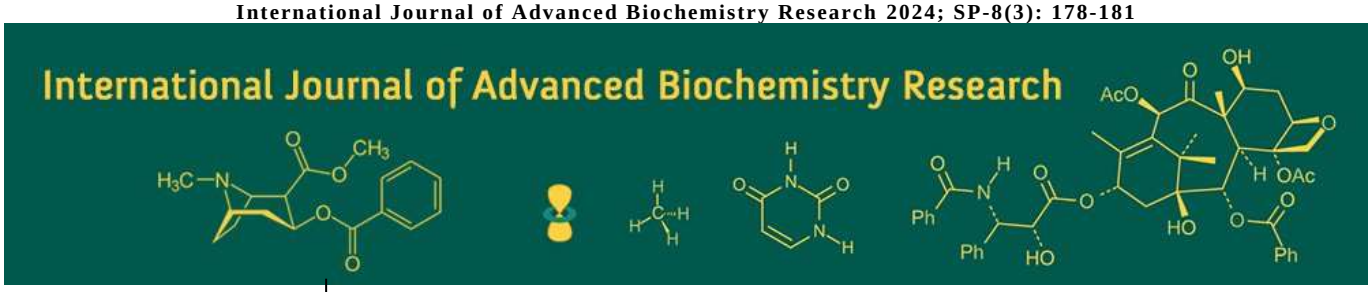

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India's growth in agricultural mechanization during last decades

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Abstract
Farm mechanization is a crucial component of contemporary agriculture. In addition to lowering cultivation costs and human labor, it increases production. Mechanization enhances the quality and value addition of the crop while also increasing worker safety and comfort and the efficiency with which other inputs are used in agriculture. Improved machinery not only allows farmers to cultivate a second crop but also increases productivity and production. The role of farm mechanization has shifted in improving agricultural production as well as productivity through time-saving of field operation and by enabling proper utilization of critical inputs. Utilizing appropriate farm machines for field preparation can save time and energy and enables the farmers to sow the crops in time and thus obtain higher yields. Farm mechanization also improves quality of life by reducing drudgery and by providing respectability to farm operators. The annual share of power availability per ha 2020-21 was 2.761 kW. During the year 2020-21, it increased by 47.03 percent as compared to 2011-12 (262.921 million kW) of a source of power accessibility in India. During the year 2022-23, in India, sales of power tillers and tractors were recorded at 35,000 and 835,000, respectively.

Keywords: Agriculture, farm mechanization, farm machinery, power availability

Introduction
India is a large agricultural country with a geographic land area of 329 million hectares, of the 329 million hectares in total geographic area of the country. There are 166 million hectares that can be farmed, and in the last thirty years, the net sown area has remained around 141 million ha of which about 65 million ha (46%) is irrigated and remaining 76 million ha (54%) is rain-fed. The entire process of preparing for tillage, planting, weeding, spraying, harvesting, threshing, and post-harvest operations is included in the agriculture field value chain. The utilization of farm equipment and machinery improves the efficiency of man and machine at each stage of the crop production life cycle. Farm mechanization reduces labor and time expenditures, but it additionally decreases production costs and losses. Mechanization facilitates the most efficient use of available resources (e.g. land, labour and water) and costly inputs for farming (chemicals, fertilizers, and seeds). Efficient use of time, labour, and resources helps facilitate sustainable multi-cropping and timely planting of crops, which can give crops more time to mature leading to an increase in productivity. Additionally, using equipment minimizes drudgery, pollution, and losses. Improved agricultural inputs combined with farm mechanization have been demonstrated to increase yields by 10% to 15%. According to additional estimates, using appropriate equipment can boost output by up to 30% and minimize cultivation costs by approximately 20%.

In terms of importance, agriculture leads the Indian economy. Indian farmers used to mostly depend on both human and animal power. However, with time came the development of tractors and tractor-driven agricultural tools through government-sponsored initiatives. Over the past ten years, it has been noted that the idea of farm mechanization and its significance have gained traction, leading to the development and commercialization of new farm tools and equipment. In addition to decreasing the drudgery involved in farming operations, this has enhanced productivity and production to feed the world's growing population. Due to the opportunities it provides for operators, mechanics, salespeople, and other professionals, farm mechanization has contributed positively to the growth of employment in rural areas.

With the help of a centrally supported program, the use of tractors and other farm machinery and equipment has increased significantly in India, although its distribution has been uneven. According to Singh *et al.* (2009) [4], the country's total farm power availability was 2.24 kW/ha in 2016–17. Tractors, power tillers, combine harvesters, diesel engines, electric motors, humans, and draught animals accounted for 1.324 kW/ha, 0.018 kW/ha, 0.021 kW/ha, 0.0460 kW/ha, 0.193 kW/ha, 0.091 kW/ha, and 0.130 kW/ha, respectively. Singh (2015) [7] reported that sale of tractors was highest in state of Uttar Pradesh during the year 2000-01 to 2013-14. During this period, more than 68 percent of the tractor sales in the country were from Uttar Pradesh, Madhya Pradesh, Rajasthan, Maharashtra, Andhra Pradesh, Gujarat and Haryana. Singh (2021) [8] reported that the power availability per ha in the year 2020-21 was 2.761 kW. Of this power availability per ha from the tractor, power tiller, diesel engine, electric motor, animal and human is 1.64 kW, 0.03 kW, 0.39 kW, 0.54 kW, 0.084 kW and 0.080 kW respectively.

Materials and Methods

The present study was conducted in the India and other states which are the major agriculture production areas. The information was gathered from various Agriculture Departments and affiliated departments.

Table 1: Available power from different sources during periods in India

Year	Source of power Availability, million kW						Total power million kW
	Human	Animal	Tractor	Power Tiller	Diesel engine	Electric motor	
2011-12	13.15	16.903	118.8229	1.927	45.987	66.130	262.921
2020-21	11.5	11.694	229.5291	3.951	54.225	75.678	386.576

In the table 1, the Availability of farm power from human, animal, tractor, power tiller, diesel engine and electric motor were 13.15 kW, 16.903 kW, 118.8229 kW, 1.927 kW, 45.987 kW and 66.1330 kW during the year 2011-12. The Availability of farm power from human, animal, tractor, power tiller, diesel engine and electric motor was 11.5 kW, 11.694 kW, 229.5291 kW, 3.951 kW, 54.225 kW and 75.678 kW during the year 2020-21.

Table 2: Yearly Sales of Power Tillers and Tractors (Thousand Numbers)

S.No.	Year	Tractor	Power Tiller
1	2004-2005	248	17
2.	2005-2006	296	22
3.	2006-2007	353	25
4.	2007-2008	347	26
5.	2008-2009	343	35
6.	2009-2010	394	39
7.	2010-2011	545	55
8.	2011-2012	535	60
9.	2012-2013	591	47
10.	2013-2014	697	56
11.	2014-2015	681	46
12.	2015-2016	571	45
13.	2016-2017	662	52
14.	2017-2018	797	52
15.	2018-2019	890	52
16.	2019-2020	880	45
17.	2020-2021	899	54
18.	2021-2022	971	54
19.	2022-23 (April to Dec. 2022)	835	35

(**Source:** Department of Agriculture & Farmers Welfare)

In table 2, Year-wise sales of tractors and power tillers have continuously increasing during the year 2004-05 to 2022-23. In the table 2, during year 2022-23, the sale of tractors and power tillers was observed 835,000 and 35,000 number in India.

Results and Discussion

Table 3: Power available from different sources during periods in India

S. No.	Total Power million, kW	2011-12	2020-21	Absolute Change	Relative Change %
1	Source of power Availability, million kW	262.921	386.576	123.655	47.03%

Table.1 showed the increasing trends in the power available from tractors, power tillers, diesel engines and electric motors while negative trends were observed with human and animal power availability. Power available from human power beings showed increasing trend up to decade of 2011-12 and during the period 2020-21, a negative trend is assessed. This may be due to the migration of farm workers to cities for livelihood. In table 3, in year 2020-21, it is increased by 47.03 percent as compared to 2011-12 (262.921 million kW) of a source of power accessibility in India.

Table 4: Sale of Tractor and Power Tiller (Thousand Number)

S. No.	Sales of Tractor and Power tiller	2011-12 (Thousand Number)	2021-22 (Thousand Number)	Absolute Change	Relative Change %
1	Tractor	535	971	436	81.49%
2	Power Tiller	60	54	-6	-1%

In the table 4, during the year 2011-12, the sales of Tractor in India were found to be 535,000. During the year 2021-22, the sales of Tractors in India were found to be 971,000. It is increased by 81.49 percent as compared to 2011-12. In the table 4, during the 2011-12, the sales of power tillers in India were found to be 60,000. During the year 2021-22, the sales of power tillers in India were found to be 54,000. It is decreased by -1 percent as compared to 2011-12.

Table 5: State wise sale of tractors during 2022-23(Number) (April 2022 to December 2022)

S.No.	State/UTs	Sale of Tractor
1	Andhra Pradesh	29339
2	Telangana	35871
3	Assam	5279
4.	Bihar	36318
5.	Jharkhand	7547
6.	Gujarat	69146
7.	Haryana	35162
8.	Himachal Pradesh	1542
9.	Jammu & Kashmir	2627
10.	Karnataka	50087
11.	Kerala	525
12.	Maharashtra	85845
13.	Madhya Pradesh	96853
14.	Chhattisgarh	23766
15.	Odisha	12585
16.	Punjab	21211
17.	Rajasthan	81902
18.	Tamil Nadu	23350
19.	Uttar Pradesh	99968
20.	Uttarakhand	2679
21.	West Bengal	12844
22.	Other (North Eastern States & UTs)	07

(**Source:** Department of Agriculture & Farmers Welfare)

In the table 5, during the year 2022-23**,** the highest sales of Tractors in different states such as Uttar Pradesh, Madhya Pradesh and Maharashtra were found to be 99968, 96853 and 85845. In the table 5, during the 2022-23, the lowest sales of tractors in different state such as North Eastern & UTs, Kerala and Himachal Pradesh were found to be 07, 525, and 1542.

Table 6: State wise Area Covered under Micro-Irrigation (as on 31/03/2022) (Hectares)

S.No.	Name of State	Drip	Sprinkler	Total
1	Andhra Pradesh	1400780	521165	1921945
2	Arunachal Pradesh	6245	4275	10520
3.	Assam	9603	25671	33274
4.	Bihar	15834	106995	122829
5.	Chhattisgarh	35600	345634	381234
6.	Goa	1386	1346	2732
7.	Gujarat	921010	788672	1709682
8.	Haryana	43868	639656	683524
9.	Himachal Pradesh	7984	6403	14337
10.	Jammu & Kashmir	1780	293	2073
11.	Jharkhand	30056	18211	48267
12.	Karnataka	824916	1604399	2429315
13.	Kerala	24360	9289	33649
14.	Madhya Pradesh	357328	301497	658825
15.	Maharashtra	1414185	625598	2039783
16.	Manipur	358	9933	10291
17.	Meghalaya	308	307	615
18.	Mizoram	5914	1808	7722
19.	Nagaland	8040	7277	15317
20.	Odisha	32354	142798	175152
21.	Punjab	37682	16508	54190
22.	Rajasthan	318742	1777985	2096727

23.	Sikkim	7006	10518	17524
24.	Tamil Nadu	867898	387723	1255621
25.	Telangana	222603	91085	313688
26.	Tripura	2304	3204	5508
27.	Uttar Pradesh	57963	245138	303101
28.	Uttarakhand	14941	11796	26737
29.	West Bengal	10437	107259	117696
	Total	6679434	7812443	14491877

(**Source:** Department of Agriculture & Farmers Welfare)

In the table 6, during the year 2022-23**,** largest area covered by micro-irrigation (drip & Sprinkler irrigation)in different state such as Karnataka, Rajasthan, Maharashtra were found.

Conclusions

It is stated that throughout the past ten years, the population of various farm power sources in India has noticed an increase in mechanical power (tractor and power tiller, etc.).

- In 2020–21, the power available per hectare was 2.761 kW.
- The source power availability in India increased by 47.03 percent in 2020–21 compared to 2011–12 (262.921 million kW).
- In year 2022-23 sale of tractors and power tillers were observed 835,000 and 35,000 number in India.
- During the year 2022-23**,** the highest sales of the tractors in different state such as Uttar Pradesh, Madhya Pradesh and Maharashtra have been found to be 99968, 96853 and 85845.

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