



ISSN: 0975-833X

Available online at <http://www.journalcra.com>

INTERNATIONAL JOURNAL
OF CURRENT RESEARCH

International Journal of Current Research
Vol. 10, Issue, 02, pp.65182-65186, February, 2018

REVIEW ARTICLE

MECHANISATION OF AGRICULTURE - INDIAN SCENARIO

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ARTICLE INFO

Article History:

Received 12th November, 2017
Received in revised form
23rd December, 2017
Accepted 06th January, 2018
Published online 18th February, 2018

Key words:

Mechanisation,
Farm Machines,
Power Tillers,
Farm Power,
Cropping Intensity.

ABSTRACT

Agricultural mechanisation implies the use of various power sources and improved form tools and equipment, with a view to reduce the drudgery of the human beings and draught animals, enhance the cropping intensity, precision and timelines of efficiency of utilization of various crop inputs and reduce the losses at different stages of crop production. The end objective of farm mechanisation is to enhance the overall productivity and production with the lowest cost of production. Agricultural mechanisation is also an important input to agriculture for performing timely farm operations; reducing the cost of operation; maximizing the utilization efficiency of inputs, improving the quality of produce; reducing drudgery in farm operations; improving the productivity of land & labour and for improving the dignity of labour. The present study examined the relevant background information on population dynamics, socio economic status, status and availability of form power and machinery and cropping intensity towards agricultural mechanisation in India and reveals the facts that the mechanisation technologies were first adopted by the large formers (over 10 ha form size) followed by medium scale formers (with 4 to 10 ha form size). The sale of tractors and power tillers in India has shown exponential increase over years. The combine share of agriculture workers and draught animals in total form power availability in India reduced from 60.8% in 1971-1972 to 10.10% in 2012-2013. The form power availability and productivity increased from 0.25 to 1.84 Kw/ha and from 0.52 to 1.92 t/ha, respectively over the years from 1971 to 2012. Therefore, India adopts a policy of selective mechanisation under diverse conditions, which makes the agriculture mechanisation a challenging task.

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Citation: Venkataramana Reddy, N.R. and Kalpalatha, Ch. 2018. "Mechanisation of agriculture - Indian scenario", *International Journal of Current Research*, 10, (02), 65182-65186.

INTRODUCTION

Form mechanisation is the main plank of modern agriculture and many of the progressive countries have already mechanized their agriculture including India. Of course, it is also true that the conditions in many of these countries were favourable for mechanisation. Most important reasons for use of agriculture implements and machinery were high rate of agriculture labour, large size of forms, high cropping intensity, higher percentage of irrigated area and more adoption of high yielding technology. Mechanisation is one of the critical inputs of production followed by preservation of food crops. Mechanisation can increase yields through the improvement of water control, better soil preparation for planting, more efficient weed and insect control and the proper harvesting, handling, drying, storing and processing of food, feed and fiber crops. So that, agricultural mechanisation is the art and scientific application of mechanical aids for increased

production and preservation of food and fiber crops with less drudgery and increased efficiency. Farm mechanisation is an opportunity to increase yields and reduce loss in addition to lowering cost. Mechanisation of farm work has three primary objectives: reduce the drudgery of farm work, increase the productivity of farm workers, and increase the timeliness and quality of farm work (Goering, 1992). Mechanisation allows for the work to be less difficult and the skill required to operate the machines often times increases wages. Mechanisation has also been a major contributor to the increases in hectares completed per hour of work. However, since a problem of the developing countries is one of increasing the production of food, the highest priority for power and equipment should be for kinds that will contribute to increased yields (Giles, 1967). Mechanisation can increase yield through timelier performance of operations and higher quality performance of operations. There is an optimum time for performing critical forming operations such as planting and harvesting. Crop yields tend to be highest when these critical operations are done closest to the optimum time (Goering, 1992). Form mechanisation means applications of mechanical power to perform agricultural

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

S. No	Particulars	1991	2001	2011	2020	2050
1	Country's population	846.4	1028.7	1210.7	1323.0	1612.0
2	Total no. of workers	313.7	402.2	481.7	566.0	787.0
3	No. of workers as % of population	37.1	39.1	39.8	42.8	48.8
4	No. of agricultural workers	185.3	2127.3	263.0	230.0	202.0
	a. Cultivators	110.7	127.3	118.7	110.0	-
	b. Agricultural labourers	74.6	106.8	144.3	120.0	-
5	% of agricultural workers to total workers	59.1	58.2	54.6	40.6	25.7
6	% of female workers in agricultural workers	35.1	39.0	37.2	45.0	60.0

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

Table 2. Land Holdings in India

Category	Percentage number of holding in each category				Area under each category Percentage			Average (ha)
	1971	1991	2001	2011	1991	2001	2011	2011
Marginal (<1ha)	50.6	59.2	62.4	67.0	15.0	18.7	22.2	0.38
Small (1-2 ha)	19.0	18.7	19.1	17.9	17.4	20.2	22.1	1.42
Semi-Medium (2-4 ha)	15.2	13.6	11.9	10.1	23.2	23.9	23.6	2.71
Medium (4-10 ha)	11.3	7.0	5.6	4.3	27.1	24.0	21.2	5.76
Large(>10ha)	3.9	1.5	1.0	0.7	17.3	13.2	10.9	17.37
Average holding size (ha)	2.28	1.57	1.33	1.2	--	--	--	--
All holdings (million)	70.5	106.6	119.9	137.8	--	--	--	--

Source: Ministry of Agriculture (MOA), 2013.

operations and to increase farm production and to raise the standard of living of people. Additionally, mechanisation improves the quality of the farm operation. (Parameswara Rao, 1972). A number of studies have been attempted in different parts of the country to assess the impact of farm mechanisation. The impact has been viewed in relation to agricultural production intensity, employment generation and conservation of natural resources. Binswanger (1982) defined the status of mechanisation by the growth of mechanically power operated farm equipment over traditional human and animal power operated equipment. Singh (2006) studied the status of mechanisation with reference to intensity of power or energy available and its impact in increasing agricultural and labour productivity. Ravi (2013) reviewed that the use of tractors and power tillers as increased five-fold the last forty years. According to Varma (2005) Tractor forms yields more than the non-tractor forms in Indian, especially on the commercial crops like sugarcane and potato. Patel and Patel (1972) viewed that any use of mechanized power in the place of human or animal power for agricultural operations amount to farm mechanization. This study discusses of relevant background information on population dynamics, socio economic status, status and availability of farm power and machinery and cropping intensity towards agricultural mechanisation in Indian.

Population dynamics of Indian agricultural workers

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 mechanisation in a manner that is inclusive and suitable for Indian conditions (Mehta *et al.*, 2014).

Size of Agriculture Land Holdings in India

The average size of land holdings in 2011 was 1.16 ha with only 0.7 per cent (1.0 million) consisting of forms of more than 10 ha but constituting about 11 per cent of the cultivated land while the forms of less than 1 ha (over 67 per cent) constitute about 22 per cent of the cultivated land, the rest of the forms are in the intermediate range with the largest proportion being medium forms (4 to 10 ha) and semi-medium forms (2 to 4 ha) which cultivated 24 per cent each of the total cultivated land in 2011 (Table 2). Due to the laws of inheritance the number of holdings is increasing in many states, however, the situation in Punjab, the state with the highest level of mechanisation and the highest productivity, a reverse trend has been witnessed with the marginal holdings declining from 38 per cent in 1971 to 27 per cent in 1991 and only 12 per cent in 2001, cultivating less than 2 per cent of the area. The area under holdings in the semi-medium, medium and large categories in Punjab in 2001, were 22, 43, and 27 per cent, respectively thus cultivating over 92 per cent of the total area. Similar trends are occurring in Haryana and in other parts of the country (Gajendhra Singh, 2015).

Form Machines Available in India

India is in the early stage of development as far as mechanisation infusion is concerned. A big leap toward mechanisation is expected in future due to labour shortage owing to rural employment guarantee scheme and prevailing pressure to boost productivity (Balachandar, 2014 and Srivastava, 1999). Although, India is the largest manufacturer of tractors in the world, accounting for one-third of world production (Ravi, 2013), the average power availability in the country is lower than many countries (Korea, Japan, US).

Table 3. Number of farm machines per 1000 ha net sown area in India

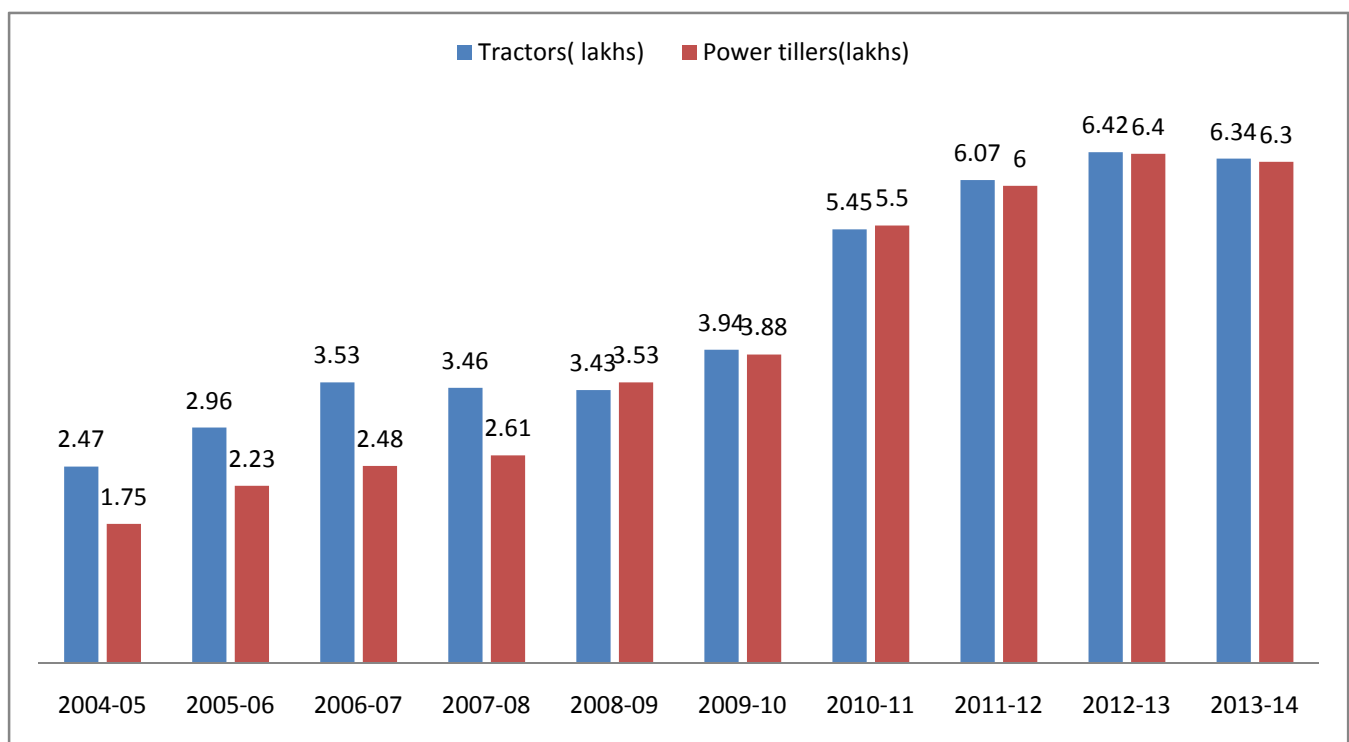
Machine	Number	Machine	Number
Manual seed drill/seed drill-cum- fertilizer drill	153.2	Power operated horticultural tools	8.9
Animal drawn leveler	84.8	Drip and sprinkler equipment	8.3
Animal drawn seed-cum-fertilizer drill	36.1	tractor drawn seed-cum-fertilizer drill	7.2
Manually operated plant protection equipment	25.5	Tractor operated disc harrow	6.6
Straw reaper	18.8	Tractor operated levlers	6.2
Power operated plant protection equipment	4.3	Forage harvester	18.2
Tractors	16.7	Potato digger	2.1
Tractor operator cultivator	12.5	Tractor operated rotavator	0.9

Source: Ministry of Agriculture (2012)

Table 4. Sale of tractors and Power tillers in India

Year	Tractors (lakhs)	Power tillers (lakhs)
2004-05	2.47	1.75
2005-06	2.96	2.23
2006-07	3.53	2.48
2007-08	3.46	2.61
2008-09	3.43	3.53
2009-10	3.94	3.88
2010-11	5.45	5.5
2011-12	6.07	6
2012-13	6.42	6.4
2013-14	6.34	6.3

Source: Technology and Manufacturing Association (TMA) -2007-2013



The migration of people to urban areas and availability of credit and money are also main factors in mechanisation. The movement of labour away from agriculture has gained momentum in recent years, although the share of workers living off the land still remains at 54.6% of the work force (Ravi, 2013). The farm mechanisation has been well received world over as one of the central elements of modernization of agriculture. There has been a substantial progress of mechanisation in agriculture; however, its spread has been in the most uneven manner. Further, efforts to identify specific farm equipments, implements and machines, for different agro climatic zones, as well as their promotion in the respective zones has been lacking. Looking at farm implements used per 1000 ha of net sown area in the country, the tractor operated machinery is commonly used (Table 3).

Sales of Tractors and Power Tillers

In the mechanisation process tractor is the common form vehicle and has played a vital role in the farm mechanisation. Now the tractor has available with several features such as air conditioned cabins, ergonomically designed pedals and levers. Tractors are available from 18 to 70 HP range. Tractor performs several functions. All tillage operations are mechanized through tractors. In India, tractor have been used for performing operations using tillage equipment like rotavator and spading machines (22.78 percent of total area) and sowing (21.3 percent of total area) and is also used for running other equipments like laser land leveler. The share of farm workers and draught animals has come down from 63.5 percent in 1971-72 to 13.6 percent in 2009-10, whereas the

Table 5. Sources of farm power available in Indian agriculture

Year	Farm Power, Kw/ha						Total Power, Kw/ha
	Agriculture Workers	Draught Animals	Tractors	Power tillers	Diesel engines	Electric Motors	
1971-72	0.045	0.133	0.020	0.001	0.053	0.041	0.293
1975-76	0.048	0.135	0.040	0.001	0.078	0.056	0.358
1981-82	0.051	0.128	0.090	0.002	0.112	0.084	0.467
1985-86	0.057	0.129	0.140	0.002	0.139	0.111	0.578
1991-92	0.065	0.126	0.230	0.003	0.177	0.159	0.760
1995-96	0.071	0.124	0.320	0.004	0.203	0.196	0.918
2001-02	0.079	0.122	0.480	0.006	0.238	0.250	1.510
2005-06	0.087	0.120	0.700	0.009	0.273	0.311	1.570
2011-12	0.100	0.119	0.804	0.014	0.295	0.366	1.698
2012-13	0.093	0.094	0.844	0.015	0.300	0.494	1.841

Source: Technology and Manufacturing Association (TMA) -1971-2013

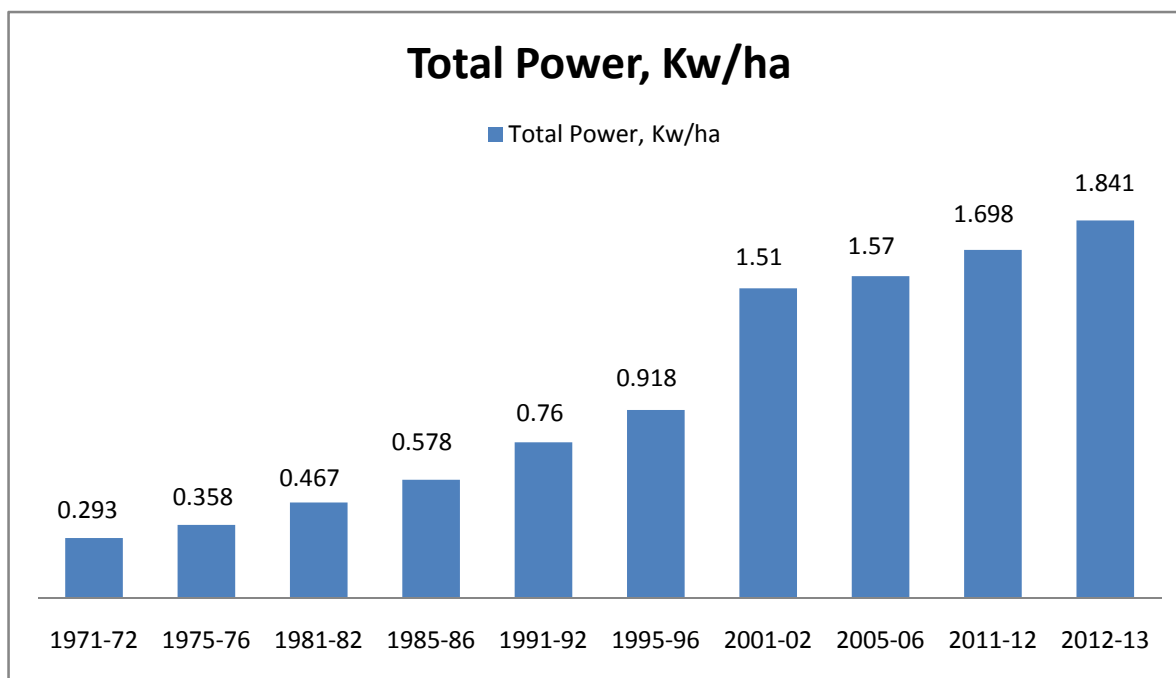


Table 6. Cropping intensity and power availability on Indian farmers

Year	Cropping intensity %	Productivity t/ha	Power available kw/ha	Power per unit production Kw/ha	Net sown area per tractor ha
1975-76	120	0.98	0.36	0.38	487
1985-86	127	1.18	0.58	0.49	174
1995-96	131	1.50	0.92	0.61	84
2005-06	132	1.65	1.50	0.91	47
2010-11	141	1.92	1.68	0.88	31
2012-13	141	2.06	1.84	0.89	30

Source: Technology and Manufacturing Association (TMA) - 1971-2013

share of tractors, power tillers, and motors has gone up from 36.5 to 86.3 percent during the same period (Ravi, 2013). The contribution of tractors has increased from 7.5 percent in 1971 to over 51 percent in 2010-11 (Singha *et al.*, 2012). In view of shortage of labour, the need for tractor mechanisation arises. According to Sharma (1998) the projected demand for tractors in India is 22.58 lakh in 2024-25. The sale of tractors and power tillers in India as shown exponential increase over years (Table-4).

Farm Power Available in India

Table-5, shows the availability of Agricultural workers, draught animals, tractors, power tillers, diesel engines, electric motors are used as sources of farm power in Indian agriculture. It indicates that the composition and relative share of different sources of power for farming operations has undergone

significant change during the period 1971 -1972 to 2012-2013. The availability of draught animals power has come down from 0.133 kW/ha in 1971-1972 to 0.094 kW/ha in 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. In India the availability of total farm power will be increased from 0.293 kw/ha in the year 1971-72 to 1.841 kw/ha year 2012-13.

Cropping Intensity and Power Availability

The cropping intensity in Indian agriculture increased with increase in power availability (Table 6). 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 during the period

1975-2013, indicated the reverse trend. The power availability per unit production increased from 0.38 Kw/t in 1975-76 to 0.89 kw/t in 2012-13. The farm power availability and productivity increased from 0.25 to 1.84 Kw/ha and from 0.52 to 1.92 t/ha, respectively over the years from 1951 to 2012. 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 (Mehta and Pajnoo, 2013). Similar trends were also observed by Giles (1975).

Conclusion

The Present study examined the status of mechanisation in Indian Agriculture in terms of population dynamics, socio economic status, status and availability of farm power and machinery and cropping intensity. The average farm size in India is 1.16 ha and mechanising small and non-contiguous group of small farms is against 'economies of scale' especially for operations like land preparation and harvesting. Mechanisation technologies were first adopted by the large farmers (over 10 ha farm size) followed by medium scale farmers (with 4 to 10 ha farm size). With continued shrink-age in average farm size, more farms will fall into the adverse category thereby making individual ownership of agricultural machinery progressively more uneconomical. The sale of tractors and power tillers in India has shown exponential increase over years. The combine share of agriculture workers and drought animals in total farm power availability in India reduced from 60.8% in 1971-1972 to 10.10% in 2012-2013. The farm power availability and productivity increased from 0.25 to 1.84 Kw/ha and from 0.52 to 1.92 t/ha, respectively over the years from 1951 to 2012. Therefore, India adopts a policy of selective mechanisation under diverse conditions, which makes the agriculture mechanisation a challenging task.

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