**Farm Mechanization for Rural Development in India**

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**Introduction:**

**Agriculture scenario in India**

The agriculture and allied sector continues to be significant for the inclusive and sustainable growth of the Indian economy. Indian Agriculture Sector not only ensures food security but also provides employment for substantial volume of population, directly & indirectly. The majority of the country’s population depends on agriculture for their livelihood. Although agriculture sector plays a crucial role in the Indian Economy, there is a constant drop in this sector. Agriculture in India contributes about 14% towards the GDP. But the labor force engaged in agriculture is 48%. This shows the scarcity of mechanization development in India. Mechanization will contribute towards the increase in land productivity and quality of cultivation. It will give the opportunities to relieve labor shortages. It will reduce poverty and achieve food security while improving people's livelihoods. According to the estimation of the World Bank, half of the Indian population would live in urban areas by the year 2050. It is estimated that percentage of agricultural workers in total work force would drop from 58.2% in 2001 to 25.7% by 2050. This shows the need to enhance the level of farm mechanization in the country. Moreover, country’s drastic increase in level of farming and global competition facilitated the use of machines in farming operations

The productivity of farms depends greatly on the availability and judicious use of farm power by the farmers. Farm Power is an essential input in agriculture for timely field operations for operating different types of farm equipment and for stationary jobs like operating irrigation equipment, threshers/shellers/cleaners/graders and other post harvest equipment. Agricultural implements and machines enable the farmers to employ the power judiciously for production purposes. Agricultural machines increase productivity of land and labour by meeting timeliness of farm operations and increase work out-put per unit time. Besides its paramount contribution to the multiple cropping and diversification of agriculture, mechanization also enables efficient utilisation of inputs such as seeds, fertilisers and irrigation water.

Farm Mechanization of agriculture is an essential input in modern agriculture. It enhances productivity, besides reducing human drudgery and cost of cultivation. It also helps in improving utilization efficiency of other inputs, safety and comfort of the agricultural worker, improvements in the quality and value addition of the produce. Efficient machinery helps in increasing production and productivity, besides enabling the farmers to raise a second crop or multi crop is making the Indian agriculture attractive and a way of life by becoming commercial instead of subsistence. Increased production will require more use of agricultural inputs and protection of crops from various stresses. The average farm power availability for the cultivated areas of the country has also been increased from 0.48 kW/ha (1975-76) to 1.84 kW /ha (2013-14) and 2.49 kW/ha (2018-19), which needs to be increased to 4.0 kW/ha by the end of 2030 to cope up with increasing demand of food grains. According to a recently released paper by the[**National Council of Applied Economic Research (NCAER)**](https://www.drishtiias.com/daily-updates/daily-news-analysis/ncaer-report-on-farm-machinery-industry-in-india)**,** the farm machinery industry in India faces significant challenges in meeting the demands of small and marginal farmers. The**farm machinery industry is characterized by both demand and supply-side challenges.** Farm mechanization in India, at 40-45%, remains low compared to the rest of the world; in the US it is 95%, Brazil 75%, and China 57%. Despite low levels of farm mechanization in India, skills shortages and a lack of awareness among farmers about technology and machinery management pose significant obstacles to progress. There is a need for special efforts in farm mechanization for these categories of farmers to enhance production and productivity of agriculture.

As per the Vision 2030 document by Indian Council of Agricultural Research, domestic demand for food grains is expected to increase at around 2% CAGR in CY2000-30. Food grains demand is expected to reach 355 MT in CY30 vis-à-vis 192 MT in CY10. Fruits and Vegetables demand is expected to reach 290 MT in CY30 vis-à-vis 136 MT in CY10. However, given the limitations in land use and in increasing cropping intensity over a certain period, increasing the yield from the same land is an urgent requirement to meet the needs of a growing domestic population. This limitation can only be overcome by increasing the food productivity, for which farm mechanization plays a vital role. (Farm Mechanization - National Round Table Conference)

Farm mechanization is the application of engineering and technology in agricultural operations to do a job in a better way to improve productivity. Farm mechanization is technique which refers to those activities normally occurring inside the boundaries of the farm unit or at the farm unit level.

Farm machinery comprises equipment used at various stages of farm operations like

* Seed bed preparation,
* Soil working,
* Seeding,
* Planting and  plant protection,
* Harvesting and threshing.

**Benefits of farm mechanization**

1. Input savings: Studies have shown a direct relationship between farm mechanization (farm power availability) and farm yield. Farm mechanization is said to provide a number of input savings:

• Seeds (approximately 15-20 percent)

• Fertilizers (approximately 15-20 percent)

• Increased cropping intensity (approximately 5-20 percent).

1. Increase in efficiency: Aside from the above stated inputs, farm machinery also helps in increasing the efficiency of farm labour and reducing drudgery and workloads. It is estimated that farm mechanization can help reduce time by approximately 15-20 percent. Additionally, it helps in improving the harvest and reducing the post-harvest losses and improving the quality of cultivation. These benefits and the savings in inputs help in the reduction of production costs and allow farmers to earn more income.
2. Social benefits : There are various social benefits of farm mechanization as well:

* Helps in conversion of uncultivable land to agricultural land through advanced tilling techniques and also in shifting land used for feed and fodder cultivation by draught animals towards food production.
* Decrease in workload on women as a direct consequence of the improved efficiency of labour.
* Improvement in the safety of farm practices.
* Helps in encouraging the youth to join farming and attract more people to work and live in rural areas.

1. Only alternative to deal with Increasing cost of labour: The cost of deploying labour for agriculture operation is increasing substantially. Farm mechanization is the only way to reduce labour cost, and thus cost of cultivation. The Table 14 & Fig. 10 shows the trend in increasing labour cost. (Shivam Raju Nikhade andAnimesh Suresh Gunaki, 2020)

**Scope of Farm Mechanization:**

            There is a good scope of farm mechanization in India due to the following factors:

1. Improved irrigation facility in the country.
2. Introduction of high yielding varieties of seeds.
3. Introduction of high dose of fertilizers and pesticides for different crops.
4. Introduction of new crops in different parts of the country.
5. Multiple cropping system and intensive cultivation followed in different parts of the country.

Some other Factors which are responsible to encourage Farm Mechanization are:

1. Population of the country is increasing at the rate of about 2.2% per year. Steps have to be taken to arrange food and fibre for such large population by adopting intensive farming in the country. Intensive farming requires machines on the farm.
2. In multiple cropping programme, where high yielding variety of seeds are used, all farm operations are required to be completed in limited time with economy and efficiency. This is possible with the help of mechanization.
3. Farm mechanization removes drudgery of labour to a great extent. A farmer has to walk about 66 km on foot while ploughing 1 ha land once by bullocks with a country plough having 15 cm furrow width.
4. Avoiding the risk of family members to work at farm (females and children )
5. The proper utilization of basic inputs like water, seeds and fertilizers will be possible with proper equipment.
6. There are certain operations which are rather difficult to be performed by animal power or human labour such as:

* Deep ploughing in case of deep rooted crops.
* Killing the pernicious weeds by deep tillage operations.
* Levelling of uneven land.
* Land reclamation.

1. Application of insecticides during epidemic seasons. These operations need heavy mechanical equipment.

**Issues/ Bottlenecks in Indian Farm Mechanization System**

* Low annual use of tractors (only 500-600 hrs/year against recommended 1000 hrs/yr).
* Non availability of matching equipment.
* Cumbersome and energy inefficient designs.
* Poor reliability, frequent breakdowns and high repair and maintenance cost.
* Low quality.
* Use of ungraded materials, absence of inter-changeability of components.
* Inadequate R&D, Testing &Training facilities and inadequate Research funding.
* Inadequate user education.
* Lack of standardization.
* Non-availability of relevant literature like operator’s manual, parts catalogues etc.
* Fragmented land-holdings
* Practice of subsistence agriculture
* Higher participation of small and marginal farmers in agriculture
* Lack of awareness in using the technology
* High cost of equipments’ and inadequate after-sale services
* Lack of credit access to buy farm equipments
* Low penetration of farm machinery with 40-45%
* Tedious acquiring process of subsidized farm machinery
* Feminisation of agriculture and the need to train them

**Government of India Initiatives for Promotion of Agricultural Mechanization**

* **The Sub Mission on Agricultural Mechanization (SMAM)** is providing a suitable platform for converging all activities related to agricultural mechanization by providing a ‘single window’ approach for implementation with accelerated and inclusive growth of agricultural mechanization in India. The scheme is implementing in all the states, to promote the usage of farm mechanization and increase the ratio of farm power to cultivable unit area up to 2 kW/ha by the end of 12th plan.

The main objectives of SMAM are:

a. To increase the reach of farm mechanization to small and marginal farmers and to the regions where availability of farm power is low;

b. Promoting custom hiring centres to offset the adverse economies of scale arising due to small landholding and high cost of individual ownership;

c. Creating hubs for hi-tech & high value farm equipment’s;

d. Creating awareness among stakeholders through demonstration and capacity building activities; and,

e. Ensuring performance testing and certification at designated testing centres located all over the country.

Under this scheme, financial assistance @ 40% to 50% of the cost of machines depending on the categories of farmers, is provided for purchase of agricultural machines.  Financial assistance @ 40% of the project cost is also provided to rural youth & farmer as an entrepreneur, Cooperative Societies of Farmers, Registered Farmers Societies, Farmer Producer Organizations (FPOs) and Panchayats for establishment of Custom Hiring Centres (CHCs) and Hi-tech hubs of high value agricultural machines. Financial assistance @ 80% of the project cost for the projects costing upto Rs. 10 lakhs is provided to the Cooperative Societies, Registered Farmer Societies, FPOs and Panchayats for setting up of village level Farm Machinery Banks (FMBs). The rate of financial assistance for the North Eastern States for establishment of FMBs is @95% of the project cost for the projects costing up to Rs. 10 lakhs. The major focus of the scheme is towards expanding the network for Custom Hiring Services of agricultural machines and equipments to increase utilization of farm power and ensuring availability of farm equipment and machines for small farms. Since inception of the scheme, more than 40900 CHCs/Hi-tech Hubs/FMBs have been established in various States.

* **Human Resources Development in Farm Mechanization**: Developing human resources and generation of self-employment by way of providing skill-oriented training in the agricultural sector is important aspect.  Keeping this in view, Farm Machinery Training and Testing Institutes (FMTTIs) have been established at Budni (M.P.) in 1955, Hissar (Haryana) in 1963, Garladinne, District Anantapur in 1983 and Biswanath Chariali (Assam) in 1990.  These Institutes have since then engaged in developing human resource for agricultural mechanization.  The FMTTIs have been conducting different types of training programmes in the selection, operation, repair/maintenance and management of farm machinery for the benefit of nominees of Central/State Governments, Private Organization, retired/retiring Defence Personnel, technician, rural youth, farmers and engineering graduates.
* **Quality Control of Agricultural Machines and Implements**: Improved and quality agricultural implements and machines play a pivotal role in sustainable development of agriculture and enhancement of crop productivity. Therefore, identification of quality and need based agricultural machines/equipments are of paramount importance. Quality is also a critical factor in accessing competitive new markets for the manufacturers. The FMTTIs have been engaged in testing of agricultural machines and implements with the objectives of assessing suitability of machines to Indian conditions, educating clientele on comparative performance of various machines, providing data and material to extension workers for guiding farmers, helping financial institutions in more effectively financing their schemes of assistance for procurement of machinery. The institutes also assist in grant of BIS Certification, contribute to export promotion through assessing conformity of product to ISO/OECD specifications and carry out Batch Testing programme to help manufacturers in product improvement thereby providing better equipment to farmers.
* **Popularization of New Agricultural Machines**: For improving adoption of technologies for crop production, it is necessary to properly demonstrate utility of technologies to farmers for achieving higher production and productivity. Therefore, with objective of induction of improved/new technology in agricultural production system, demonstration of newly developed agricultural/ horticultural equipments at the farmers’ fields have been introduced  100% grant-in-aid is given to the implementing agencies i.e State Governments/UTs and Government organizations like ICAR and State Farm Corporation of India (SFCI) for procurement and demonstration of identified equipment.
* **Incentives for Purchase of Agricultural Machines/ Implements**: In order to make available various agricultural implements and machines at cheaper rates, assistance in the form of subsidy @ 25%to 50% of the cost of equipment/machine with permissible ceiling limits is available to all category of farmers for the purchase of various agricultural equipments under various schemes of the Department of Agriculture and Cooperation such as  Macro Management of Agriculture, National Food Security Mission, Rashtriya Krishi Vikas Yojana, National Horticulture Mission etc.
* **Incentives for setting up of Custom Hiring Centres of Agricultural Machines**: Incentives in the form of subsidy is supported through the RKVY and Macro Management Schemes so that the established  Farm Machinery Banks would make available costly equipment to the farmer and would supplement the efforts of the Government in extending appropriate mechanization in the country, make available different input supply and services to needy farmers, provide gainful employment to rural unemployed youth, resulting in timeliness of farm operations thus ultimately leading to increase in production and productivity.
* **Promotion of Post Harvest Management**: The post harvest management is promoted by way of establishment of post harvest technologies in the production catchments under the bilateral agreement of ICAR and Self Help Group (SHG)/User Groups (UG) of farmers/Cooperative Societies of Farmers/Non-Governmental Organizations (NGOs) with 40% assistance from the Government and remaining 60% coming from the beneficiary. Establishment of low cost Post Harvest Technology (PHT) with Government assistance @ 40% of the total cost of technology/project is also supported and the technologies involving initial project investment upto Rs. 2 lakh may be opted by individual farmer. Demonstration of the crop/area specific post harvest technologies is also being undertaken through State Governments, All India Coordinated Research Projects on Post Harvest Technology Centres and KVKs of ICAR, Council for Scientific and Industrial Research (CSIR) Extension Centres and State Agricultural Universities.

**Mechanization for small farmers**

Mechanization of farms does not mean only use of machines at the farm for tilling and threshing. Rather a much broader gamut of mechanization exists in other areas as well, such as irrigation, transportation to markets, and processing of produce, etc.

Small farm mechanization has a host of benefits and economic potential. Given the right conditions, it can transform the Indian agricultural sector, pave the way to food security, and enhance farmer income. Benefits include:

* A shift to commercial agriculture. Marginal and subsistence farmers often struggle with low yields, vagaries of the weather, and the resulting low return. Modern technology leads to an adoption of commercial farming techniques and productivity goes up. Farmers who transition to commercial farming are able to reach out and fetch a better return on their investment and efforts.
* Labor shortage issues addressed. Small farmers are dependent on external labor in the sowing and harvesting season, as most of the work is done manually, using primitive methods. Migration has added to a shortfall in available labor for manual operations. Thus, mechanization eases the dependence on manual labor and helps to enhance productivity and minimize losses.
* Productivity increased. Small farm mechanization results in efficiency in the farming process. Turnaround time is reduced, and the farmer is able to multiply their gains through better productivity and proper utilization of resources.
* Increased yield and lower input costs. Farm mechanization has shown to create an increase in yield from 15 to 50 percent, depending on the crop. Small farming tends to ignore certain input costs such as labor. When opportunity costs are accounted at prevailing wage rates, small Indian farms are found to be less profitable. With better farming methods, input costs come down as wastage and labor costs reduce over time.
* Enlarged cropping area due to effective land utilization. With reduced or no dependence on animals, land use for cropping increases. Besides mechanized farming brings efficiencies in tilling and other farming operations, resulting in better coverage of cropping area. For small farmers, this has added economic implications.

**Priority Areas for Indian Agricultural Mechanization**

* 1. Intensification of Research and development to introduce energy efficient machines for relatively un-mechanized crops such as cotton, sugarcane, oil seeds, pulses, vegetables & fruits.
  2. Intensify research in the area of tractor design engineering due to their extensive use in Indian farming.
  3. Farm machinery management research to find out use patterns, annual usage, breakdown frequencies, repair & maintenance cost and above all reliability.
  4. Research on safety, comfort, exhaust emissions and health hazards in the use of mechanical power sources and machines needs to be expedited.
  5. Emphasis be laid on conservation farming and energy saving/energy efficient tools and machines.
  6. Emphasis be laid on design and manufacture of high capacity and precision machines for multi farm use, for corporate/contract farming as well as for custom hiring through Agri. Business Centres being promoted by Govt. of India for the benefit of rural youths.
  7. Equipment for post harvest transport, bulk handling, cleaning grading drying milling packaging and storage are required. These could be imported wherever non-existent. Next revolution in agriculture must be ushered in the area of efficient food processing & agro industries to transform the rural areas & utilize the surpluses.
  8. Mechanization of hill-agriculture (20% total cultivated area), horticulture and floriculture, forage production and handling equipment, forestry mechanization, and efficient transport equipment are some important areas.
  9. Women-friendly tools and gadgets need to be evolved by modifying the existing ones and designing the new tools to reduce drudgery to women workers.
  10. The present credit policy may not be favorable to small farmers to own mechanical prime movers. It excludes them from the benefits of farm mechanization and supplementing their incomes through hiring out their spare operational capacity. Instead of land mortgage, viability and hypothecation of the machinery may be better criteria.
  11. Increasing emphasis on Integrated Pest management and Organic farming would require use of efficient cultivation machinery for weeding and hoeing. Research in this area would be necessary to evolve optimum planting geometry and practices.

**Strategies for Farm Mechanization of Indian Agriculture**

Agricultural mechanization should contribute to sustainable increase in productivity and cropping intensity so that the planned growth rates in agricultural production are achieved. Mechanization is capital intensive and substantial sums have been invested in our country. In the absence of good planning and direction, investment on mechanization may not yield the expected results. India adopts a policy of selective mechanization under diverse conditions, which makes the agricultural mechanization a challenging task. An appropriate mechanization technology suiting to the needs of the farmers is required to be adopted. This may be achieved by following a few points as mentioned below.

1. The widely fragmented and scattered land holdings in many parts of the country need to be consolidated (virtual or real) to give access for their owners to the benefits of agricultural mechanization.
2. There is a need to have more interaction among the farmers, research and development workers, departments of agriculture and industry to make farm machinery research and development base stronger.
3. To achieve higher production levels, the quality of operations like seedbed preparation, sowing, application of fertilizer, chemicals and irrigation water, weeding, harvesting and threshing will have to be improved by using precision and efficient equipment.
4. The benefits of agricultural mechanization should be extended to all categories of farmers with due consideration to small and marginal farmers, to all cropping systems including horticultural crops and to all regions of the country especially the rainfed areas.
5. Provision may be made for special credit support at lower interest rates to rural individuals, venturing into entrepreneurial use of farm machinery through custom hiring (Mehta and Pajnoo, 2013). Farmers should be extended with financial assistance in the form of subsidy for the purchase of agricultural equipments and should have the discretion to select the quality machinery to be purchased with subsidy rather than it being pre decided vide norms.
6. Manufacturing units that are set-up in areas with lower mechanization needs to be supported by extending tax and duty sops. This would result in easier reach of the equipment to farmers in those areas (Mehta and Pajnoo, 2013).
7. There is a need for strengthening training programmes at various levels and for different categories of people on operation, repair and maintenance of agricultural machinery, tractors, power tillers, rice transplanters, combines etc. and for transfer of technology.
8. The quality of life and work environment of farmers/farm women need to be improved. Their work involves considerable drudgery and discomfort. Proper ergonomic designs of agricultural equipment, incorporating latest safety measures and ‘comfort features’ should be made available.
9. Training Young Farmers/Owners/Operators: [Krishi Vignan Kendras](https://www.drishtiias.com/state-pcs-current-affairs/haus-krishi-vigyan-kendra-got-the-best-center-award-at-the-national-level) and related industry should be made responsible for training young farmers/owners/operators on how to select, operate and service farm machinery. They should also provide information on developments in mechanisation including the availability of new and better farm equipment for different applications.
10. Strengthening Front-line Demonstration: Front-line demonstration of farm machinery should be strengthened and handheld training to users of new-generation farm machinery may encourage the extension and adoption of farm power.
11. Address Skilling Shortages: The Agricultural Skills Council of India should work at the district level to address skills shortages on the demand side. [Public-private partnerships](https://www.drishtiias.com/daily-updates/daily-news-analysis/railways-to-bid-for-16-stations-through-ppp-model) with Custom Hiring Centres may be especially useful, and[Indian Council of Agricultural Research (ICAR)](https://www.drishtiias.com/daily-updates/daily-news-analysis/indian-council-of-agricultural-research) institutes can offer short courses that address skills shortages on the demand side. Industrial Training Institutes (ITIs) can be leveraged to address the skill gaps in repair and maintenance, and service centres at the regional and State levels may be promoted in the private and industrial sectors.
12. Provisioning available Technical Knowledge and Skills: The District Industries Centre should work with local industrial clusters so that ITIs can provide relevant courses with the latest available technical knowledge and skills.

**Conclusion**

Technological improvements in Indian agriculture since the mid-sixties have enabled a substantial increase in food grains production. Farm mechanization has been considered as one of the important elements of modernizing agriculture. The level and appropriate selection of agricultural machinery has direct impact on land and labour productivity, farm output and income, environmental safety and economic condition of the farmers. Yet, farm mechanization is at various stages of adoption in India. The use of improved farm implements has the potential to increase productivity. Farm Mechanization in enhancing farm efficiency and making farming more profitable, Government of India has given highest priority to this sector. But given the plethora of issues and constraints the country is yet to realize its full potential. Though policy makers have initiated preliminary support to farm mechanization by including it as focus area in broader schemes such as in Rashtrya Krishi Vikas Yojna and Macro Management of Agriculture schemes, concerted focus on this sector is still lacking. According to recent studies, India's agricultural mechanization is relatively low compared to advanced countries, with only 40% of mechanization achieved at present. As labor costs continue to rise, small and medium farmers are migrating from rural to urban areas for better economic opportunities. Consequently, farmers are losing interest in agricultural work due to changes in monsoon patterns, and water sources in rain-fed areas in rural regions are dwindling. Moreover, high agricultural machinery costs make it difficult for small and medium farmers to afford. A lot more focus needs to be brought in to further enhance the growth of this sector and to tap the immense potential it offers. With the increasing population, farm fragmentation and conversion to real estate development further reduce available land. To expand planted areas, increase production volume and productivity, and reduce costs, more efforts are required to strengthen mechanization levels and address agricultural economic factors. In the future, lower cost machinery should be developed to suit the needs of medium and marginal farmers.

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