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Trends of Agricultural Mechanization in India

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Indian agriculture

India accounts for only about 2.4% of the world’s geographical area and 4% of its water resources, but has to support about 17% of the world’s human population and 15% of the livestock. Agriculture is an important sector of the Indian economy, accounting for 14% of the nation’s GDP and about 11% of its exports. Agriculture in India is currently growing at an average compound annual growth rate (CAGR) of 2.8%. About half of the population still relies on agriculture as its principal source of income and it is a source of raw material for a large number of industries. Accelerating the growth of agriculture production is therefore necessary not only to achieve an overall GDP target of 8% and meet the rising demand for food, but also to increase incomes of those dependent on agriculture and thereby ensure inclusiveness in our society (Anonymous, 2013).

There was a record food grains production of 259.32 million tonne during 2011-12, of which 131.27 million tonne was during kharif season and 128.05 million tonne during the rabi season. The increases in production of wheat, bajra, maize, groundnut and total oilseeds can mainly be attributed to increase in yields, whereas the growth in production of gram, tur, pulses, soybean and cotton is driven by a combination of both expansion in area and increase in productivity. This situation necessitates the role of mechanization in terms of minimal use of inputs, time saving and labour saving.

Increasing demand for industrialization, urbanization, housing and infrastructure is forcing conversion of agricultural land to non-agricultural uses. The scope for expansion of the area available for cultivation is limited. As per agriculture census 2010-11, small and marginal holdings of less than 2 hectare account for 85% of the total operational holdings and 44% of the total operated area. The average size of holding for all operational classes (small and marginal, medium and large) have declined over the years and has come down to 1.16 hectare in 2010-11 from 2.82 hectare in 1970-71 (Anonymous, 2013).

The availability of labour to work in agriculture is crucial in sustaining agricultural production. The population dynamics of Indian agricultural workers shows that by 2020, the population of agricultural workers in the country will be about 230 million of which 45% will be the female workers (Table 1). It is predicted that the population in rural areas will decrease to 62.83% in 2025 and to 44.83% in 2050. Thus, there is going to be a significant role of farm workers in country’s agricultural production. Agricultural wages have traditionally been low, due to low productivity and large disguised unemployment in agriculture sector. However, in
recent years there is sharp increase in agricultural wages due to economic growth and adoption of employment generation policy like the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) and increase in minimum wages under the Minimum Wages Act. However, agricultural wages, in general, are still much lower than the industrial wages. This further strengthens the necessity for agricultural mechanization in a manner that is inclusive and suitable for Indian conditions.

Table 1 Population dynamics of Indian agricultural workers (No. in million)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particulars</th>
<th>1991</th>
<th>2001</th>
<th>2011</th>
<th>2020*</th>
<th>2050*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Country’s population</td>
<td>846.4</td>
<td>1028.7</td>
<td>1210.7</td>
<td>1323.0</td>
<td>1612.0</td>
</tr>
<tr>
<td>2</td>
<td>Total no. of workers</td>
<td>313.7</td>
<td>402.2</td>
<td>481.7</td>
<td>566.0</td>
<td>787.0</td>
</tr>
<tr>
<td>3</td>
<td>No. of workers as % of population</td>
<td>37.1</td>
<td>39.1</td>
<td>39.8</td>
<td>42.8</td>
<td>48.8</td>
</tr>
<tr>
<td>4</td>
<td>No. of agricultural workers</td>
<td>185.3</td>
<td>234.1</td>
<td>263.0</td>
<td>230.0</td>
<td>202.0</td>
</tr>
<tr>
<td></td>
<td>Cultivators</td>
<td>110.7</td>
<td>127.3</td>
<td>118.7</td>
<td>110.0</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Agricultural labourers</td>
<td>74.6</td>
<td>106.8</td>
<td>144.3</td>
<td>120.0</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>Percentage of agricultural workers to total</td>
<td>59.1</td>
<td>58.2</td>
<td>54.6</td>
<td>40.6</td>
<td>25.7</td>
</tr>
<tr>
<td></td>
<td>workers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Percentage of female in agricultural workers</td>
<td>35.1</td>
<td>39.0</td>
<td>37.2</td>
<td>45.0</td>
<td>60.0</td>
</tr>
</tbody>
</table>

*Vision 2050 document of Central Institute of Agricultural Engineering, Bhopal, India

Women in rural India play a major role in shaping the economy of the country. In Indian agriculture, women perform four different types of roles viz. as a worker (a source of power), as an operator (a controller), as a manager (a farmer) and as an entrepreneur (a business person). At present, most of the Indian women carry out the role of workers only. The tools/equipment available have been primarily developed for male workers, and women workers have to use these whenever required. As a result, the output is lower and may lead to many occupational health problems. To make them capable for other roles, it is necessary to design machines suitable to them and upgrade their skill for operating these machines. Also for the roles of manager and entrepreneur, their knowledge base will have to be suitably updated.

Against the backdrop of the burgeoning population’s demands for food grains, degrading natural resource base, emerging concerns of climate change and other challenges, the Government of India has focused on mobilizing higher investment in agriculture, bridging yield gaps that exist across the states/regions, timely and adequate supply of quality inputs, and providing adequate support services to the farmers to make agriculture a remunerative vocation on a sustainable basis. Increasing agricultural production with limited natural resources in a sustainable manner for ensuring food and nutritional security and providing income security to farmers are the major challenges before the Government of India.

Farm power availability

Agricultural workers, draught animals, tractors, power tillers, diesel engines, electric motors are used as sources of farm power in Indian agriculture. Table 2 shows the available farm power (kW/ha) in Indian agriculture from these sources and total farm power. It indicates that the composition and relative share of different sources of power for farming operations has undergone significant change during the last four decades. The availability of draught animals power has come down from 0.133 kW/ha in 1971-72 to 0.094 kW/ha in
Trends of Agricultural Mechanization in India
CSAM Policy Brief, June 2014

2012-13, whereas the share of tractors, power tillers, diesel engines and electric motors has increased from 0.020 to 0.844, 0.001 to 0.015, 0.053 to 0.300 and 0.041 to 0.494 kW/ha, respectively during the same period. The total power availability on Indian farms has increased from 0.293 to 1.841 kW/ha at a CAGR of 4.58% during the last forty one years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Farm power, kW/ha</th>
<th>Total power, kW/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agriculture workers</td>
<td>Draught animals</td>
</tr>
<tr>
<td>1971-72</td>
<td>0.045</td>
<td>0.133</td>
</tr>
<tr>
<td>1975-76</td>
<td>0.048</td>
<td>0.135</td>
</tr>
<tr>
<td>1981-82</td>
<td>0.051</td>
<td>0.128</td>
</tr>
<tr>
<td>1985-86</td>
<td>0.057</td>
<td>0.129</td>
</tr>
<tr>
<td>1991-92</td>
<td>0.065</td>
<td>0.126</td>
</tr>
<tr>
<td>1995-96</td>
<td>0.071</td>
<td>0.124</td>
</tr>
<tr>
<td>2001-02</td>
<td>0.079</td>
<td>0.122</td>
</tr>
<tr>
<td>2005-06</td>
<td>0.087</td>
<td>0.120</td>
</tr>
<tr>
<td>2011-12</td>
<td>0.100</td>
<td>0.119</td>
</tr>
<tr>
<td>2012-13</td>
<td>0.093</td>
<td>0.094</td>
</tr>
</tbody>
</table>

The percentage share of agricultural workers and draught animal power sources in total power reduced from 15.4 to 5.0% and 45.4 to 5.1%, respectively over the years from 1971-72 to 2012-13 (Fig. 1). The combine share of agricultural workers and draught animals in total farm power availability in India reduced from 60.8% in 1971-72 to 10.1% during 2012-13. On the other hand, the share of tractor and electric motor in farm power availability increased from 6.8 to 45.8% and 14 to 26.8%, respectively during the last 41 years. The share of tractor power was maximum and increased by 39% during the period. The share of diesel engine was almost the same over the years from 1971-72 to 2012-13. The share of power tiller is less than one per cent during the period in spite of small size farms in India.

![Fig. 1 Trend in use of power sources in Indian agriculture](image-url)
Cropping intensity and power availability

The cropping intensity in Indian agriculture increased with increase in power availability (Table 3). It was 120% with power availability of 0.36 kW/ha during 1975-76 and increased to 141% with increase in power availability to 1.84 kW/ha during 2012-13. Net sown area per tractor shows the reverse trend during the same period, which was 487 ha/tractor in 1975-76 and reduced to 30 ha/tractor in 2012-13. The power availability per unit production increased from 0.38 kW/t in 1975-76 to 0.89 kW/t in 2012-13 during last thirty seven years. There may be many reasons including rainfall, crop variety, timely use of tractors, electricity availability etc in increasing the food grain productivity during the period.

### Table 3 Cropping intensity and power availability on Indian farms

<table>
<thead>
<tr>
<th>Year</th>
<th>Cropping intensity, %</th>
<th>Productivity, t/ha</th>
<th>Power available, kW/ha</th>
<th>Power per unit production, kW/t</th>
<th>Net sown area per tractor, ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975-76</td>
<td>120</td>
<td>0.94</td>
<td>0.36</td>
<td>0.38</td>
<td>487</td>
</tr>
<tr>
<td>1985-86</td>
<td>127</td>
<td>1.18</td>
<td>0.58</td>
<td>0.49</td>
<td>174</td>
</tr>
<tr>
<td>1995-96</td>
<td>131</td>
<td>1.50</td>
<td>0.92</td>
<td>0.61</td>
<td>84</td>
</tr>
<tr>
<td>2005-06</td>
<td>132</td>
<td>1.65</td>
<td>1.50</td>
<td>0.91</td>
<td>47</td>
</tr>
<tr>
<td>2010-11</td>
<td>141</td>
<td>1.92</td>
<td>1.68</td>
<td>0.88</td>
<td>31</td>
</tr>
<tr>
<td>2012-13</td>
<td>141</td>
<td>2.06</td>
<td>1.84</td>
<td>0.89</td>
<td>30</td>
</tr>
</tbody>
</table>

It has been observed that farm power availability and food grain productivity have a direct relationship ($r^2 = 0.986$) during the last six decades (Fig. 2). States with higher farm power availability have, in general, more productivity. The farm power availability and productivity increased from 0.25 to 1.84 kW/ha and from 0.52 t/ha to 1.92 t/ha, respectively over the years from 1951 to 2012 (Fig. 2). The predicted values of farm power availability and productivity in India for the year 2020 are 2.2 kW/ha and 2.3 t/ha, respectively.

![Fig. 2 Trend of farm power and agricultural productivity from 1951 to 2012](image-url)
Status of farm mechanization

Farm mechanization saves time and labour, cuts down crop production costs in the long run, reduces post-harvest losses and boosts crop output and farm income. Steady growth was observed in manually operated tools, animal operated implements, and equipment operated by mechanical and electrical power sources in India. In manually operated equipment, the number of sprayers has almost doubled. After liberalization and with development of prototypes of machines, manufacturing got a big boost particularly in Haryana, Punjab, Rajasthan, Madhya Pradesh and Uttar Pradesh states of India.

The Indian agricultural equipment market is experiencing a rapid growth with expected strong potential for future growth as well. The demand for agricultural machinery in Asia-Pacific region was more than twice than in any other region. In Asia-Pacific, India has remained one of the primary nations which fuelled the growth of the agricultural equipment market. The tractors, power tillers, combine harvesters, rotavators, threshers and rice transplanters are some of the equipment for which a surge in demand has been witnessed over the past few years.

The sale of tractors in India has grown at a CAGR of 10.64% from 217,456 in 2001-02 to 661,431 in 2012-13 during the last 11 years. The Indian tractor market has traditionally been dominated by 23-30 kW tractor segment. The power wise sale of tractors in India during the last 13 year is shown in Fig. 3. The trend shows that sale of more than 37 kW tractors increased from 7.3% to 13.8% during the last thirteen years (2000-2013). Similarly, the sale of tractors in the range of 31-37 kW increased from 14.1 to 36.4% during the same period. It indicates that requirement of higher power category tractors in India increased for using higher capacity machines on custom hiring basis. During the same period, the sale of medium power tractors (23-30 kW) decreased from 55 to 40.4% and low power tractors (15-22 kW) from 23 to 6.3%. The sale of less than 15 kW tractors was only 3.13% during 2012-13. The current trend in sale of tractors in different power range in India indicates the highest share of 40.4% for 23-30 kW category tractors. Haryana state of India has the highest tractor density of 84 tractors per thousand hectare of net sown area and is followed by Punjab (76), Uttar Pradesh (51), Bihar (44), and Tamil Nadu (43) states. Overall tractor density per thousand hectare of net sown area in India is 33. The lowest tractor density is in Kerala (4) and is followed by Assam (9), and West Bengal (17) among the states of India.
The current market for power tillers in India is estimated at 56,000 numbers during 2013-14. The market for power tillers in India is mainly concentrated in the eastern and southern parts of the country owing to the small land holdings per farmer in these regions and high cultivation of rice crops. Overall power tiller density is 2.21 per thousand hectare of net sown area. The power tillers market in India is dominated by two players from south India viz. VST Tillers Tractors Ltd., Bangalore (Karnataka) and Kerala Agro Machinery Corporation Ltd. (KAMCO), Athani (Kerala).

The combine harvesters market in India is estimated at 4,000-5,000 units annually by sales which have grown at a CAGR of 28% since 2006. The tractor mounted combine harvesters occupy around 60% of the total combine harvesters market in India and is mainly concentrated in southern states viz. Tamil Nadu, Kerala, Andhra Pradesh and Karnataka of the country on custom hiring. This is followed by self-propelled combine harvesters which represent 40% of the market. Tractor operated combine harvester, costing about 60-70% of the self propelled combine are owned individually by farmers with large size farms (> 4 ha). The self-propelled combines are largely owned by custom-hiring contractors (Singh, 2004). Manufacturers such as CLAAS India Ltd., Preet Agro Industries Pvt Ltd, Balkar Combines, Vishal Combines, Standard Combines, Kartar Agro Industries Pvt Ltd, Hira Agro Industries and others are some of the manufacturers based in Punjab state that have a strong presence in the combine harvester market in India.

Table 4 presents the market overview of the major agricultural machinery used in India. From the table it is estimated that the highest annual requirement is 100,000 for threshers and followed by 60,000-80,000 for rotavator, and 25,000 for power weeder. Light weight power weeders are also required for hilly terrains. In case of market growth per annum, the highest growth of 50% was for rice transplanter. It has been observed that the sale of machinery like combine, laser guided land leveller and rice transplanter are growing fast on custom hiring mode even though cost is higher, since the demand is more.

The market for threshers (multi-crop and paddy), rotavator, planters and zero till drill in India is highly un-organized and is dominated by large number of small and medium scale enterprises (SMEs) located majorly in the states of Punjab, Haryana, Uttar Pradesh, Bihar, Madhya Pradesh, Gujarat, Maharashtra, Tamil Nadu and Andhra Pradesh. The future growth of the threshers market is estimated at a CAGR of 10% and trend is towards use of tractor operated high capacity threshers on custom hiring mode.

The rotavators are being considered better than the conventional tillage equipment among the Indian farmers. This equipment has saved considerable amount of fuel and accomplished soil pulverization in short time. The rotavators market in India is expected to reach at a size of 60,000-80,000 units by 2014-15 by growing at a CAGR of 20%.

The market for rice transplanter in India was almost nil 5-6 years back as the rice transplantation was done completely manually with the use of labour. Presently, many companies in India are importing rice transplanters from China and Korea and marketing them in all regions of the India. The rice transplanters market in India has grown from about 550 in 2008-09 to 1,500-1,600 units in 2013-14. The industry is expected to grow by more than 50% in 2014-15 with Chhattisgarh, Odisha, Bihar and southern states showing positive sign of adoption of technology. The rice transplanter market in India is dominated by players from south India viz VST Tillers Tractors Ltd., Yanmar India and Kubota Agricultural Machinery India Pvt. Ltd. The high subsidies up to 50% provided by the government are expected to encourage large number of paddy farmers to purchase rice transplanters in coming years.
### Table 4 Market Overview of the major farm machinery used in India

<table>
<thead>
<tr>
<th>Name of machinery</th>
<th>Market annually</th>
<th>size annually</th>
<th>Approximate cost, US $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tractor</td>
<td>600000</td>
<td></td>
<td>7000-12000</td>
</tr>
<tr>
<td>Power tiller</td>
<td>56000</td>
<td></td>
<td>2100</td>
</tr>
<tr>
<td>Combine harvester</td>
<td>4000-5000</td>
<td>22200-35000</td>
<td></td>
</tr>
<tr>
<td>Thresher</td>
<td>100000</td>
<td>1600-2500</td>
<td></td>
</tr>
<tr>
<td>Rotavator</td>
<td>60000-80000</td>
<td>1300-2000</td>
<td></td>
</tr>
<tr>
<td>Rice transplanter</td>
<td>1500-1600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking type</td>
<td></td>
<td>2500-4200</td>
<td></td>
</tr>
<tr>
<td>Riding type</td>
<td></td>
<td>3300-16600</td>
<td></td>
</tr>
<tr>
<td>Self-propelled vertical conveyor reaper</td>
<td>4000-5000</td>
<td>1300-2000</td>
<td></td>
</tr>
<tr>
<td>Zero till seed drill</td>
<td>25000-30000</td>
<td>750-850</td>
<td></td>
</tr>
<tr>
<td>Multi -crop planter</td>
<td>1000-2000</td>
<td>850-1000</td>
<td></td>
</tr>
<tr>
<td>Laser land leveller</td>
<td>3000-4000</td>
<td>5800-6500</td>
<td></td>
</tr>
<tr>
<td>Power weeder</td>
<td>25000</td>
<td></td>
<td>8500</td>
</tr>
</tbody>
</table>

The zero till drill is preferred by farmers from Indo Gangetic plains particularly in northern states of India viz Punjab, Haryana and Uttar Pradesh. The sale of zero till drill in India is around 25,000-30,000 per annum in rice-wheat cropping system due to limited time available for sowing of wheat after rice harvesting.

The overall mechanization level in India is only 40-45% even though 90% of the total farm power is contributed by mechanical and electrical power sources. However, all operations are not uniformly mechanized. Operation-wise level of mechanization varies from 42% for soil working and seed bed preparation, 29% for seeding and planting, 34% for plant protection and 37% for irrigation. In case of harvesting and threshing, the level of mechanization is 60-70% for wheat and rice and less than five per cent for others crops. The operation wise mechanization for harvesting, crop care and seeding are top priority for the farmers in India for cereals and horticultural crops. But mechanization of above operations is not up to the level of farmers expectations till date. Farmers need complete mechanization package for major crops.

**Manufacturing, marketing and after sale services of agricultural machinery**

Today, India is recognized as a leading country in the world for development and manufacturing of agricultural implements and equipment. The range of equipment includes tractors, harvesting and threshing equipment, plant protection machines, irrigation and drainage pumps, sprinkler systems, land development machinery, dairy and agro-processing equipment, etc. The overall demand for agricultural machinery increased during the last decade due to non-availability of labours or high cost of labours during peak sowing and harvesting seasons.

The adoption of mechanization technology depends upon the local manufacturers and after-sales-services besides credit and financial incentive provided by the Government. The manufacturing of agricultural machinery in India is quite complex comprising from village artisans, tiny units, small scale industries to State Agro-Industrial Development Corporations.
and organized tractor, combine, power tiller, rice transplanter, engine and processing equipment industries.

Traditional hand tools and bullock drawn implements are largely fabricated by village craftsmen and small scale industries. The small-scale industries seldom have research and development (R&D) facilities and depend upon public institutions for technological support. They require not only drawings but also prototypes and technical guidance to manufacture the equipment. These industries however, upgrade the technology with experience. Very few small-scale industries have established their marketing network and therefore provide service support in their premises. In the absence of standardization of parts and components, farmers are compelled to carry their machines to the manufactures for repair and replacement of parts and components. Due to this, their market size is limited to their proximity, and they are not able to develop their businesses. The village artisans on the other hand are located in the villages and therefore address needs of the farmers in their neighbourhoods. Therefore, the tools and implements made by them are against specific requirements of individual customers.

The medium and large scale industries manufacture diesel engines, electric motors, irrigation pumps, sprayers and dusters, land development machinery, tractors, power tillers, combine, post harvest and processing machinery and dairy equipment. These industries upgrade their product and process technologies through their own R&D efforts, in addition to technological support from external agencies. The medium and large scale manufacturers have well organized distributors and dealers network throughout the country to undertake advertising and product promotion in their respective territories, to conduct product awareness training programmes for the prospective customers and to provide after-sales service to the customers including free services, repair and maintenance, supply of parts, etc.

The tractor manufacturing industry in India not only fulfills the country’s demand for agricultural tractors but also export around 65,000 tractors per annum to South African countries and other developed countries. Sugarcane harvesters, cotton pickers and rice transplanter are the major agricultural machinery being imported by India. Now, most of tractor manufacturers have also started manufacturing and sale of farm equipment and machinery in country. They are providing complete farm mechanisation solution for wheat and paddy crops. A number of world leading farm machinery manufacturers such as John Deere India Pvt. Ltd., BCS India Pvt. Ltd., Lemken India Agro Equipment Pvt. Ltd., Maschio Gaspardo India Pvt. Ltd. etc. have also established their farm machinery manufacturing units in India to cater to the needs of Indian market. Indian farm machinery manufacturers are also exporting farm machinery to south Asian countries and developing countries.

**Challenges in farm mechanization in India**

Farm Mechanization in India is still in its early stages during the last two decades and is only able to achieve a meagre growth rate of less than 5%. Even though, higher share of labour (55%) with lesser contribution to GDP (14%) with overall mechanization level of 40-45% makes farming in India less remunerative. The level of mechanization in India is still lower than United State (95%), Western Europe (95%), Russia (80%), Brazil (75%) and China (57%) (Renpu, 2014). The average farm power availability in the country is still at a low level as compared to China, Korea and Japan. Unlike other agricultural sectors, farm mechanization sector in India has a far more complex structural composition. It is facing various challenges related to farm machinery and equipment, technology, markets, operations, legislation, policy framework and other related areas. Land size, cropping pattern, market price of crops including Minimum Support Price (MSP), availability of labour and cost of
labour are the major factors deciding the agricultural mechanization. These challenges pose a serious impediment to the growth of the industry and agriculture. The key challenges faced by the farm mechanization in India (Mehta and Pajnoo, 2013) are as follows:

i. The average farm size in India is small (less than 2 ha) as compared to the European Union (14 ha) and the United States (170 ha). Therefore, there will be little mechanization unless machines appropriate for small holdings are made available or substantial farm amalgamation takes place. Due to small size of land holdings, it is difficult for the farmers to own machinery. As a result, the benefits of mechanization are enjoyed by only a section of the farmers who have large farm holdings.

ii. Mechanizing small and non-contiguous group of small farms is against economies of scale especially in operations like land preparation and harvesting. With continued shrinkage in average farm size, more farms will fall into the adverse category thereby making individual ownership of agricultural machinery progressively more uneconomical.

iii. The major constraint of increasing agricultural production and productivity is the inadequacy of farm power and machinery with the farmers. The average farm power availability needs to be increased to minimum 2.5 kW/ha to assure timeliness and quality in field operations, undertake heavy field operations like sub-soiling, chiseling, deep ploughing and summer ploughing.

iv. There is an urgent need to design, develop and adopt machinery especially suitable to Indian farming conditions such as dryland farming, paddy transplanting, sugarcane harvesting, potato combining, cotton picking, spraying tall plants such as fruit and forest trees etc.

v. The quality and after sales service of farm machinery are the other concerns in India as the majority of farmers are cost conscious. There are inadequate service centers for proper up-keep of the machinery. In addition, the inability of local low cost manufacturers to come up to the levels of standard designs of equipment also poses a big challenge to farm mechanization.

vi. Almost 90% of tractors are sold in India with the assistance of some financial institution. Sale of farm machinery is driven by factors like financial support, limit of funding (in terms of percentage of the cost), funding/financing institution and the applicant’s profile (deciding the credibility of the loanee).

vii. The high cost and energy efficient farm machinery are capital intensive and majority of Indian farmers are not able to acquire these assets due to shortage of capital with them. Therefore, an arrangement to provide custom hiring service facility for these farm machinery to the farmers by engaging unemployed rural youth will go a long way in meeting the requirements.

viii. Cropping pattern decides the extent of mechanization required for timely operations and achieving optimum results. The scope of mechanization increases with intensive cropping pattern. Price realized by the crop is also an important factor, as it indicates the cash in hand for the farmer.

ix. Matching equipment for tractors, power tillers and other prime movers are either not available or farmers make inappropriate selection in the absence of proper guidance, resulting in fuel wastage and high cost of production.

x. Hill agriculture, which covers about 20% of cultivated land, has little access to mechanization. This situation has to be improved by developing and promoting package of technology for mechanization of hill agriculture to achieve higher productivity.
xi. The quality of farm implements and machinery manufactured by small scale industries in the country is generally not of desired standard resulting in poor-quality work, longer down time, low output and high operational cost. The quality of equipment has to be improved.

Approach for mechanization of Indian agriculture

Agricultural mechanization should contribute to sustainable increase in yields, 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. This selective mechanization aims to achieve optimum utilisation of the available sources of farm power. Small and marginal land holdings are being mechanised by improved hand tools and animal drawn equipment. However, medium and large land holdings are being mechanised by tractor-drawn and self-propelled farm machinery. An appropriate mechanization technology suiting to the needs of the farmers is required to be adopted.

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. So the loss of agricultural production, both in quality and quantity, should be reduced through timely operations and improvement in equipment and techniques. The Indian farmers have limited access to the latest equipment and technology. This results in high production cost and difficulty in competing in international market for sale of surplus produce. There are wide technology gaps in meeting the needs of various cropping systems and regions. 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. The benefits of mechanization in India have been so far confined mostly to wheat based cropping system. These benefits have to be extended to all cropping systems including rice and horticultural crops. The approach of the Government of India for development of farm equipment and machinery and their testing, quality control and popularisation among the stakeholders is given below.

Research and development

Research and development efforts and approaches in agricultural mechanisation in India have been directed towards finding cost-effective solutions to location-specific problems of agriculture. Indian Council of Agricultural Research (ICAR), New Delhi is the apex body which primarily looks after the need of research and development activities, need-based region specific technologies and specific problem related issues. The engineering division of ICAR comprises five research institutes, six All India Coordinated Research Projects (AICRPs), one network project/outreach programme and National Initiative on Climate Resilient Agriculture project. The thrust areas identified are:

i. Development of precision machinery and strategies for carrying out timely and efficient agricultural operations in irrigated, rain-fed and hill agriculture, horticulture, livestock and fisheries production.

ii. Increasing work efficiency for human, animal and mechanical systems and reduction of occupational hazards in agricultural operations.
iii. Energy management and utilization of conventional and non-conventional energy sources in agricultural production and processing activities.

iv. Utilization of surplus agricultural residues for decentralised power generation, and

v. Reduction of post-harvest losses, value addition to agricultural produce, processing and utilization of by-products.

Four Coordinating Cells of AICRPs with their centres are operating from the Central Institute of Agricultural Engineering, Bhopal, which caters to the engineering needs emphasising on sustainable agricultural mechanisation of the country. These are i) Farm Implements and Machinery (24 centres), ii) Ergonomics and Safety in Agriculture (10 centres), iii) Renewable Energy Sources (18 centres) and iv) Utilization of Animal Energy (13 centres).

Public-private linkage

The private sector involvement in Indian agriculture is a recent development. Future breakthrough technologies in agriculture mechanisation will come increasingly from the private sector, and India’s private sector has the strength to multiply those technologies and to reach millions of farmers (small and big) in the fastest possible way. There is a need to channelize these sources in an orderly manner, so that in the process, apart from the private sector profitability, the farming community is also benefited. This will assist in pushing Indian agriculture to a higher and more sustainable growth which would be the most powerful engine for poverty reduction. For areas where the private sector has not shown much interest such as rain-fed areas, tribal areas, natural resource management, pulses, millets, the role of public research system would continue to be critical. In addition, a number of equipment are being developed in public-private partnership mode by involving manufacturers at the research and development stage.

Extension

Extension activities are mainly carried out by Krishi Vigyan Kendras (KVK) and centres of AICRPs. Today, India has as many as 637 KVKs under eight zones. These KVKs are located in different parts of the country, to promote region-specific, farmer-friendly newer technologies for enhancing agricultural production through minimum use of inputs.

Testing and quality control

The adoption of agricultural machinery is greatly influenced by testing/standardization, quality control and after sales services available to the farmers. Since most of farm machinery is manufactured in India in small-scale industries, the quality is affected by the manufacturing technology adopted by them. Testing and evaluation helps in up-gradation and quality production of machinery. In addition to the four major farm machinery training and testing institutes located in Madhya Pradesh, Haryana, Andhra Pradesh and Assam states, recently 29 new centres including Agricultural Universities and Institutes under Indian Council of Agricultural Research have been approved by Government of India to conduct quality certification evaluation for manufacturers.

Research and development institutions and quality certification agencies conduct the Testing and Evaluation (T&E). Testing and evaluation is conducted on newly developed equipment during its serial production, to facilitate and ensure quality, reliability, durability, functional ease, comfort in operation and reduced cost of operation. Testing is conducted
with well defined standard parameters, defined in Bureau of Indian Standards (BIS), ISO, or OECD standards, and whereas evaluation is done to measure the performance under simulated or field conditions for the parameters for which the equipment has been designed. Standardization and quality of implement manufacturing in India is ensured mainly by BIS and over 500 standards on agricultural machinery are prescribed.

The Bureau of Indian Standards (BIS) has the statutory authority to inspect the quality of products manufactured and marketed in India. The agricultural machines manufactured by the organized sector like tractors, earth moving machinery, irrigation equipment, plant protection, dairy equipment, processing machinery etc. are certified for their quality by BIS.

**Training (vocational academic, short term focussed training on specific topics)**

Vocational trainings, academic trainings, short-term focused trainings on specific topics and need-based private-industry oriented trainings are also conducted by ICAR institutes and agricultural universities. At CIAE, Bhopal, Technology Transfer Division conducts periodical and need-based trainings. Technology developed is also exhibited in various kissan melas and agricultural machinery exhibitions which help in disseminating the newly developed technologies, leading to sustainable agricultural mechanization.

**Financial institutions**

The purchasing power of the farmers in India is low. The government provides subsidy and credit at reduced rate to the farmers who are economically and socially at disadvantageous position to adopt modern technologies. The long-term credit is usually availed for the purchase of mechanization inputs and short term for the purchase of seed, fertilizer etc. The agricultural machines and tractors are purchased through credit, available from organized financial institutions. National Bank for Agriculture and Rural Development (NABARD) is the main refinancing institution. The Government also provides incentives to farmers for modernization of agriculture. This is linked to crop specific programmes operated by state governments. The state government have to strengthen their extension machinery for providing incentives to the farmers. The financial requirement for the purchase of agricultural machinery has increased considerably. A large number of nationalized banks, private banks and commercial and cooperative banks provide credit for purchase of machinery. All nationalized banks have exclusive agricultural banking divisions. Almost all state governments have agro industries development corporations.

**Sub-mission on agricultural mechanization**

In order to lay special emphasis on farm mechanization in India and to bring more inclusiveness, a dedicated Sub-Mission on Agricultural Mechanization (SMAM) for the XII Plan (2012-17) has been launched with an estimated outlay of US$ 350 million for the plan period by Machinery & Technology Division (M&T), Department of Agriculture and Cooperation, Ministry of Agriculture of Government of India. SMAM will put Small & Marginal Farmers at the core of the interventions with a special emphasis on reaching the unreached i.e. bringing farm mechanization to those villages where the technologies deployed are decades old. Besides, the mission also proposes to cater to adverse economies of scale by promoting Custom Hiring Services through the rural entrepreneurship model. The Mission will aim at catalyzing an accelerated but inclusive growth of agricultural mechanization in India.
The Sub-Mission on Agricultural Mechanization will provide assistance for promotion and strengthening of agricultural mechanization through training, testing and demonstration; post-harvest technology and management; procurement of selected agriculture machinery and equipment; establishment of farm machinery banks for custom hiring; establishing hi-tech productive equipment centres to target low productive agricultural regions and assistance for increasing farm mechanization. The strategies under the sub-mission are as follows:

i. Conduct performance testing for various farm machinery and equipment at the four Farm Machinery Training and Testing Institutes (FMTTI) and 29 designated State Agricultural Universities (SAUs) and ICAR institutions;

ii. Promote farm mechanization among stakeholders by way of on-field and off-field training and demonstrations

iii. Provide financial assistance to farmers for procurement of farm machinery and implements to promote ownership of various agricultural machinery and equipment.

iv. Provide suitable financial assistance to establish Farm Machinery Banks for custom hiring for appropriate locations and crops.

v. Provide financial assistance to set up hi-tech and high productive machinery hubs for high value crops like sugarcane, cotton etc.

vi. Provide financial assistance on per hectare basis to the beneficiaries hiring machinery/equipment from custom hiring centres for promotion of mechanized operations in low mechanized areas.

vii. Provide financial assistance to small and marginal farmers for hiring machinery and implements in low mechanized regions.

viii. Provide financial assistance to promote appropriate technologies and to set up Farm Machinery Banks in identified villages in low mechanised states.

ix. Promotion of farm machinery and equipment in north-eastern region by extending financial assistance to beneficiaries in high-potential but low mechanised states in the north-east.

References


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CSAM, Centre for Sustainable Agricultural Mechanization, is a regional institution of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), based in Beijing, China. CSAM started operations in 2004, built on the achievements of the Regional Network for Agricultural Machinery (RNAM) established in 1977 with support of UNDP, FAO and UNIDO, and the United Nations Asian and Pacific Centre for Agricultural Engineering and Machinery (UNAPCAEM). CSAM serves the 62 members and associate members of UNESCAP.

The vision of CSAM is to achieve production gains, improved rural livelihood and poverty alleviation through sustainable agricultural mechanization for a more resilient, inclusive and sustainable Asia and the Pacific.

CSAM’s objectives are to enhance technical cooperation among the members and associate members of UNESCAP as well as other interested member States of the United Nations, through extensive exchange of information and sharing of knowledge, and promotion of research and development and agro-business development in the area of sustainable agricultural mechanization and technology transfer for the attainment of the internationally agreed development goals including the Millennium Development Goals in the Asia-Pacific region.

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