



Farm mechanization – trends and policy for its promotion in India

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ABSTRACT

Indian agriculture is diverse and capable of producing most of the food and horticultural crops of the world. In spite of its top ranking in production of a number of crops including rice, wheat, sugarcane, fruits and vegetables, the stagnancy in productivity and shortage of agricultural produce are two major bottlenecks of Indian agriculture. Several studies suggest a direct correlation between farm mechanization and crop productivity. It saves inputs like seeds and fertilizers by 15–20%, labour requirement and operational time by 20–30%, increases cropping intensity by 5–20% and crop productivity by 10–15%. At present, Indian farmers are adopting farm mechanization at a faster rate in comparison to recent past. Farm power availability from tractors has grown from 0.007 kW/ha in 1960–61 to 1.03 kW/ha in 2013–14 and it is further estimated to reach 3.74 kW/ha by 2032–33. According to the World Bank estimates, half of the total Indian population would be in urban areas by 2050. It is further estimated that the percentage of farm workers of total work force would reduce to 49.9% in 2033 and 25.7% in 2050 from 54.6% in 2011. The share of agricultural workers in total power availability in 1960–61 was about 16.3%, which is going to reduce to 2.3% in 2032–33. The overall level of farm mechanization in the country is only 40–45% and 90% of the total farm power is contributed by mechanical and electrical power sources. To assure timeliness and quality in various field operations, the average farm power availability needs to be increased to a minimum of 2.5 kW/ha by 2020.

Key words: Farm mechanization, Farm power, Mechanization policy

India is a country with various landforms ranging from mountains to ravines, deltas, high altitude forests in Himalayas, sprawling grasslands in Indo-Gangetic plains, peninsular plateaus in South Eastern and South Western India and several other geographical formations. The climate of India is full of extremes; and agriculture is the most prone sector to rainfall variations, either deficit or excess, particularly when it coincides with susceptible/critical crop growth stages. Due to presence of a wide range of geological and climatic conditions, Indian agriculture is diverse and complex, having both irrigated and dry land areas. It can cultivate most of the food and horticultural crops of the world. India has an estimated 142 million ha (Mha) cultivated area of which about 57 Mha (40%) is irrigated and remaining 85 Mha (60%) is under rainfed (Singh *et al.* 2015). With growing level of industrialization, formation of special economic zones, urbanization and development of housing sector, there is a possibility of reduction in the cultivable land. In India, rice, wheat, maize, sorghum, and millets are the five main cereals. Along with cereals,

pulses, sugarcane, oilseeds, cotton, jute and potato are the other major crops.

India ranks second in the world in terms of farm output but the contribution of agriculture to India's GDP is constantly decreasing with India's broad-based economic growth (Singh 2015a). In India, 63% of the total holdings are below 1 ha accounting for 19% of the cultivated area while more than 86% of the total holdings are below 2 ha accounting for 40% of the total cultivated area. Fragmentation of farm land holdings is a major concern; the average size of farm holdings has reduced from 2.82 ha in 1970–71 to 1.1 ha in 2010–11. India is the second largest producer of rice and wheat and third largest producer of pulses, sugarcane, root and tuber crops, vegetables, dry fruits, coconut, agriculture-based textile raw materials, inland fish and eggs (Singh *et al.* 2015). The country has produced 275.11 million metric tonnes (MT) of foodgrains during 2016–17 surpassing all earlier records. Record production has been achieved in the case of rice (109.7 MT), wheat (98.51 MT), cotton (32.58 million bales), and sugarcane (306.07 MT).

Status of farm mechanization in India

Mechanization has been identified as the major factor for increasing agricultural productivity worldwide. As Indian market is considerably reliant on increasing agricultural produces, promotion of farm mechanization is essential.

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It is projected that the demand of agricultural implements will be about US\$ 200 billion by 2018 worldwide and Asian countries will contribute more than 60% to it. Farm mechanization has been known to provide several economic and social benefits to the farmers. It saves inputs like seeds and fertilizers up to 15–20% and labour requirement and operational time by 20–30%. On the other hand, it increases cropping intensity by 5–20% and crop productivity by 10–15%. It helps in encouraging the rural youth to join agriculture as a profession and attract people to work in the field. At present, farmers in India are adopting agricultural mechanization at a faster rate in comparison to past. Although, the sale of tractors cannot be considered as the only measure of farm mechanization but to a great extent it reflects the farm mechanization level of the country. Tractor industries in India have emerged as the largest in the world and account for about 1/3rd of total global tractor production. In India, agriculture sector has observed a considerable reduction in the use of animal and human power (animate power). The role of tractors in India reflects the increasing trend of tractorization in the country. Different sources of farm power available for performing various farm operations are—mobile power, i.e. human, draught animals, tractors, power tillers, self-propelled machines; and stationary power, i.e. diesel/petrol/kerosene engines and electric motors. The population of agricultural workers of the total rural population has reduced from 69% in 1951 to 54.6% in the year 2010–11. However number of workers in absolute terms has increased because of increase in overall population. Table 1 presents the variation in number of farm power sources over the years and also its future estimates.

Over the years the annual utilization of draught animals as a farm power source has decreased. Earlier annual use of

a pair of animals was 1200–1800 h, which has now come down to 300–500 h, that too for operations such as tillage, sowing, weeding and transportation.

Due to too much involvement of human labour in several farm operations, the cost of cultivation of many crops in the country is very high as compared to developed countries.

The agricultural workers' share in the total power availability was about 16.3% in 1960–61 which is going to reduce to 2.3% by 2032–33. Compound annual growth rate (CAGR) of different power sources on Indian farms has been given in Table 2.

Tractors and power tillers are fulfilling the high demand of mobile power for timely farm operation and increased cropping intensity. Number of tractors in India has increased from 0.037 million in 1960–61 to 4.427 million units in 2010–11. It is estimated that number of tractors will increase to 20.36 million by 2032–33 (Table 1). The availability of farm power from the tractors has accordingly grown from 0.007 kW/ha in 1960–61 to 1.03 kW/ha in 2013–14 at an overall growth rate of about 10% in the last 54 years. It is estimated that power availability from tractor will reach to 3.74 kW/ha by 2032–33.

Over the years, the shift in share of farm power has been towards the mechanical and electrical sources. In 1960–61, about 93% total farm power was contributed by animate power sources, which has reduced to about 12.6% in 2010–11 (Fig 1), whereas mechanical and electrical sources of power have increased from 7% to 87.4% during the same period. It is estimated that by 2032–33 the share of animate power will reduce to 4.1% in total farm power.

The operation-wise farm mechanization level in the country is about 40% for tillage and seedbed preparation, 29% for seeding and planting, 35–45% for plant protection, 60–70% for harvesting and threshing for wheat and rice and below 15% for other crops. The farm mechanization level varies significantly in different regions. Northern states (Punjab, Haryana and western Uttar Pradesh) have higher level of farm mechanization (70–80% overall and 80–90% for rice and wheat) because of highly productive

Table 1 Farm power sources in India

Year	Number of farm power sources, million					
	Agricul- tural workers	Draught animal power	Tract- ors	Power tillers	Diesel engines	Electric motors
1960–61	131	80.4	0.037	0	0.23	0.20
1970–71	126	82.6	0.168	0.0096	1.70	1.60
1980–81	148	73.4	0.531	0.0162	2.88	3.35
1990–91	185	70.9	1.192	0.0323	4.80	8.07
2000–01	234	60.3	2.546	0.1147	6.226	13.25
2010–11	263	51.3	4.427	0.2943	8.134	17.488
2011–12*	266	50.4	4.843	0.3442	8.212	17.873
2012–13*	269	49.5	5.211	0.3801	8.290	18.245
2013–14*	272	48.6	5.653	0.4240	8.368	18.606
2019–20*	291	43.8	8.370	0.7000	8.860	21.07
2023–24*	304	40.9	11.000	1.0400	9.190	22.89
2032–33*	336	34.8	20.360	2.5300	10.030	27.57
CAGR(%)*	1.13	-1.79	8.49	10.34	0.95	2.09

Sources: Singh (2015b), Singh *et al.* (2015), Anonymous (2015 b) and* author's computation, CAGR, Compound annual growth rate

Table 2 Compound annual growth rate (CAGR) of different power sources on Indian farms

Years	CAGR (%)					
	Agricul- tural workers	Draught animals	Trac- tors	Power tillers	Diesel engines	Electric motors
1960–61 to 1990–91	1.16	-0.42	12.27	6.25	10.66	13.12
1991–92 to 2013–14	1.54	-1.33	6.65	12.03	2.5	3.29
1960–61 to 2013–14	1.38	-0.82	9.79	9.3	7.04	8.74
2010–11 to 2032–33*	1.13	-1.79	8.49	10.34	0.95	2.09

Source: Singh (2013), Singh *et al.* (2010), Singh *et al.* (2009), Livestock Census 2012, 2007, 2003 and * author's computation

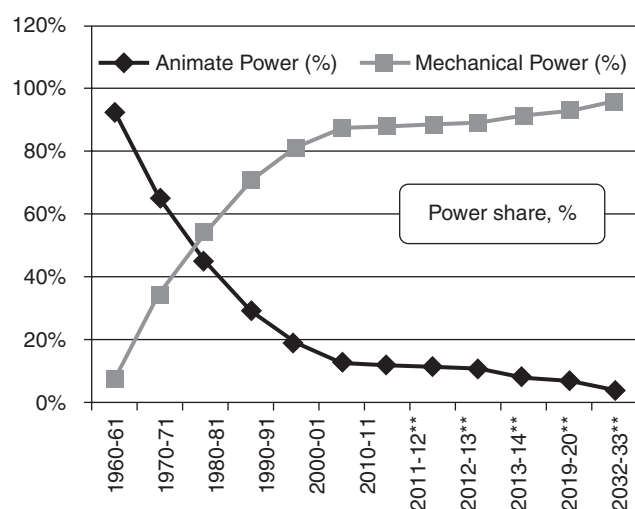


Fig 1 Trends of animate and mechanical power in Indian agriculture [Source: Singh and Sahni (2019) and ** author's computation].

land, declining agricultural labour force and support from state governments. States in eastern and southern part of the country have lower level of farm mechanization (35-45%) because of smaller and more fragmented land holdings. States in north-eastern part have very low level of farm mechanization mainly because of hilly topography, higher transportation cost of farm equipment, and farmers' socio-economic conditions.

Indian agriculture sector has been dependent on cheap and surplus labour for a long time. Now, the situation has changed with more job opportunities available in factories and services sector as well as in the Government's national rural employment creation programs. The shortage of labour has become a major problem during peak cropping season because of enactment of Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and very high demand of labour in construction sectors. Now, labour is available at higher cost and leads to higher demands for farm mechanization. The percentage of agricultural workers to total workers in India is continuously decreasing from 59.1% in 1991 to 54.6% in the year 2011 (Table 3). It is

expected to further decline to 49.9% in 2033 and 25.7% in 2050 leading to severe agricultural worker shortage.

In Asian countries, China leads in terms of production and sales of agricultural machinery. In 2011, China surpassed the European countries and USA to become the world's largest producer of farm machines/equipment. Agriculture in the countries such as the USA and other European countries is fully mechanized. China and Japan have also seen higher percentage of farm mechanization. Indian agriculture sector requires an increase in farm equipment. Countries which have higher level of farm mechanization are able to increase their production and are better equipped to meet their present and future demands. The demand factors in India are expected to rise drastically. Thus, there is a need to increase the farm mechanization level in India.

Farm mechanization in India stands at about 40-45% and it is lower in comparison to US & Western Europe (95%), Russia (80%), Brazil (75%) and China (48%). The availability of farm power has increased from 0.28 kW/ha in 1960-61 to 2.10 kW/ha in 2013-14 and expected to increase to 5.17 kW/ha by 2032-33. Operation-wise level of farm mechanization for major crops has been given in Table 4.

The two major segments of equipment, tractor and power tillers have shown a constant growth over the years (Fig 2). India is considered to be the largest tractor market worldwide. Amidst growing concerns about labour availability and shrinking profitability of agriculture as an enterprise the need has been felt for affordable, appropriate and energy efficient machines and technologies for profitable production and processing of crops focused at increased yield, reduced cost of cultivation, prevention of losses and value addition through location specific management practices. Farmers have understood these advantages and level of farm mechanization is on a rising trend in several parts of the country. However, the kind of implements appropriate for cultivation and the rate of introduction of new implements are to be considered with multi-disciplinary approach specific to the site-specific requirements. During the past four decades a large number of farm tools, implements and machines have been developed for different farm operations and are being used by the Indian

Table 3 Population dynamics of Indian agricultural workers

Particulars	Population dynamics of Indian agricultural workers (Million)					
	1991	2001	2011	2020*	2024*	2033*
Country's population	846.4	1028.7	1210.7	1347.3	1411.5	1570.9
Total number of workers	313.7	402.2	481.7	553.2	587.6	674.9
Workers' as percentage of population, %	37.1	39.1	39.8	41.06	41.63	42.96
Number of agricultural workers including cultivators and agricultural labourers	185.3	234.1	263	290.99	304.37	336.76
Agricultural workers' as percentage of total number of workers, %	59.1	58.2	54.6	52.6	51.8	49.9
Women workers as percentage of agricultural workers, %	35.1	39.0	37.2	38.2	38.6	39.6

Source: Anonymous (2015b) and *author's computation

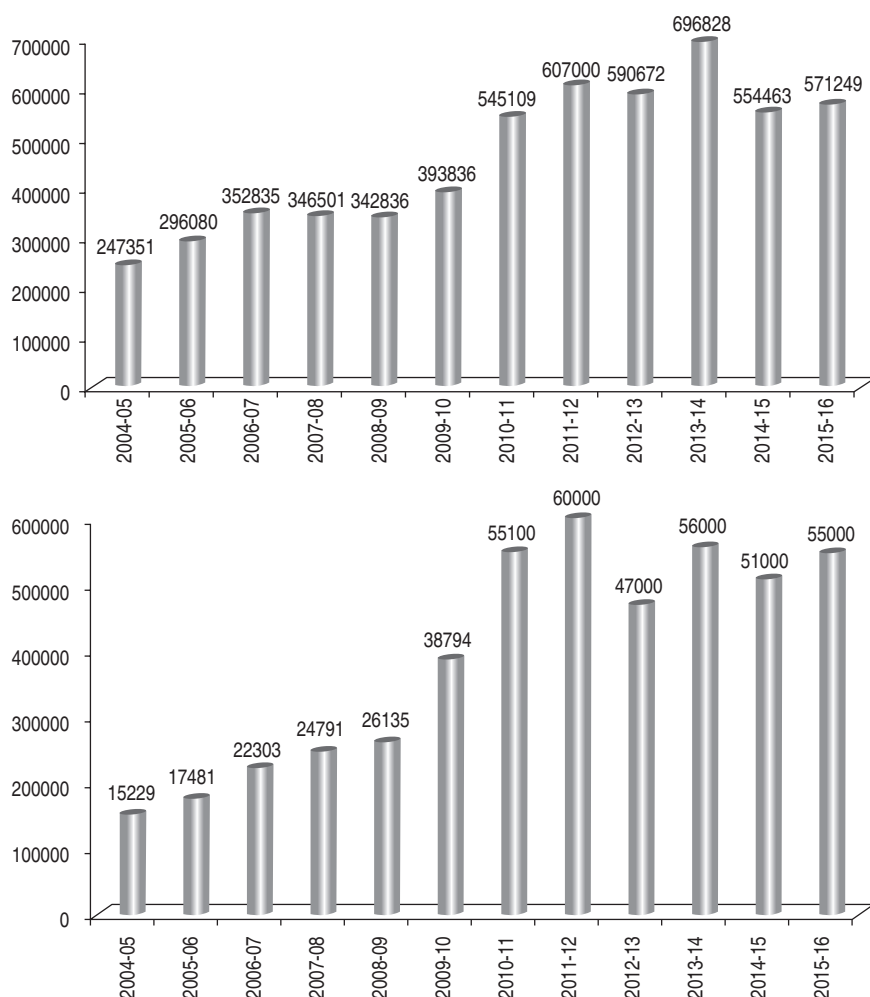


Fig 2 Sale of (a) Tractors and (b) Power tillers. [Source:Kale *et al.* (2016)]

farmers (Table 4). The scenario of farm mechanization has certainly changed as the agricultural machinery market has experienced a rapid growth with higher potential for future growth as well.

Availability of power operated and animal operated implements with regard to net cultivated area are shown in Table 5 and Table 6.

India's small and marginal farms often do not present an economic condition to allow the extensive application of farm machinery. Given the constraint of limited annual usage of machinery, the operational and capital costs may be optimized for the farmers by making the machinery available to the farmers on custom hiring. Thus, even the small and marginal farmers may be able to get the advantage of farm mechanization.

The large scale and medium scale industries manufacture tractors, power tillers, diesel engines, land development machinery, irrigation pumps, electric motors, sprayers and dusters, postharvest machinery and dairy equipment. Most of them are under unorganized sector except the tractor and power tiller industries. The promotion and marketing of agricultural machinery is done by these manufacturers through their network of dealerships and therefore, they are able to provide effective post sale services

to the farmers. These manufacturers upgrade their products and process their technologies through their own Research and Development (R&D) efforts, along with technical support from external agencies.

Impact of mechanization on crop productivity

The timeliness in farm operations is considered to have a greater significance in achieving optimal yields from different crops, which is possible by way of farm mechanization. The adoption and application of package of farm machinery and technology for agricultural mechanization has significantly contributed to improve the cropping intensity and farm productivity during the last 40 years. It has been observed that foodgrain productivity in India has increased from 0.636 t/ha in 1965-66 to 2.20 t/ha in 2013-14, while power availability has grown from 0.32 kW/ha to 2.10 kW/ha in the same period. It is estimated that foodgrain productivity and farm power availability will increase to 3.96 t/ha and 5.17 kW/ha by 2032-33. The relationship between foodgrain productivity and power availability for the period 1960-61 to 2032-33 have shown a linear function,

with highly significant value of coefficient of determination

Table 4 Level of mechanization by crop wise and operation wise

Crop	Seed bed preparation	Sowing/ planting/ transplanting	Weed and pest control	Harvesting and threshing
Paddy	85-90	5-10	80-90	70-80
Wheat	90-95	80-90	70-80	80-90
Potato	90-95	80-90	80-90	70-80
Maize	90-95	80-90	70-80	50-60
Cotton	90-95	50-60	50-60	0
Sorghum	80-90	30-50	60-70	20-30
Gram	90-95	50-60	60-70	30-40
Oilseeds	80-90	30-40	60-80	20-30
Millets	80-90	30-40	60-70	20-30
Sunflower	80-90	40-50	80-90	60-70
Fodder crop	80-90	20-40	80-90	10-20
Horticultural crops	60-70	30-40	40-50	<1
Vegetable crops	70-80	5-10	80-90	<1

Source: Tiwari *et al.* (2017)

Table 5 Number of farm machines in India

Farm machinery	Number of farm machines available ('000)							
	1992-93	2003-04	Per cent increase over 1992-93	2013-14	Per cent increase over 2003-04	2031-32*	Per cent increase over 2013-14	*CAGR %
<i>Manually operated machinery</i>								
Sprayers	1827	2046	12.0	2214	8.2	2611.27	17.9	0.92
<i>Animal operated machinery</i>								
Wooden ploughs	43464	44267	1.8	44997	1.6	46440.72	3.2	0.17
Steel ploughs	12649	19622	55.0	25972	32.4	48205.13	85.6	3.49
Seed drills/Seed-cum-fertilizer drills	472	963	104.0	1474	53.1	3908.61	165.2	5.57
Wet land puddlers	5151	8550	39.7	11640	36.1	23424.81	101.2	3.96
Animal carts	15220	16577	8.9	17663	6.5	20056.07	13.5	0.71
<i>Tractor/power operated machinery</i>								
Power operated sprayers/dusters	303	561	85.1	796	41.9	1823.82	129.1	4.71
MB ploughs	408	852	108.8	1328	55.9	3650.89	174.9	5.78
Cultivators	706	949	34.4	1170	23.3	1800.80	53.9	2.43
Disc harrows	531	913	71.9	1260	38.0	2642.02	109.7	4.20
Seed-cum-fertilizer drills	390	1011	159.2	2852	182.1	15708.63	450.8	9.94
Planters	54	75	38.9	92	22.7	145.27	57.9	2.57
Levelers	1057	1827	72.8	2343	28.2	4629.77	97.6	3.86
Threshers/Multi crop threshers	2597	5309	104.4	7775	46.4	19898.79	155.9	5.36
Combines (Tractor drawn and self-propelled)	8.5	20	135.3	59	195.0	311.06	427.2	9.67

Source: Tyagi *et al.* (2010), Livestock Census (2003) and * author's computation

Table 6 Availability of power operated implements with regards to the net cultivated area (no./1000 ha)

Year	Sprayers & dusters	Harrows	Threshers	Tillers	Ploughs	Planters	Levellers
1972-73	0.249	0.398	1.4631	0.582	0.405	0.064	0.348
1982-83	0.884	1.347	7.3058	2.245	1.019	0.221	2.951
1992-93	2.131	3.734	18.2630	4.965	2.869	0.380	7.433
2002-03	3.810	6.218	35.8569	6.565	5.708	0.517	12.472
2012-13	5.459	8.651	53.1709	8.107	9.040	0.636	16.292
2022-23*	7.134	11.125	70.7360	9.689	12.343	0.750	17.261
2023-24*	7.302	11.381	72.5283	9.851	12.663	0.765	17.132
2024-25*	7.472	11.622	74.2776	10.007	12.967	0.772	16.941
2032-33*	8.990	13.850	90.2800	11.390	15.800	0.870	15.720
CAGR, %	2.34	2.21	2.47	1.63	2.50	1.46	-0.93

Source: Tyagi *et al.* (2010), Agricultural Statistics at a Glance 2011-2013 and *author's computation

($R^2 = 0.98$). It is apparent that the farm power availability needs to be increased further to achieve high foodgrain productivity, also the composition of power from different farm power sources to be appropriately balanced to meet its timeliness of different farm operations.

The overall level of farm mechanization in the country is only 40-45% and 90% of the total farm power is contributed by mechanical and electrical power sources. The average power availability on Indian farms required to be increased to 2.5 kW/ha by 2020 to assure timeliness and quality in farm

operations, to carry out heavy farm operations like chiseling, deep ploughing, sub-soiling and summer ploughing. The concentrated efforts have resulted in the mechanization of several critical farm operations of major crops in several states. The economic benefit due to adoption of improved implements is of the order of ₹ 833.75 thousand crores per annum, which is only a small fraction of the existing potential for improvement. This has also created job opportunities for rural youth and artisans for manufacturing, operation, service and maintenance of farm machines. Because of

Table 7 Availability of animal operated implements with regards to the net cultivated area (no/1000 ha)

Year	Wooden ploughs	Steel ploughs	Puddlers	Seed drills & planters	Bullock carts	Cane crushers
1972-73	0	0	0	0	0	0
1982-83	294.783	50.770	17.954	41.247	98.418	4.939
1992-93	305.654	88.952	36.224	54.191	107.032	5.345
2002-03	312.989	134.469	58.364	69.306	116.579	6.027
2012-13	317.260	178.934	80.021	83.771	124.011	6.716
2022-23*	323.100	224.253	102.059	98.033	131.288	7.438
2023-24*	323.846	228.909	104.320	99.462	132.047	7.514
2024-25*	324.363	233.407	106.508	100.822	132.705	7.585
2032-33*	330.67	273.90	126.06	112.77	138.55	8.230
CAGR, %	0.23	2.02	2.16	1.41	0.54	0.98

Source: Tyagi *et al.* (2010), Agricultural Statistics at a Glance 2006-16 and * author's computation

continuous decline in agricultural workforce, higher levels of farm mechanization become necessity for sustainable production and profitability in agriculture.

Major thrusts towards farm mechanization

As such there is no policy for farm mechanization in India. In order to have a special emphasis on agricultural mechanization and to bring more extensiveness, a special Sub-Mission on Agricultural Mechanization (SMAM) for the XII Plan (2012-17) was launched by the Indian government. SMAM puts 'Small and Marginal Farmers' at the center of the interventions with an emphasis on 'reaching the unreached', i.e. bringing farm mechanization to the villages where the implements and technologies deployed are very old. Also, the mission caters to 'adverse economies of scale' by promoting 'Custom Hiring Services' from 'the rural entrepreneurship' model. Custom Hiring Centres (CHCs) are unit consisting of a set of agricultural machinery, implements and equipment for hiring to farmers. CHCs provide agricultural machines on rent basis to the small and marginal farmers who cannot purchase machines. States such as Punjab, Haryana, Madhya Pradesh, Uttar Pradesh, Uttarakhand, Gujarat, Maharashtra, Karnataka and Tamil Nadu have maximum number of registered and unregistered CHCs providing the machinery and equipment support to small and marginal farmers. The government has also recognized the importance of CHCs and the role they play in mechanization of several farm operations. As a result, establishment of agricultural implement banks for Custom Hiring Services is one of the major components of SMAM.

The mission is catalyzing an augmented but comprehensive growth of farm mechanization and providing help for strengthening and promotion of farm mechanization by proper training and demonstration, testing, post-harvest technology and management, procurement of specific farm implements, establishment of agricultural implement banks

for custom hiring, establishment of hi-tech productive equipment centres to help low productive regions and provide support for increase in farm mechanization in the country. To make the cost of implements affordable and available to all farmers including small and marginal farmers, the government has launched a credit-linked subsidy scheme for establishment of agricultural machinery banks and hi-tech high productive equipment hubs for custom hiring services for improving the reach of farm mechanization to small and marginal farmers and to those regions where farm power availability is low.

Farm Machinery Banks are promoting farm mechanization in the location (district wise) with lower farm power availability, facilitating custom hiring services of various farm implement/equipment used for several farm operations, expanding mechanized activities in larger areas especially under those with small and marginal farm holdings, and introducing newly developed/improved farm equipment in crop production. Hi-Tech, high productive equipment hubs are promoting use of hi-tech equipment for higher agricultural productivity, providing custom hiring services for several high value crop specific implements used in several operations, expanding mechanized activities for large areas, and involving manufacturers for development of such centres.

Government's role in farm equipment sector

In India, the government has implemented several agricultural mechanization programs through various schemes such as Rashtriya Krishi Vikas Yojna (RKVY), National Food Security Mission (NFSM), National Mission on Oilseeds and Oil Palm (NMOOP), Mission for Integrated Development of Horticulture (MIDH), and lately Sub-Mission on Agricultural Mechanization (SMAM). In addition, government has also implemented the National Mission on Agricultural Extension and Technology (NMAET) to strengthen the extension machinery and utilize it for synergizing the interventions made in various schemes.

Future prospects for mechanization and suggested policies for its promotion

Small and fragmented land holdings, high initial cost of implements, non-availability of hi-tech precision equipment, poor quality of equipment available in the market and poor after sale services are some of the major challenges for mechanization of Indian agriculture, which hinders faster growth of farm mechanization. The efforts so far have been mainly towards tractorization rather than mechanization of Indian agriculture. Although, farmers have several options for financing, a number of challenges hinder the credit flow to the beneficiaries. These challenges include higher collaterals especially for loans of more than ₹ 1 lakh, higher interest rates and comparatively lower repayment periods (5–7 years). Small and marginal farmers are still far away from the benefits of farm mechanization. Even after a large number of custom hiring centres are in operation small and marginal farmers struggle to perform the farm operations

timely. Since, about 85% of farm holdings are under small and marginal category, this group of farmers needs to be targeted with appropriate farm machines and technologies.

The future investment in agricultural mechanization will be influenced by several factors. Tractor sales data of past years reveals growing preference among farmers in the power range of 41–50 hp or higher hp range. Higher capacity equipment such as laser land levelers, rotavators, harrows, seed drills and planters, high clearance sprayers, high capacity threshers and self-propelled and tractors operated combines will also be preferred in future. The custom hiring services of mechanical power for operations such as tillage, harvesting, threshing and irrigation will be preferred by small and marginal farmers who cannot afford to have their own machines. The present trend in farm mechanization is for application of high capacity machines through custom hiring services. Smaller and hand operated tools and implements will only grow slowly as the number of farm workers increase. Animal operated equipment will decrease because of gradual decline in number of draft animals. In contrast, the application of power operated implements will increase rapidly. Horticulture mechanization and mechanization of hill agriculture are areas where mechanization has miles to cover to increase the farmer's income by reducing labour requirement.

Business friendly policies, rules and regulations, physical and institutional infrastructures development to boost commercial activities and entrepreneurship development in agriculture, agricultural input supply, output handling, processing, popularizing and marketing are important factors for the success of farm mechanization in several states of India. Following strategic policies may be considered for promoting farm mechanization in the country:

- Reduce or eliminate subsidies and use these funds to decrease the interest rates on agricultural loans and taxes for purchase of implements and equipment for agricultural operations.
- Promote on-farm storage, processing and marketing facilities in catchment areas.
- Number of custom hiring centers, especially in areas of small and marginal land holdings should be increased substantially.
- Quality of farm machines must be assured as it brings more confidence among farmers for adoption of farm mechanization.
- Strengthen support for R&D services; testing and standardization; human resource development in support of farm mechanization.
- Manufacturing facilities should be developed especially in areas with low level of farm mechanization by providing incentives to manufacturers establishing such facilities in these areas.
- Since percentage of women workers in agriculture is increasing day by day, development of gender friendly equipment should be taken up.
- In order to provide economical mechanization solutions to the farmers, cooperative farming should be promoted

in areas of small sizes of holdings.

- More R&D efforts should be diverted towards development of machines for mechanization of horticulture and hill agriculture.
- In order to decrease the input cost the use-efficiency of several farm inputs needs to be improved through high-tech interventions such as site-specific nutrient management, mechatronics and optoelectronics.
- Skill development in the area of operation, repair and maintenance of farm machines should be taken up.

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