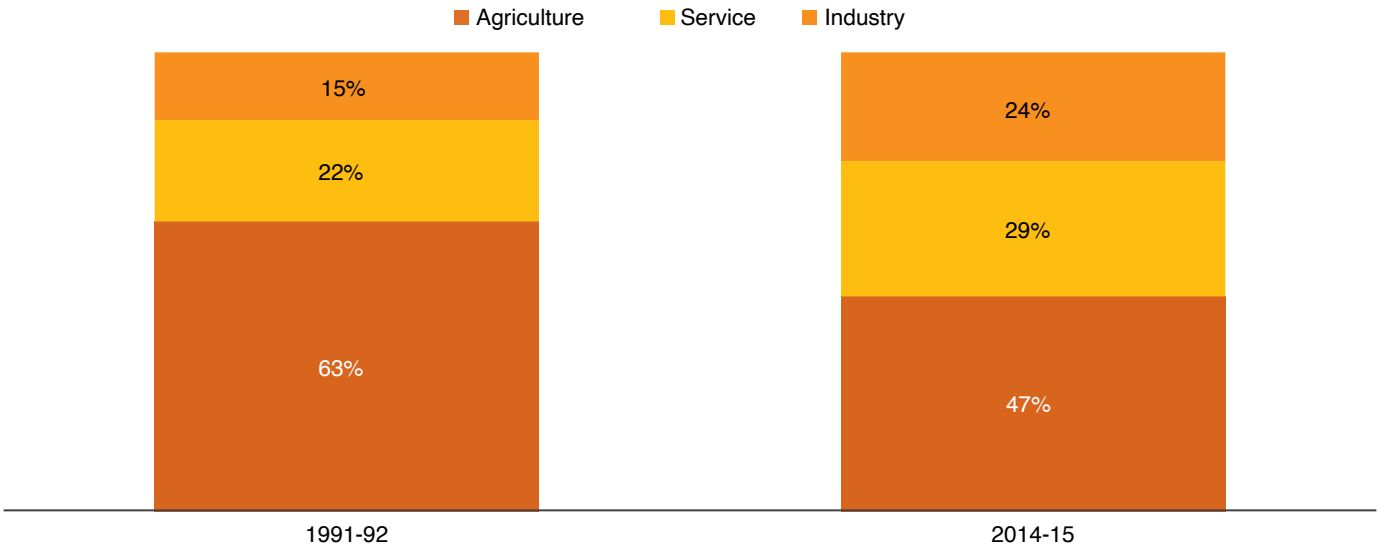
In addition to credit availability from institutional sources, various government schemes and incentives have provided further impetus to mechanisation by improving access to funds and availability of credit.

Increased labour migration and shortage

Increased shortage of labour on farms due to migration to other sources of employment for higher wages is one of the factors driving mechanisation growth. Labour shortage has increased further in the recent past due to schemes like MGNREGA.

There has been a significant shift in employment **from the agriculture sector – from 63% in 1991–92 to 47% in 2014–15.**

Trend in shift of employment from agriculture sector to service and industry sectors

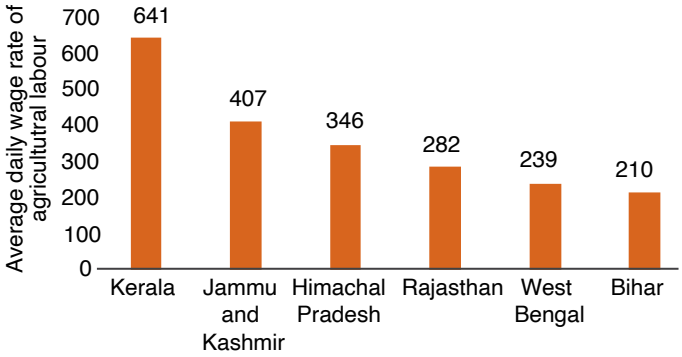


Source: International Labour Organization Statistics, 2017

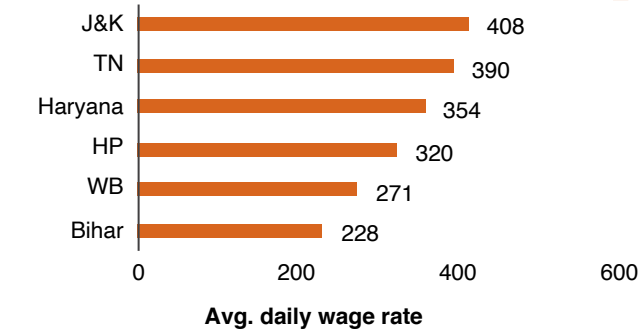
Significant variations have also been noted in daily agricultural as well as non-agricultural wage rates across Indian states. In addition to dismal wage rates in several states, better opportunities like the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and rise of commercial and service sectors increase labour migration.

Average wage rate of agricultural and non-agricultural workers across states

Daily wage rate (in INR) of agricultural labour



Daily wage rate (in INR) of non-agricultural workers



Source: India stat, Labour migration from Bihar, IGC (International Growth Center) report, Indrajit Roy, Jan 2016

Observations:

- The average wage rate in the agricultural as well as non-agricultural sector in Bihar is considerably lower than that in Kerala, Jammu and Kashmir, Rajasthan and West Bengal, and results in migration.

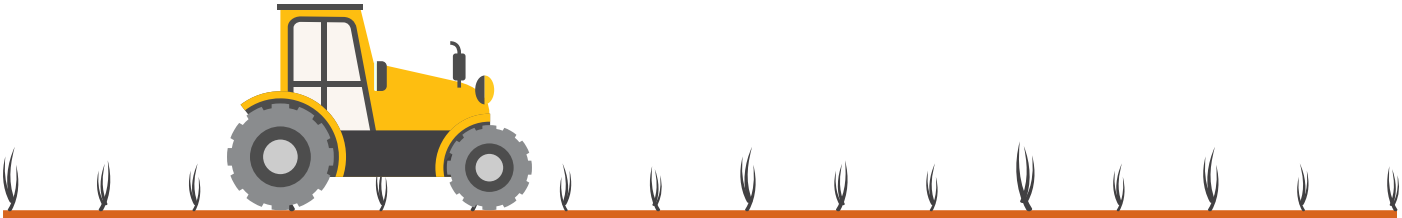
Other growth drivers

There are a few other growth drivers of mechanisation which are majorly location-specific.

Drivers	Details
System of Rice Intensification (SRI)	• Increasing **SRI** has stimulated the rice productivity of Indian farmers significantly. In order to ease the weeding process during farming operations, mechanical weeders are developed. But placing the rice plant at wide and identical intervals is essential to ease the use of mechanical weeders. This equipment mixes the weeds into the soil, turning them into green manure. At present, a variety of weeders is accessible, ranging from manual ones to motorised ones. • Guided by the farmers' needs and existing soil conditions, many advanced and cost-effective designs of mechanical weeders have been introduced in the market.[26]
Zero tillage	• As found out by the researchers of the International Maize and Wheat Improvement Center (CIMMYT), in Bihar, there has been an **average increase of 6% in the income of wheat farmers with the adoption of zero tillage (ZT) method.** • The ZT method involves planting of wheat without ploughing and without removing previous crop residue, because of which a farmer saves irrigation water, enhances organic content in soil and stops the weed growth. • Access to ZT services has been facilitated by the CIMMYT-led Cereal Systems Initiative for South Asia (CSISA) via enabling the ZT drill procurement, imparting technical know-how and trainings. **ZT service providers in Bihar increased from 17 in 2011 to 1,624 in 2014, covering around 44,700 acres.**[27]

26 Directorate of Rice Research, Hyderabad

27 Cereal Systems Initiative for South Asia (CSISA), 2015



Drivers	Details
Mechanisation drive from the dairy sector	• In the dairy sector, mechanisation is at an initial stage but can contribute at various stages of production such as grass harvesting, milking parlour, spreading slurry, maize-based silage preparations. Keeping in view the high nutritional value of maize, several dairy farmers in Punjab are mechanising maize-based silage. • These farmers are using specialised tractors of high HP (>65) for maize silage preparation, and the initiative has been promoted by the Punjab government through special incentives for these high-HP tractors, used for silage purpose. • Training and capacity building on silage preparation are being imparted by the private sector, especially seed players on package of practices. • **Emergence of such lateral avenue could be replicated by other states with high impetus on dairy farming.**
Stubble management[28]	• The burning of crop residue results in grave air pollution issues and extreme loss of nutrients in soils, adversely affecting soil health. • Burning of stubble is responsible for **12% to 60% of air pollution experienced by Delhi and the National Capital Region (NCR). The National Green Tribunal (NGT) banned this activity, implementing the ban has been a challenging task for the administration.** • Around **3 kgs of particulate matter, 60 kg of carbon monoxide (CO), 1,460 kgs of carbon dioxide (CO2), 199 kg of ash and 2 kg of sulphur dioxide (SO2)** is released when one ton of paddy straw is burned. Deterioration in air quality causes eye and skin diseases and fine particles worsen heart and lung diseases. • In order to reduce stubble burning, various machines/equipment, namely super **straw management system (SMS)** attachments to the Happy Seeder, combine harvester, Rotary Slasher, Straw Chopper, Rotavator, etc., have been introduced and their use demonstrated to the farmers of Punjab and Haryana. • A significant step taken in this direction was the launch of the 'Central Sector Scheme on promotion of Agricultural mechanization for in- situ management of Crop residue in the states of Punjab, Haryana, UP and NCT of Delhi' in FY19. In this scheme, farm and machinery banks (FMBs) and CHCs are being promoted around machinery/implements for in-situ crop residue through additional financial incentives, over and above of existing SMAM support. • Promotion of such FMBs and CHCs through effective engagement of stakeholders including farmers, co-operative societies, farmer producer organisations (FPOs), SHGs, private entrepreneurs, registered farmers' societies, groups or SHGs of women farmers would not only give a significant spurt to mechanisation levels, but would also have long-lasting positive impact on the environment.

In addition to the above-mentioned driving indices at the national level, a high thrust on technology integration in farm mechanisation would unfold new opportunity avenues and further expand the growth of the sector. These technology integrations have been named Mechanization 2.0 in the national context, and the same has been elaborated upon in the next section.

28 Operational Guidelines, CSS on Promotion of Ag. Mechanization for in-situ management of Crop residue in the states of Punjab, Haryana, UP and NCT of Delhi, 2019

Mechanisation 2.0: The future of agriculture

The major sectors of the Indian economy are undergoing a flourishing technological innovation and agriculture is not far away from experiencing the same. Technological developments in the forms of technical know-how on farming, soil condition assessment, predictions on weather conditions, yield forecasting and any other practice resulting in yield increment will prove to be immensely beneficial for the agriculture sector. Start-ups offering such technological interventions or enabling technology solutions in agriculture and allied sectors are popularly known as 'AgriTech start-ups'.

India is one of the top six countries worldwide with the largest number of transactions in terms of agricultural technology. Leading industrial research suggests that every ninth AgriTech start-up in the world is originating from India. Growing at the rate of 25% year on year, India currently hosts more than 450 start-ups in the AgriTech sector. As of June 2019, the sector has received more than USD 248 million in funding, a massive growth of 300% as compared to FY19, during which it received USD 73 million in funding.[29]

With the rise in emphasis and scope of technology integrations in the farming equipment sector, four specific categories of AgriTech themes applicable to the FM sector have been identified. Development of technologies around these categories will drive the next phase of growth in farm mechanisation and the overall agriculture sector in the country. The four identified categories are Farming as a Service (FAAS), big data-based mechanisation technologies, Internet of Things (IoT)-based mechanisation technologies and artificial intelligence (AI)-based mechanisation technologies. Together, these future technology solutions have been named as 'Mechanisation 2.0'.

Role of Mechanisation 2.0 in developing FAAS

FAAS is a key category among agriculture start-ups in India. FAAS start-ups work on the development of specific farming practices that provide technological breakthrough services, such as farm equipment renting. FAAS aims to provide affordable and technology-driven practices for effective and efficient farming. Start-ups working in the FAAS category look to help small and marginal farmers with more affordable farming methods through converting fixed costs into variable costs.

In the farm equipment sector, FAAS usually works through development of an app-based **farmer-to-farmer aggregation platform,** which bridges the demand and supply gap of machinery or equipment requirements by connecting owners of tractors and farming equipment with those who require their services. This unique model addresses the demand and supply issue of both tractor owners and those who require services, thereby increasing farmers' income at both ends. The implements seeker does not need to invest in new implements (ensuring cost savings), whereas the existing tractor/machinery owner enhances the equipment's economic realisation (income enhancement), resulting in a **true win-win situation** for both the parties.

An application beneficial to both the equipment seeker as well as the supplier:

Farmers (with farm equipment)

- Improves economics for existing farmers through enhanced utilisation of their tractors
- Improves current income of farmers

Farmers (in need of farm equipment)

- Provides access to minimum needed farm equipment (cultivators, rotavators, ploughs, seed drills, etc.) from other farmers in the vicinity
- Assures equipment availability at requested time slots
- Higher earning from increased quality of inputs
- Ensures fair and transparent rental process
- Extends access to farm's agri services (advisory on modern farm practices, implement usage, quality of inputs)

Such an app creates a transparent 'for-hire' platform, linking machinery (such as tractors and harvesters) owners and CHCs (being run by equipment and machinery owners) to the farmers who require farm mechanisation services. Such a system ensures reliable and quality on-time services.

29 NASSCOM: Agritech in India – Emerging trends in 2019

Mechanisation 2.0 around big data

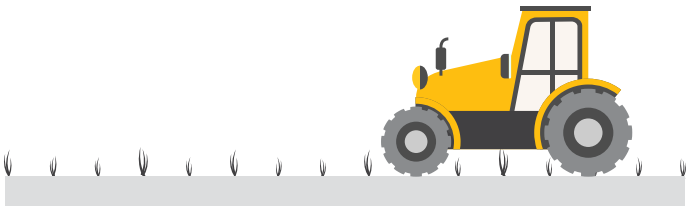
In the agriculture sector, big data capturing comprises collecting granular data from multiple sources such as rainfall, fertilizer requirements, soil moisture, market prices, selling locations, etc. and using the data to help farmers take smart decisions, which can result in problem solving and profitable returns. For example, historical data pertaining to crop yields, input requirements, soil nutrient status, prevailing weather conditions, available farm machinery, market linkage options, prevalent and forecasted prices can enable a farmer to take a scientific decision on which crop to plant and when, acreage, harvesting time, and which market would be ideal for selling the produce.

Mechanisation 2.0 around IoT

IoT is made of integrated IT-related technologies such as drones, GPS, sensors, automated hardware, robotics, remote sensing. Incorporating IoT-based smart agriculture into farming practice leads to improvement in yield. With high emphasis on precision agriculture in India, most equipment manufacturers are ensuring the integration of above-mentioned technologies to enhance their equipment's effectiveness and get a competitive lead in the market.

Mechanisation 2.0 around AI

AI is being used to develop machines and computers that can act or react as intelligently as humans do. Therefore, algorithms programmed with in-depth knowledge and historic and live data can help in precision or smart farming practices on field. Various farming processes such as weeding, spraying, harvesting can be enabled with AI, leading to improved accuracy and productivity. Presently, use of AI in agriculture is in its initial stages, but is gaining momentum because of production-enhancement and cost-reduction requirements.



Policies for sectoral reform

GoI is committed to induce policy reforms in the agriculture sector to strengthen it. Government interventions include forming policies on market linkages, input subsidies, credit facilities and technical know-hows contributing towards the government's larger goal of doubling farmers' income by 2022.[30]

Multiple initiatives have been taken by GoI to improve farm mechanisation in the country. Such initiatives comprise fiscal as well as non-fiscal support structures which provide several incentives and support at different stages of agricultural production to encourage farm mechanisation. GoI has launched various farm mechanisation programmes and schemes across the country, covering various aspects of incentives. Some of these important schemes are:[31]

- Rashtriya Krishi Vikas Yojana (RKVY)
- Mission for Integrated Development of Horticulture (MIDH)
- National Food Security Mission (NFSM).

Other than these schemes, GoI has implemented SMAM, a flagship mission to strengthen the farm mechanisation sector in India.

Scheme	Support for farm mechanisation	Funding/financing pattern
NFSM	• Assistance (up to 50% the cost of machinery) to be provided for machinery such as pump sets, tractor mounted sprayers, seed drills, zero till seed drills to varying degrees.	60% assistance from the Centre and 40% from the state
RKVY	• Farm mechanisation comes under production growth stream of RKVY – with 35% of the outlay. • Assistance for large equipment (tractors, combine harvesters, sugarcane harvesters, cotton pickers, etc.) is available for establishing custom hiring centres (CHCs)	60% assistance from the Centre and 40% from the state
MIDH	• One of the key interventions under the scheme is 'horticulture mechanisation'. • Assistance is provided for procurement of power-operated machines and tools, besides for import of new machines. • Assistance is also available for grower associations, farmer groups, SHGs, women farmer groups (with more than 10 members), etc., that are engaged in cultivation of horticulture crops.	60% assistance from the Centre and 40% from the state

30 Doubling Farmers' income: Rationale, Strategy, Prospects and Action Plan, NITI Aayog, 2017

31 Source: Department of Agriculture, GoI

SMAM[32]

SMAM, a centrally-sponsored scheme for promotion of farm mechanisation was launched by the Ministry of Agriculture and Farmers' Welfare in 2014-15, to be implemented through state departments of agriculture, farm machinery testing and training institutes (FMT&TIs), selected agricultural universities and Indian Council of Agricultural Research (ICAR) institutes for a duration of five years. The key aspects of the SMAM scheme are:

- training, testing and demonstrations of farm machinery and equipment
- establishment of custom hiring centres
- disbursement of subsidy through state departments of agriculture for purchase and distribution of farm implements
- promotion of post-harvest technology for promoting primary processing.

Key objectives of SMAM

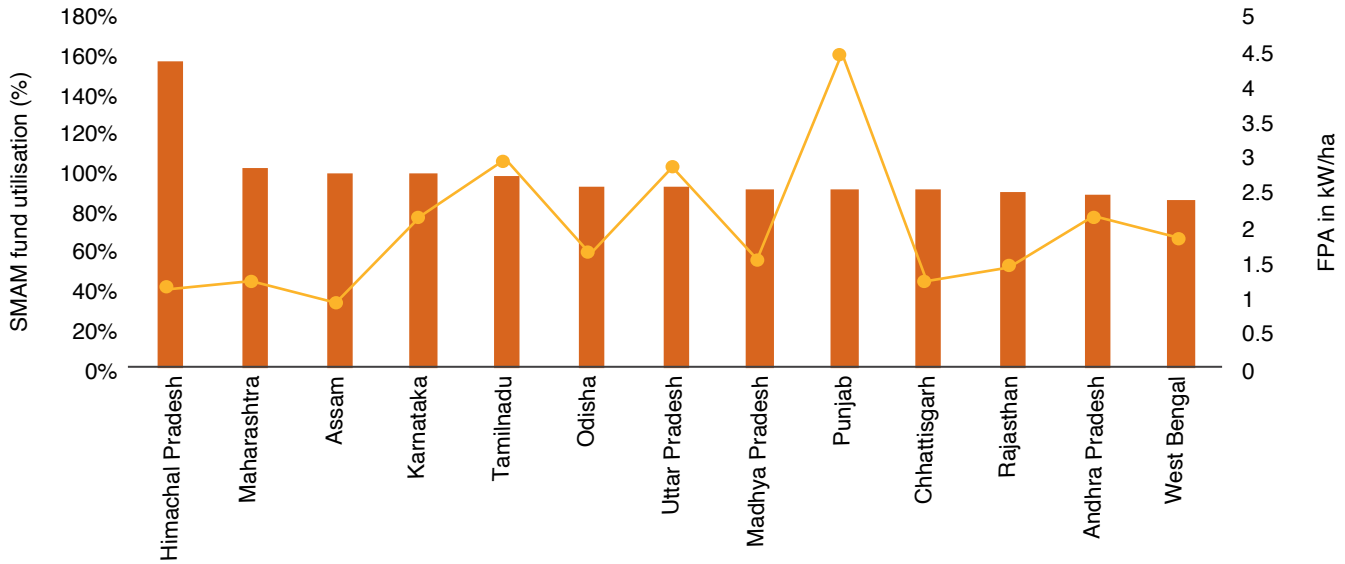
- increasing the reach of farm mechanisation to small and marginal farmers and to the regions where availability of farm power is low.
- promoting CHCs to offset the adverse economies of scale arising due to small landholding and high cost of individual ownership.
- creating hubs for hi-tech and high-value farm equipment
- creating awareness among stakeholders through demonstration and capacity-building activities.
- ensuring performance testing and certification at designated testing centres located all over the country.

Through effective implementation of SMAM, GoI aims to achieve the future FPA requirement of the country, which has been forecasted to grow from the present national average of 2.02 kW/ha to 2.50 kW/ha by 2022 and 4.0 kW/ha by 2030.[33]

In addition to improving affordability of farm equipment through financial assistance, training and capacity enhancement are vital parts of the sub-mission because they contribute towards sustainable and proper utilisation of technology in order to maximise production and enable better returns to farmers.

Nationwide, FPA in the states of Haryana, Punjab, Tamil Nadu and Andhra Pradesh is more than the national average of 2.02 kW/ha. However, FPA in the rest of the states is quite low, especially in eastern and western regions, which creates the need for encouraging and promoting farm mechanisation in mission mode.

Comparative analysis of SMAM fund utilisation pattern (%) across key states in India (FY14–FY17, FPA in kw/ha)



Source: Final report on Monitoring, Evaluation and Impact assessment of SMAM, M&T Division, MoA&FW, May 2018

- Fund utilisation percentage in Himachal Pradesh, Maharashtra, Assam and Karnataka have been either 100% or more than that for received SMAM fund between FY14 and FY17.
- Most of the key states, including low FPA states across all the agroclimatic regions of India, have performed considerably very well (>85% utilisation) in SMAM fund utilisation during the period.

32 Operational Guidelines, Sub- Mission on Agricultural Mechanization, 2018-19

33 http://farmech.dac.gov.in/SMAM/Evaluation Report SMAM/Final Report M&E SMAM .pdf

The seven-year plan,[34] which is effective from 2016-17 to 2021-22 and is under implementation since August 2017, has identified new targets for the SMAM such as:

- FPA of **2.5 kW/ha to be achieved by 2022 from the level of 2.02 kW/ha in FY18**
- **148,000 trainees** to be trained to develop skilled manpower in farm mechanisation sector
- **10,270 agricultural machineries** to be tested
- **280,000 CHCs to be established at the village level**
- **19,000 demonstrations to be organised** on farmer fields.
- **19,00,000 farm machinery to be distributed under SMAM**
- **8 new FMT&TIs** to be established
- **200,000 beneficiaries to benefit from distribution of farm machinery for individual ownership in north-eastern and Himalayan region.**

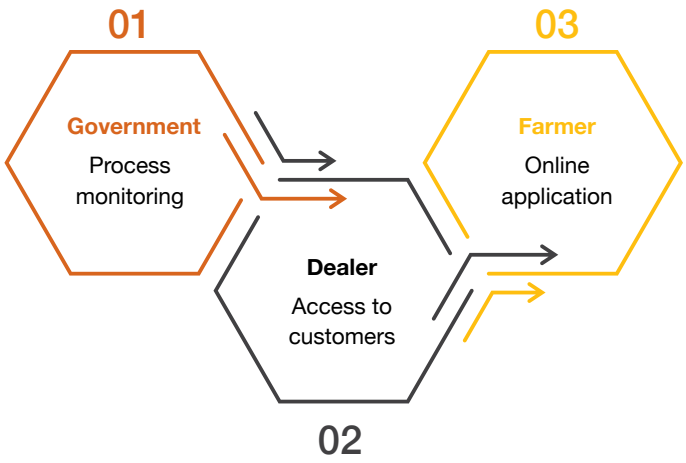
Digital initiatives in capacity building, subsidy disbursal and DBT

As an important step towards digitisation, the Department of Agriculture and Farmers Welfare (DAC&FW) has launched the National Portal on Mechanization and Technology, an online portal to assist farmers across the country to get awareness on and benefit from various schemes and subsidies for which they are eligible. Through the portal, farmers can book appointments for farm machinery testing, fill applications for financial support and avail other assistance from remote rural locations.

In order to improve the overall operational efficiency from subsidy application to disbursal, information and communication technology (ICT)-enabled initiatives have also been taken by various state governments. Among these state government initiatives, Bihar has pioneered implementation of the **Online Farm Mechanization Application Software (OFMAS)** to address the need for integrated information flow mechanism across various stakeholders involved, from subsidy application to disbursal. The government of Bihar introduced subsidy distribution via this web-based platform from 2014-15 and a detailed description has been presented herewith.

Use of OFMAS in Bihar[35]

Online Farm Mechanization Application Software (OFMAS)



OFMAS has been designed, developed and hosted by the National Informatics Centre (NIC), Bihar and is being implemented by the state department of agriculture. It has given momentum to implementation of ICT through the state agriculture department.

OFMAS creates a cost-effective and transparent environment for farmers, dealers and manufacturers to sell and purchase farm equipment and machinery. The OFMAS application offers government-to-government (G2G), government-to-business (G2B) and government-to-consumer (G2C) services and has a role-based architecture.

The role-based framework of the application has resulted in the development of a transparent system of subsidy distribution to farmers pertaining to farm machinery. This initiative has been appreciated at all levels from farmers, dealers, manufacturers to officials, as it has been effective in implementation of farm mechanisation schemes across the state. Via this portal, farmers can apply for subsidies, manufacturers can promote their products for their target audience and officials can plan and monitor the implementation of the SMAM scheme.

The application has an SMS alert feature to send regular alerts to indicate different stages of an application.

In addition to digitisation of the entire subsidy disbursal processes, implementation of Direct Benefit Transfer (DBT) has also been a key enabler for promoting farm mechanisation in India. Focussing on DBT in agriculture has subsequently improved through the launch of the **Pradhan Mantri Kisan Samman Nidhi Yojana (PM-Kisan) scheme.** Through this scheme, **GoI has released INR 2,021 crore (USD 284.48 million) directly to the bank accounts of more than 10 million beneficiary farmers, as on February 24, 2019.**[37] This has provided significant spurt to effective and faster subsidy distribution mechanism in agriculture, including in the sector of farm mechanisation.

34 Mechanisation – Key to higher productivity to double farmers' income, 2017, FICCI

35 OFMAS official website

36 Online Farm Mechanization and Application Software, GoB

37 Industry reports, PwC analysis

E. Sectoral constraints and key challenges

India's position in terms of agricultural production and farm mechanisation presents a contradictory picture. While India is a leading producer of agricultural products globally, the level of farm mechanisation in the country is lower than the global average. However, there exists ample prospects for the sector despite the current challenges it faces. The constraints of the sector can be categorised into operational, financial, capacity-building and policy-related constraints.

1. Operational constraints

Operational constraints comprise fragmented landholdings, diverse soil conditions and cropping pattern, supply-demand mismatch, dismal FPA in many states, tractorisation, quality and serviceability constraints, inefficiencies in farm equipment testing, etc.

Fragmented landholdings affecting economies of scale

The average landholding size in India (2 ha) is smaller in comparison to many other countries. 33% of all agricultural households in India own less than 0.4 ha of land, leaving minimal scope for mechanisation and resulting in low yields. It is not commercially feasible for famers owning small and discontinuous fields to possess farm machinery individually as doing so would not be cost-efficient.

Diverse soil conditions and cropping pattern

India has the tenth-largest arable land resources in the world. With 20 agri-climatic regions across the country, all the 15 prominent climates from across the globe exist in the country. India is also home to 46 of the world's 60 soil types.[38] Due to diversity in agri-climatic conditions and differing soil types, various cropping systems have evolved across the country over a period of time. Accommodating these variable conditions and ensuring optimal utilisation of precision farm equipment would require geographical and crop-based customisation.

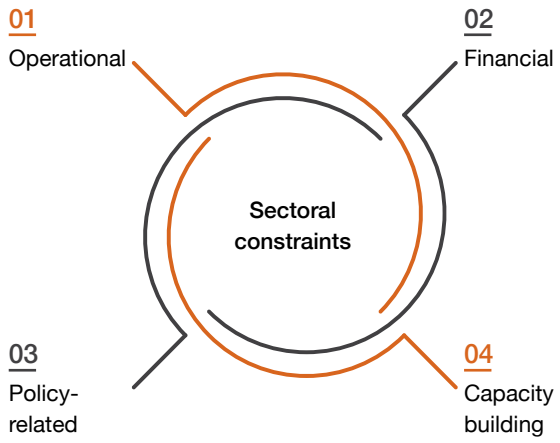
Supply demand mismatch

It has been observed that despite high concentration of tractors and farm equipment in a specific geography or zone, poor mechanisation levels continue to exist due to high supply and demand mismatch. Due to disaggregated demand for agricultural implements and minimal synapse of same with supply points i.e. implements owners, utilisation of the equipment remains low.

Dismal FPA in many states

It has been observed that despite high concentration of tractors and farm equipment in a specific geography or zone, poor mechanisation levels continue to exist due to high supply and demand mismatch. Due to disaggregated demand for agricultural implements and minimal synapse of same with supply points i.e. implements owners, utilisation of the equipment remains low.

Sectoral constraints and challenges of the farm mechanisation sector in India



Source: PwC analysis

Tractorisation, not mechanisation

Tractors dominate the farm equipment market in India. The rest of the farm equipment (sowers, tillers, harvesters, etc.) contributes 15–20% of the market share, mainly due to absence of knowledge about the benefits of using additional equipment and practices in terms of productivity and yield, operative challenges, etc. However, it is expected that dissemination of additional farm machinery will advance in the coming years as a result of growing prominence of mechanisation, impetus of GoI and multilateral agencies on running mechanisation-based schemes for betterment in awareness, accessibility to financial assistance, improved irrigation facilities, and enhanced focus on farmer aggregations and linkages, etc.

38 Agriculture and allied industries, India Brand Equity Foundation, August 2019

Quality and serviceability constraints associated with unorganised manufacturers

Several local and unorganised farm equipment manufacturers develop farm equipment without considering the quality and design required for the finished product and thus offer them at very competitive prices to the farmers in comparison with the same offered by the organised manufacturers. Given the huge gap in prices of both categories of equipment, farmers become partial to local manufacturers. However, low-costing equipment leave much to be desired in terms of quality, break down more often, have higher operating expenses and result in lower yields. Servicing costs in rural areas are much higher and not bearable for local equipment manufacturers.

Inefficiencies in farm equipment testing

Under SMAM, four FMT&TIs located in Madhya Pradesh, Haryana, Andhra Pradesh and Assam conduct tests of farm equipment. Apart from these four institutes, testing is also conducted at selected state agricultural universities (SAUs) and ICAR institutions.. Despite the availability of such facilities, the overall number of centres which can accord certifications for farm equipment is low, which poses logistical challenges for farm machinery manufacturers.



2. Financial constraints

Financial constraints constitute of poor access to finance, high cost of precision equipment and a subsidy-boosted market with low demand drive.

Poor access to finance

Sale of tractors through financial schemes accounts for around 90% of the overall tractor sales in the country and these financing schemes depend on the applicant farmer's profile for determining eligibility. In this scenario, the uneven income levels for majority of the small farmers becomes a hindrance in gaining support as for short- and medium-term loans in rural areas, the interest rates can reach up to 40% per annum. In addition to high interest rates, especially on term loans, requirement of collateral in availing credit for CHS entrepreneurs and procedural difficulties involved in credit availing processes are other key impediments, further discouraging farmers from availing loans or other financial assistance.

High cost of precision equipment

More sophisticated farm equipment such as potato combines, combine harvesters, paddy transplanters, sugarcane harvesters, laser-guided land levellers are highly priced and require financial investments. Tractor costs vary from USD 7,000 to USD 12,000, while the price of laser-guided land levellers range between USD 5,800 and USD 6,500. Most small and marginal farmers are unable to afford such high investments. This is one of the main reasons for lower dissemination rates of agricultural machinery in the country.

Subsidy-boosted market with low demand drive[39]

In India, farm mechanisation requires heavy investments and the central and state governments have launched various schemes to share the financial burden of farmers through subsidies. As per the current trends and practices, the subsidies for farm mechanisation are dependent on the central and state governments' budget allocation. However, the same should be altered from time-to-time to suit the farmers' needs. The budget allocation at state and district levels may be guided by the demand to ensure viability for farmers.

Lack of institutional credit mechanism to support and sustain CHCs

Project financing has been a key impediment in the farm mechanisation sector, leading to poor offtake of farm machines as well as CHS projects in country. Back-ended subsidy mechanisms increase the initial capital requirement and hinder large scale investment. This further gets worsened, as small and marginal farmers are less capable of furnishing secondary collateral for hypothecation to banks. Hence, there is a need to strengthen the credit delivery system and facilitate the flow of credit to the farm mechanisation sector.

39 Farm mechanization Sectoral paper: NABARD, 2018

3. Policy-related constraints

Policy-related constraints include poor implementation of government support programmes and inefficiencies associated with DBT and subsidy disbursal.

Poor implementation of government support programmes

Industry interactions[40] suggest that there has been limited market orientation in finalising lists of implements identified under the financial assistance component of SMAM. Emerging trends in selection and distribution of implements under subsidy programmes have not been well tapped. For example, combines and crop-specific planters need better support through subsidy programmes. Also, there have been limited orientations on the crop-region-implement matrix in finalising the implements for CHCs supported under SMAM, leading to poor economic viability for the farmers.

Inefficiencies associated with DBT and subsidy disbursal

Despite the government's efforts, the adoption rate of SMAM's subsidy scheme is quote low. One of the predominant reasons for experiencing lower adoption rates is the tiresome and complicated process which the farmers are required to go through to avail the subsidy in question. The subsidy application requires the farmer to submit multiple documents and get clearances from various departments. Once the procedures are completed, more checks and approvals from the district agriculture officer are required to avail the subsidy. In other words, the complete 'application to disbursement' process is challenging and time-consuming for a farmer.

Several state governments have made significant efforts to bring operational efficiency in the subsidy disbursal process through the launch of online farm mechanisation application portals. But low conversion rates across stages of operation, higher lead time taken between two subsequent activities and lack of awareness and ease in filling online-based applications by farmers are several key impediments, which often become roadblocks in the subsidy disbursal process.

4. Capacity-building constraints

Capacity-building constraints comprise of insufficient trainings and awareness related issues, lack of skilled manpower in usage of high cost farm machinery, etc.

Insufficient training and lack of awareness

Industry interaction suggests that the training programmes and other events conducted to increase awareness on farm mechanisation are inadequate. Awareness on incentive support under CHS, along with adequate know-how of schemes, business models and applications processes has been missing amongst farmers.

Lack of skilled manpower in usage of high-value farm equipment

Industry interaction[41] suggests that there has been lack of in-house knowledge in the areas of operation, maintenance and repair of high-value equipment across key states in the country, which increases dependency on trained manpower resources from select states (mostly Punjab and Haryana). Hence, there is need for in-house training programmes for agri-engineers/technicians in the farm machinery sector so that mechanical issues can be adequately addressed.



40 Roundtable discussions with farm mechanization players on Draft Policy for Strengthening Farm Mechanization in Bihar, FICCI, 2017

41 Roundtable discussions with farm mechanization players on Draft Policy for Strengthening Farm Mechanization in Bihar, FICCI, 2017

F. Strategic interventions

Proper farm mechanisation ensures effective usage of machinery-related inputs and reduces the labour-intensive nature of farming activities, thereby ensuring timely and increased productivity. Although farmers in India have been adopting improved farm equipment regardless of their landholding size, but the true potential of mechanisation in the Indian agriculture sector is yet to be realised. With a national FPA average of 2.03 kW/ha in 2017–18 , India needs to progress to 2.5 kW/ha by 2022 and 4 kW/ha by 2030 to ensure better returns from the sector and make it a profitable enterprise.[42]

Farm equipment to ease tilling methods, irrigation, sowing, threshing and other farming activities have been well received and can be afforded by medium and large farmers, whereas small and marginal farmers prefer renting equipment and machinery via custom hiring to enhance productivity and reduce operating costs.

India stands on the threshold of finding ways to promote precision farming through automation and mechanisation and effectively adopt such technologies. Going ahead, we need to find diligent ways to promote 'Right technology' through an acceptable 'model for maximising adoption'.

This knowledge report proposes a few strategic interventions which would help India to achieve the stated mechanisation objectives in upcoming years. Efficient scheme implementation and improved delivery mechanisms, forging operational PPP models, ensuring future ready farm mechanisation, skill upgradation and improved access to finance are the key strategies proposed and elaborated below.

Strategic interventions for strengthening farm mechanisation in India



Source: PwC analysis

1. Efficient scheme implementation and delivery mechanism

Effective and efficient implementation of government mechanisation schemes, especially SMAM will be pivotal for the successful dissemination of mechanisation technologies. Following are the sub-strategies identified under this category:

Ensure an enabling and rationalised subsidy support mechanism: Mechanisation is still a cost-intensive activity to be undertaken by farmers and the central and state governments have been rightly subsidising mechanisation costs for better uptake of machines at the ground level. The following steps could be helpful to make government interventions more effective:

1. Providing frontend support to farmers on mechanisation rather than relying on back-ended subsidy support.
2. The model of assistance adopted by the Gujarat Green Revolution Company (GGRC) which assists in micro-irrigation (MI) promotion and retention pricing scheme (RPS) for farmers would be useful, as subsidy assistance for high-end and precision farm implements could be directly routed to manufacturers. This will reduce the burden of high initial capital costs for farmers and improve the offtake of the precision machineries.
3. An institutional mechanism to fix rational prices of equipment every year per state would be very useful. This institutional mechanism could fix a centralised rate of farm implements and based on distance, add the costs of logistics.
4. Similar to the Yantradoot programme launched by the government of Madhya Pradesh, there is need to devise and assist CHCs through a special top-up subsidy assistance provided by the state governments. This would ensure better offtake of CHCs as each selected CHC would be supported in the form of the state government providing for **50%** of the cost of equipment and machinery purchased, up to a maximum of **INR 50 lakh.** The overall subsidy support would involve **10% top-up from state funds and 40% from SMAM.** The selection of eligible projects could be done through standard request for proposal (RFP) and bid process management.

42 Report on Monitoring, Concurrent Evaluation and Impact assessment of SMAM, M&T Division, MoA&FW

5. The hiring charges of farm implements at the CHC need to be decided by the market.
6. The government may consider providing subsidy on the implements with a shelf life of three years, on repeated basis. Since the CHC (established with government subsidy) has a lock-in period of 5–6 years, once the subsidised implements wear out, they cannot be replaced as per current SMAM norms. Hence, subsidy needs to be provided once again for buying the same implement after three years.
7. The government could provide differential support in the form of subsidies on high precision machineries and routine farm implements.

Ensuring proper dissemination of technology at the grass-roots level

I. Relevant authorities should try to organise a farm mechanisation exhibition cum sales fair at the block level at least twice a year.
II. Organising a state level mechanisation fair cum exhibition at least once a year would facilitate effective dissemination of best mechanisation technologies suited to a specific region in a state.
III. There is a need to establish FM demonstration cum skilling centres at each Krishi Vigyan Kendra (KVK)/DAO office. This could be promoted by state governments in collaboration with suitable private players in a PPP model.

Enhanced and faster implementation of government support

1. There is need to enable time bound and deemed approval mechanism in OFMAS to improve overall operational efficiency in subsidy disbursal.
2. There should not be any carry-over of subsidy disbursal. Subsidy to be disbursed should be released during the same financial year.
3. Reduction in lead time from application to physical verification of implements to release of subsidy through improved traceability mechanisms like introduction of radio frequency identification (RFID)- /blockchain-enabled technologies.

Rationalisation of GST for improved offtake of farm equipment

I. GST rates applicable on tractors and their components vary from 12% to 28%. Most tractor spare parts come under the 28% GST slab, resulting in an overall increase in tractor costs and other farm equipment. Further, farm equipment requires several spare parts such as rubber, blades and gear box, and all come under different GST rates. This creates a practical and logistical burden on the distributors of spare parts and implements due to the varying GST rates and in many cases, requirement for separate invoicing. Reiterating the government's agenda for GST as a unified and simplified taxation processes, it may consider re-assessing the numerous harmonised system (HS) codes for varying categories of farming equipment and group them under a single tax slab to promote farm machinery usage in the country. A uniform GST rate of 12% on tractors their spare parts would be ideal for promotion and further usage of mechanisation.
II. Similar to Australia and Canada, there is a need to establish an agri-specific council on the functional lines of the GST council. This council could explore a mechanism to reimburse GST farmers pay during the purchase of agri inputs, including farm equipment.



2. Forging PPP models

As per the Comprehensive Policy Recommendations of the Report of the Committee on Doubling Farmers' Income (September 2018), agriculture machineries can be a part of FAAS so that farmers could gain ease in accessibility to mechanisation and associated services for hire in comparison to possessing the same. Hence, there is a need to establish CHCs at the required rate of minimum one CHC per village (when large) and one per gram panchayat or per primary agricultural credit society (PACS), covering a group of small villages.[43] These steps would be able to cater to the demand of all the basic mechanisation services required by farmers within panchayat or PACS limits. Hence, there is a requirement to promote and encourage sustainable CHCs and agricultural machinery banks via PPP models. Within a PPP-based CHC arrangement, private players could preferably explore CSR options to meet the necessary capital requirements of farmers. The CHCs can then be upgraded to aggregators of farm produce.

Promoting CSR initiatives to set up CHCs in a PPP arrangement

The financial entry barrier in establishing CHCs may be eased by suitable corporate funding or foundations through a matching grant/ interest-free loans to farmers, which can enable village entrepreneurs to take up the CHCs. This will also alleviate the problem of setting-up CHCs under government subsidy programmes.

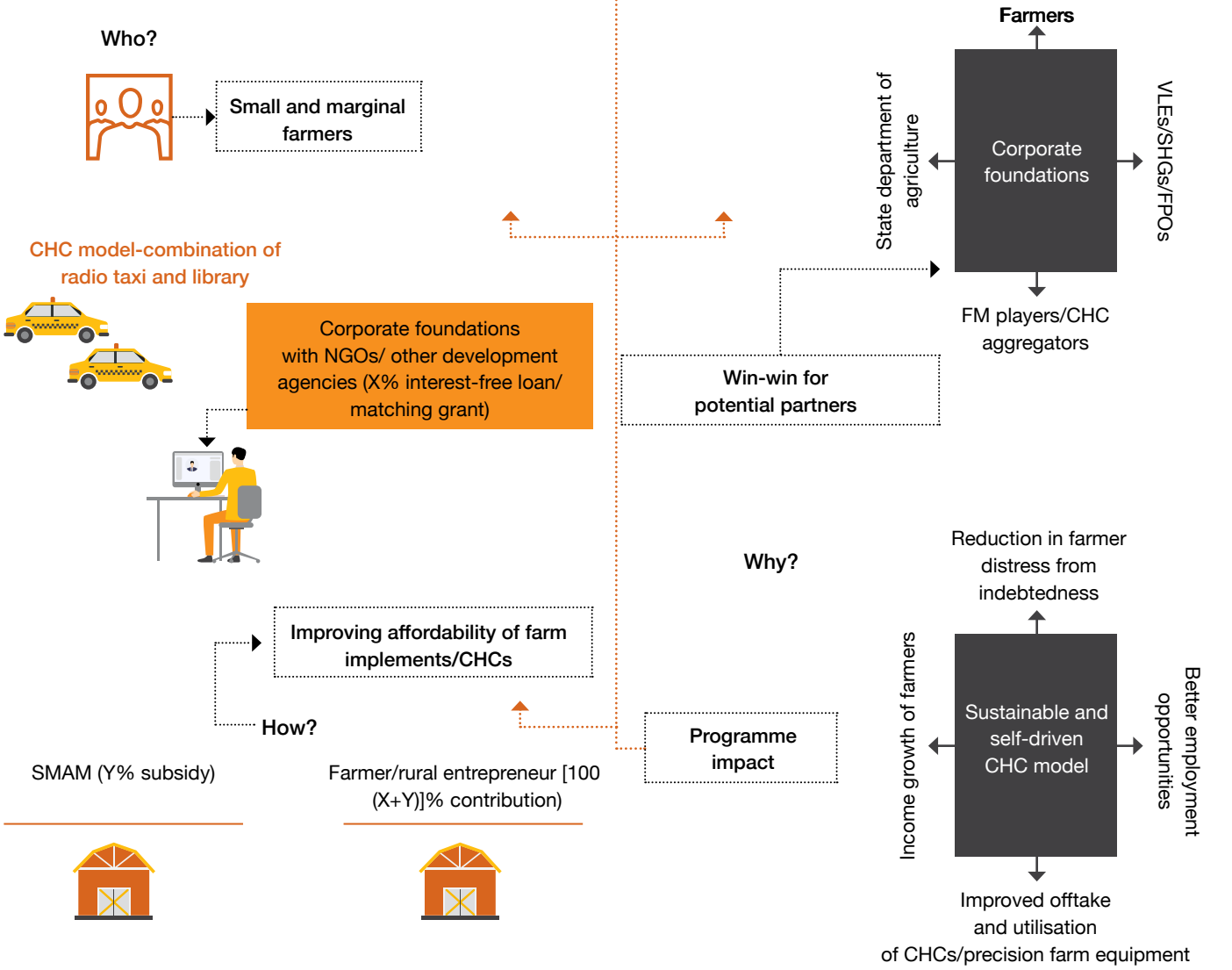
The marketability part could be addressed by integrating the CHCs on a mobile-based platform to enhance their 'zone of influence'. . This farmer-to-farmer (F2F) aggregation model could be achieved by integration with existing solution providers in the mechanisation space. This programme has been named 'Promoting CSR initiatives in grounding Custom Hiring Centres (CHCs)'.

43 Comprehensive Policy recommendations of Report of the Committee on Doubling Farmers' income, September 2018

Under the proposed CHC programme, a unique combination of a radio and library-based CHC model can be established to create a wider impact.

Promoting CSR initiatives in grounding CHCs

Integrated promotion of CHC through CSR model



In order to achieve economies of scale and to bring needed cumulative interventions, corporate foundations, state agriculture departments, farm equipment manufacturers, potential FM players or CHC aggregators, village-level entrepreneurs (VLEs), FPOs, SHGs and development agencies/private NGOs need to come together. Further, the model could also be extended for distribution of farm implements/precision farm equipment under SMAM or other existing state schemes in farm mechanisation to create a wider impact.

The proposed initiative could be structured to provide 'interest-free loans or matching grants' to a tune of **X%** to identified farmers/ VLEs/SHGs/FPOs, **enabling them avail the existing Y%** subsidy from the SMAM fund. The financial design of the programme involves X% assistance through CSR funds, Y% from subsidy under SMAM and **remaining amount as contribution from the farmer/VLE/SHG/FPO.**

Promotion of FMBs in PPP mode

Considering the majority of small and marginal farmers in the country, GoI could enter into PPPs with farm machinery majors following the build, own, operate and transfer (BOOT) model to promote FMBs. In this proposed model, the private players could establish agriculture implement resource centres (AIRCs) with tractors, a set of implements, trained operators and skilled maintenance staff. The farmers will only bear the operating costs.

Looking at the success of a similar project in Gujarat which targeted tribal maize farmers, it is inferred that such an initiative could be replicated in other states with high population of small and marginal farmers.

3. Ensuring future-ready farm mechanisation

Promotion of crop- and state-specific mechanisation priority plan, introduction of specialised equipment for small and marginal farmers through in-house manufacturing, promotion of shared utility or IT-enabled aggregation platforms, research and development (R&D) focus on scale- and gender-neutral machineries, and climate smart mechanisation are the key strategies proposed herewith to make the Indian FM sector future-ready and globally competitive.

Promotion of crop-specific and state-specific mechanisation priority plan (C&S-MPP) and related strategies

Looking at the current status of FPA across the country, it is evident that mechanisation status and needs vary across states and there is need to promote and devise strategies customised upon crop- and state-specific needs. For example, considering significant cropping acreages in India under paddy, end-to-end paddy-based mechanisation in key paddy growing states must be promoted. Such a focused approach will induce the practice of mechanisation in a major cropping system and its impact would be visible on a large scale.

A tentative crop and state prioritisation plan in this direction has been tabulated below:

Crop	Key focus states	Farm machineries for promotion
Paddy	West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab	• Laser land leveller, rice drum seeder, paddy transplanter, cono weeder, brush cutter, power sprayer, tractor-operated sprayer, combine harvester/ portable rice thresher
Wheat	Uttar Pradesh, Madhya Pradesh, Punjab, Haryana	• Raised bed planter, happy seeder/zero till drill, tractor mounted power sprayer, combine harvester, straw reaper, combine harvester
Potato	Uttar Pradesh, West Bengal, Bihar, Gujarat	• Rotavator, potato plater, power sprayer, potato digger and potato grader
Sugarcane	Uttar Pradesh, Maharashtra, Karnataka, Tamil Nadu	• Rotavator, sugarcane planter, power weeder, sugarcane harvester
Maize	Karnataka, Madhya Pradesh, Bihar	• Maize planter, rotary weeder, tractor mounted sprayer, maize harvester combine, maize sheller
Cotton	Gujarat, Maharashtra, Telangana, Punjab	• Reversible plough, raised bed planter, rotary weeder, tractor mounted power sprayer, cotton picker, ginning machine
Citrus and horticultural crops	Andhra Pradesh, Maharashtra, Madhya Pradesh	• Post hole digger, solar water pump, power sprayer/aero blast sprayer, citrus pruner, multipurpose hydraulic lift system for orchard operations
Soybean	Madhya Pradesh, Maharashtra, Rajasthan, Karnataka	• Rotavator, raised bed planter, pre-emergence herbicide strip applicator cum planter, twin wheel weeder, reaper, multi-crop thresher
Fodder and forage crops	Punjab, Haryana, Uttar Pradesh, Rajasthan	• Power-operated chaff-cutter, tractor-operated forage harvester

The C&S-MPP may be devised stage-wise and once a stage milestone is met, similar MPP may be developed for the next lot of crops and states. Such a focused strategy will help bring in a significant spurt in FPA.

Promotion of specialised equipment for small and marginal farmers through in-house manufacturing

Tractor usage in India has increased from 6 per thousand hectares to 33 per thousand hectares in last few decades.[44] But such increase has not been witnessed in usage of other segments of farm equipment. As per capita landholding of Indian farmers is decreasing, need for small farm machineries/ implements (individually operated) is constantly increasing. Looking at India's impressive rise in the **World Bank's Ease of Doing Business (EODB) 2020** rankings[45] and GoI's **Make in India** initiative, **domestic manufacturing of specialised farm implements currently being imported could be promoted here. Enabling factors** like attractive incentive structures and tax holidays for private farm implement manufacturers could also provide significant boost to the sector. This would contribute towards reducing the overall capital cost and provide sustainable mechanised solutions for majority of small and marginal farmers through better affordability.

Promotion of shared utility or IT-enabled aggregation platform

For urban transport services, connecting platforms have been proved to be quite effective. On similar lines, bringing stakeholders on a common platform is viable option for effective farm mechanisation. Stakeholders such as individual machinery owners, CHCs, Agriculture Machinery Banks (AMBs) and regional/state service centres can be brought together on a common platform and their collective efforts could be used to fulfil real-time demands in a cost-effective manner.

An F2F implement aggregation services app will act as a typical radio model of CHC, which helps in **demand-supply matchmaking and is beneficial for both the supplier and the seeker farmer.** Farmers looking to rent their existing tractors and farm equipment of any brand will be linked directly to farmers seeking to hire them free of cost. The F2F shared utility app model enables implement owners to contact farmers, negotiate rental prices and fulfil their respective requirements directly.

Improved R&D focus on scale- and gender-neutral machinery

As small and marginal landholdings in India are more prevalent, R&D should aim at developing and designing scale- and gender-neutral machinery. Further, machinery suitable for varying terrains must also be prioritised and developed.

Much needed intensive research is required, in order to **design and introduce** farm equipment appropriate for various soil types, farm sizes, crops, etc. Moreover, agricultural universities in the country are already developing path-breaking technologies in terms of farm machinery, which need to be commercialised. The public sector may not be able to take on the research activities by itself and thus policy formulation is required to facilitate and **promote private sector's efforts in research on new technologies and farming equipment, to accommodate the requirements of the country's agriculture sector.**

Promotion of climate-smart mechanisation

In the country's Indo-Gangetic Plain (IGP), where rice and wheat is predominantly grown, burning paddy straw is commonly practised in order to reach the timeline of sowing wheat. This is not only harmful to the environment but also results in loss of paddy straw's nutrient value. The **strategy to double farmers' income** can work only when not just crop produce but all other biological products of a crop is sold profitably to ensure supplementary income for farmers. Hence, agricultural mechanisation plans should also take into consideration the development of farm waste management equipment and make residue management a productive operation.

Like crop- and state-specific mechanisation priority plans, GoI could emphasise on climate-smart mechanisation through **promotion and scaling up of crop-and state-specific climate-friendly mechanisation technologies and implements. These approaches may involve promotion of happy seeders, scaling up of directly seeded rice (DSR) and SRI techniques, conservation agriculture through promotion of zero till drill, etc.**

4. FM skill upgrade through promotion of skill development centres (SDCs)

Lesser availability of skilled hands as technical service providers is the key constraint in promoting CHCs in India. There has been minimum impetus on capacity building and skill enhancement of service providers and operators of precision farm equipment like combine harvesters and laser levellers. Few private sector initiatives like SDCs in Madhya Pradesh are doing well in this regard. At these centres, **private players organise and impart training on operations, repair and maintenance** of precision farm equipment on a day-to-day basis.

Farmers in Punjab are using specialised tractors of **high HP (>65)** for maize silage preparation, and the initiative has been promoted by the Punjab government through a special incentive for these high HP tractors used for silaging. Training and capacity building on silage preparation are being imparted by the private sector, especially seed players on package of practices. These training centres have emerged as informal SDCs to promote mechanisation among dairy farmers in Punjab.

Referring to successful models in Madhya Pradesh and Punjab, GoI may contemplate running such SDCs by engaging suitable private players.

44 Sectoral Paper- Farm Mechanization, NABARD, 2017

45 Doing Business 2020–Sustaining the pace of reforms, World Bank

5. Ensuring improved access to finance

Project financing has remained a key impediment, leading to poor offtake of farm machines. Back-ended subsidy in SMAM-assisted projects aggravates the situation, increasing the need for funds. The situation gets worsened as small and marginal farmers are less capable of furnishing secondary collateral for hypothecation to banks. Currently, the subsidy support under SMAM depends upon budgetary provisions (supply-driven) instead of requirement (demand driven). **Hence, instead of a uniform slab, the subsidy proportion on each farm implement category should be customised so that the interest rate on financing precision farm machineries is brought to a minimal/lower rate for farmers to get longer payback period moratoriums.**

To motivate banks for financing farm mechanisation-related projects, it is pertinent to devise a framework that would contribute towards a stronger credit policy for farm machinery in India. Therefore, **creating a credit guarantee fund trust,** similar to the micro, small and medium (MSME) sector, would act as a solution to support the farmers and help in promoting the sector. GoI could create a **credit guarantee scheme (CGS)** to develop a robust credit delivery system and assist the flow of credit to the farm mechanisation sector.

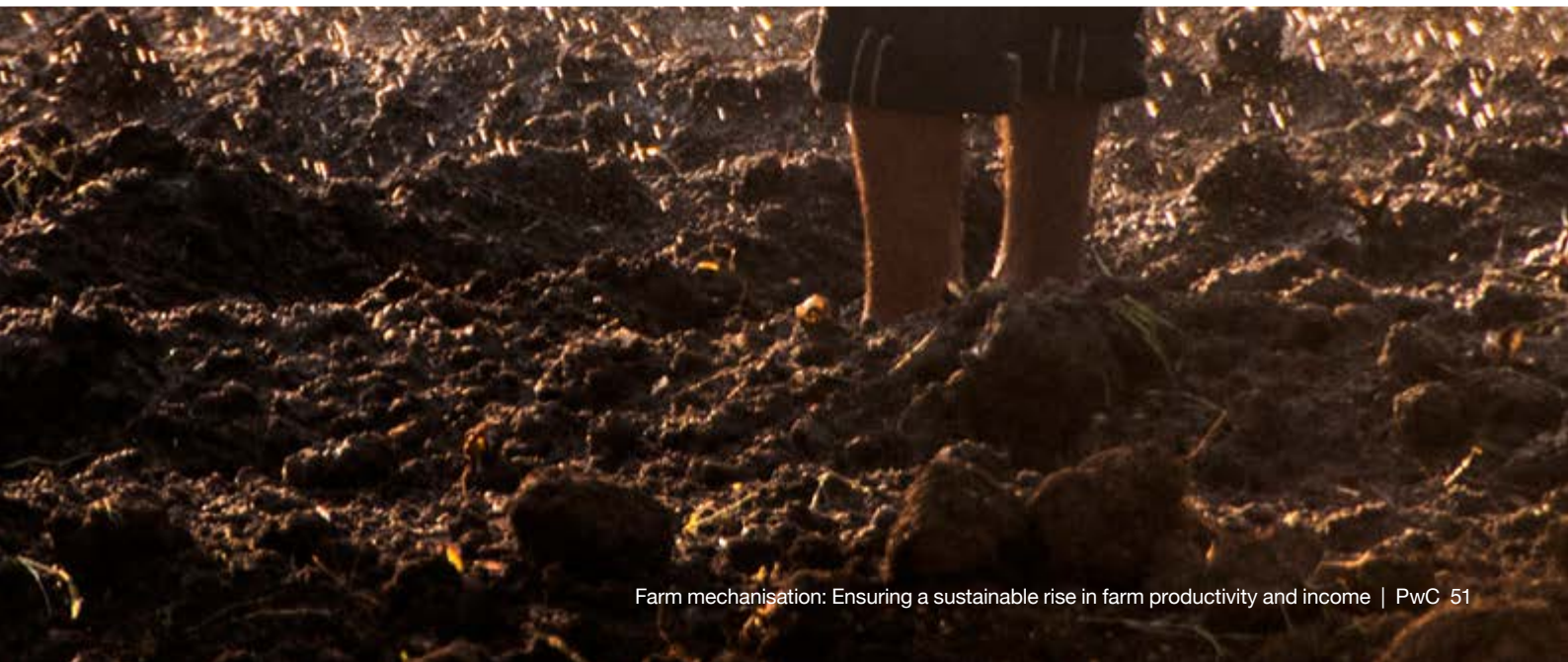
The objectives and broader outline for the same are presented in the table below:

Purpose	• Increase availability of bank credit minus the hindrances due to collaterals/third-party guarantee requirements, for promotion of CHCs in India
Objective	• CGS to provide reassurance to the lender party that, in case of an FM/CHS borrower, which received collateral-/guarantee-free credit, fails to release its obligatory liabilities to the lender, the guarantee trust would cover the loss suffered by the lender up to 80% of the credit facility.
Mechanism	• Any collateral-/third-party guarantee-free credit (including fund and non-fund-based) extended by eligible financial institutions to a new as well as an established farm machinery purchaser or CHC provider, with a maximum credit limit of INR 1 crore, would be eligible to be covered under the scheme. • Lender must cover the eligible credit as soon as the same is sanctioned. • The term of guarantee will start from the date of payment of the guarantee fee and shall run through the agreed tenure of the term credit in case of term loans/composite loans, and for a period of two years where working capital facilities alone are released to the borrowers, or for such period as may be specified by the guarantee trust in this regard.
Intended beneficiary	• VLEs, FPOs, producer groups (PGs), farmer clubs, etc., undertaking custom hiring service centres (CHSCs)
Stakeholders	• Machinery suppliers, financial institutions (FIs) including banks and non-banking financial companies (NBFCs), operation and maintenance (O&M) service providers, FM players

Strategies outlined in this knowledge report have been devised so that they address the needs of the farm mechanisation industry as well as those of other stakeholders (farmers, farmer groups/FPOs, government organisations, academicians and researchers) engaged directly or indirectly with the agriculture value chain of the country.







Notes

Notes

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FICCI provides a platform for networking and consensus building within and across sectors and is the first port of call for Indian industry, policy makers and the international business community.

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