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RESEARCH PAPER

Availability and status of different farm power sources and mechanization in Odisha state

Ajit Kumar Nayak* **and** Mithlesh Kumar
ICAR-Indian Institute of Water Management Opposite Rail Vihar, Chandrasekharpur, Bhubaneswar (Odisha) India (Email : Ajit.Nayak@icar.gov.in/anayak62@gmail.com)

Abstract : The status of farm mechanization, farm power availability, farm machinery sales are addressed in this study. The total farm power availability in Odisha agriculture is 2.93 kW/ha in 2016-17. This paper discusses the trend of mechanization status in Odisha. It has been found that there a large scope of mechanization in the state as there is minimum share of machine labour in the total cost of cultivating the principle crops.There is high need of adoption of suitable small machines and low cost especially for tillage, transplanting, weeding, harvesting and threshing operations. Massive awareness programme need to be carried out among the farmers of Odisha for popularizing the need based and crop specific machinery, available at the various research organizations of the state and the country for enhancing mechanization.

Farm mechanization in India : Mechanization of agriculture enhances productivity, besides reducing human drudgery and cost of cultivation. Mechanization also helps in improving utilization efficiency of other inputs like safety and comfort of the agricultural worker. Total farm mechanization in India has been lower at 40-45% compared to other countries such as USA (95%), Brazil (75%) and China (57%). Government has decided to enhance farm power availability from 2.02 kW/ha (2016-17) to 4.0 kW/ha by the end of 2030 to cope up with increasing demand for food grains. Farm mechanization market in India has been growing at a CAGR of 7.53 per cent during 2016-2020 due to thrust given by various government policies

Key Words : Different farm, Power sources, Mechanization

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INTRODUCTION

Marginal and small land holdings contribute about 92.97 % of total operational land holdings and cover 74.93% of total operated area (Anonymous, 2019). The varied soil type, topographic conditions, climatic conditions, flora and fauna throughout the Odisha increases the challenges of timeliness in farm activities, uniformity in technology adoption and availability of location specific farm implements and machinery (Anonymous, 2019). Hence agricultural mechanization plays a supplementary role to address above situations and to enhance input efficiency, reduce labour drudgery increase production and productivity of food grains, and reduces cost of operation and to address the issue of labour scarcity and timeliness and effective farm operations (Mehta *et al.*, 2019). Despite of challenges

of small and marginal land holdings, the agricultural mechanization in India is increasing at 7.5% per annum (Mehta *et al.*, 2019).

Agricultural mechanization is considered as an essential input of agriculture and plays key role in agricultural production (Mehta *et al.*, 2014). Small and segmented land holdings, poor groundwater utilization and lack of infrastructure are some of major constraints preventing enhanced crop production in this state (Sundaram *et al.,* 2020). Farm power availability is an indicator of the health of the agrarian situation in state (Sundaram *et al.,* 2020). Swain *et al.* (2022) studied the use pattern of important farm machinery like tractor, power tiller and combine harvester and their relationship between machine lives, maintenance cost and use pattern in selected district (Khordha, Mayurbhanj, Sonepur and Nuapada) of Odisha. The result showed that above mentioned machinery owners had medium land holdings (4-10 ha) comprising about 46% of the total power tiller, tractor and combine harvester ownership.In Odisha, about 65% of population directly or indirectly dependent upon agriculture (Swain *et al.,* 2022). Swain *et al.* (2022) reported that some agricultural operations like land preparation, levelling and threshing cannot be completed effectively with animal power.

During the peak season the agricultural activities like sowing, planting and harvesting increases the labor cost abruptly resulted in a high cost of operation. Therefore, farm mechanization helps the farmers to perform all farm activities timely and at a low cost (Swain *et al.,* 2022).

Rao *et al.* (2016) studied the trend of mechanization in Odisha and found that there is minimum share of machine labour in the total cost for principle crops, consequently there is large scope for mechanization in agriculture in this state. It is essential to organize extensive programme to increase the agricultural mechanization to a new heights. Weeding and inter-culture operation is one of the most labour consuming activities that needs suitable machine to reduce the labour costs. The large size of machine is not suitable for farmers because they cannot afford and maintain them for such activities in the fields. Low horsepower and small size machinesare much useful to farmers compared to the cost of agricultural labours. Therefore the farmers can substitute these machines successfully. Many studied reported that farmers gives more priority to tractors, tractors trolley, power tillers and combine harvesters (Rao *et al.,* 2016). Further, these could be further more appropriate to make them available with the; (i) low priced machines, (ii) minimum size and suitable scale of machine, (iii) subsidy over machines.These three criteria of agricultural machines increase the interest of farmers to purchase them for agricultural activities.

The printed booklets of all agricultural equipment/ implements/machines with references to relative use and prices of different machines may be distributed to farmers to encourage them to adopt the cost effective machines suitable for their land holdings and cropping pattern for various farm operations (Rao *et al.,* 2016). Farm mechanization is the mainstay of agriculture in many developing countries. In recent years there has been alarming increase in wages of agricultural labours. Further, enhanced cropping intensity, irrigation and technology have a need for use of machines in Odisha. Additional production and yield may be made using mechanization in agriculture. The mechanization reduces the human drudgery and the labour could be shifted to other activities which may fetch higher income to them.

Agricultural productivity and yield is greatly influenced by power availability and its optimum use of the field (Sundaram *et al.,* 2020). To improve the production level, farm mechanization is very crucial (Sundaram *et al.,* 2020). Over the last few decades, there has been considerable progress in farm mechanization in India. In India, during the last five decades, the farm power availability is increased from 0.25kW/ha in 1951 to 2.24 kW/ha in 2017 (Sundaram *et al.,* 2020). Agricultural mechanization plays key role in enhancing agricultural production and productivity in developing countries (Mehta *et al.,* 2014). The average farm size in India is small (1.16 ha) and small and marginal land holdings (<2 ha) account 85% of land holdings (Mehta *et al.,* 2014). The status of farm mechanization in India is evaluated by the trend in growth of mechanically power operated farm equipment over conventional human and animal operated equipment. From the last six decades, it was observed that there was a direct correlation between farm power availability and agricultural production (Mehta *et al.,* 2014). In India, the average tractor density per thousand hectare of net sown area is 33.

Agriculture is the key sector of Indian economy constituting 14% of the country's GDP and about 11% of their exports. More than 50% of population relies on agricultural for their principal source of income and it is also source of raw material for many industries (Mehta

et al., 2014). Therefore, accelerating the agricultural production is not only for achieving the overall GDP target and meeting the food demand of consistently rising population but also for increasing the income and to ensure inclusiveness in our society.

The term mechanization is used for overall description of application of variety of tools, implements, equipment's, machinery, power and other mechanical inputs. Proper use of mechanical inputs into agriculture has a direct and significant effect on production, productivity and profitability of agriculture farms along with labour productivity and quality of life of people engaged in agriculture (Mehta *et al.*, 2014). Stateswith greater farm power availability shows higher productivity as compared to others (Mehta *et al*., 2014; Sundaram *et al.,* 2020).

Mehta *et al.* (2014) studied the status, challenges and strategies for farm mechanization in India and revealed that the sales of transplanter, power tiller, combine harvester, rotavators and threshers is increasing at a compound annual growth rate (CAGR) of 50, 50, 28, 20 and 10%, respectively. Land holding is a key factor for deciding the use of farm power and machines (Sundaram *et al.,* 2020) because costly machines becomes uneconomical for small size farms.In Indian agriculture, agriculture workers, draught animals, tractors, power tillers, diesel engine and electric motors are the major sources of farm power. Fragmented lands, hilly topography, and socio-economic conditions, high cost of transport and lack of farm machinery manufacturing industries are the major factors the slow down the pace of mechanizations in Eastern India. Mehta *et al*. (2014) reported that average farm power availability need to be increased from 1.84 kW/ha to 2.5 kW/ha by 2025 to assure timeliness and quality in farm operations.

The production and productivity of agriculture cannot be enhanced by primitive and traditional practices of farming. It is predicted that population in rural area will decrease up to 62.83% in 2025 and 44.83% in 2050 (Soni and Ou, 2010). Farm mechanization is a vital component in Indian agriculture to increase the production and productivity of crops due to timeliness in farm operations, reduction in labour drudgery, saving time and cost of operations (Ghosal *et al*., 2021). Agricultural mechanization and availability of adequate farm power is crucial for timely farm mechanization, handling the crop produce, increasing the crop production, and reducing the post-harvest losses (Ghosal *et al.*, 2021). With the help of mechanization, the land can be made easily for next crop. Greater degree of farm mechanization can reduce the issue of labour scarcity to a great extent during the peak farm operations like sowing, transplanting and weeding (Ghosal *et al*., 2021). Farm mechanization is India is still in its early stage with an overall farm mechanization level of 40-45%, which is much lower than the United States (95%), Western Europe (95%), Russia (80%), Brazil (75%) and China (57%), respectively (Ghosal *et al.*, 2021).

Study area :

Odisha is a major agrarian state of India. More than 70% of population directly or indirectly dependent upon

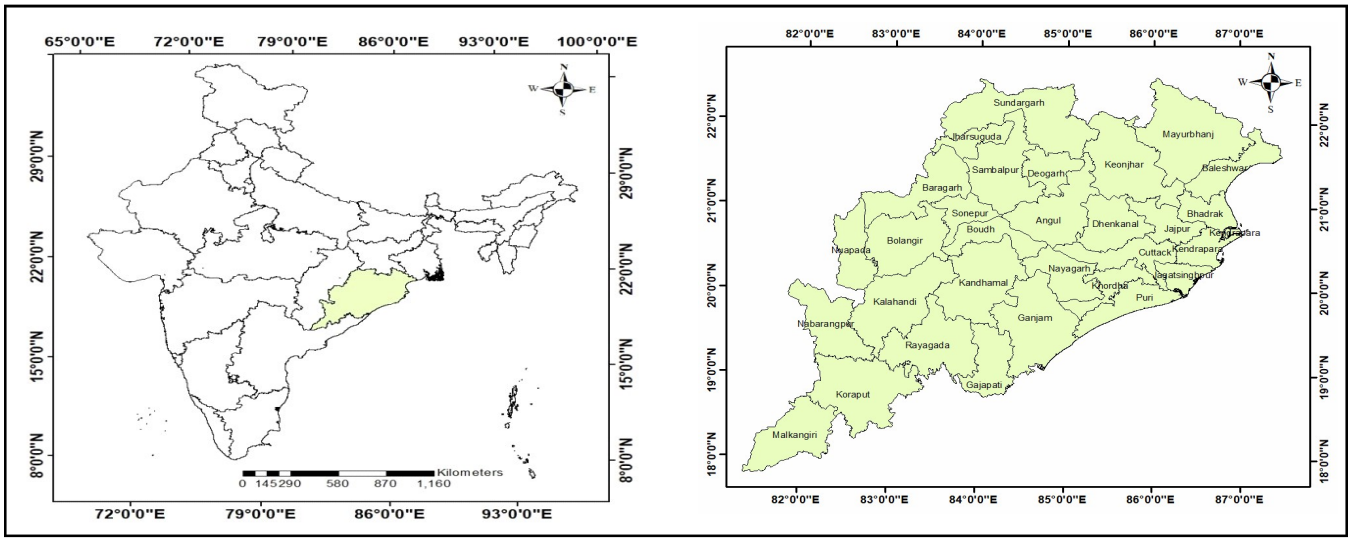

Fig. 1: Location of study area

agriculture. Further, the agriculture not only provides food to population but also provides the job opportunity to more than 60% of work force of the state (Ghosal *et al.*, 2021). Odisha is divided into ten agro-climatic zones based on different soils types, land use, topography, climatic conditions and cropping pattern and constituted geographical area of 1,55,707 km^2. The total cultivated land of the state is 61.80 lakh ha out of which 29.14 lakh ha (47%), 17.55 lakh ha (28%), and 15.11 lakh ha (25%) are high, medium and low lands, respectively. The state has witnessed a decline net sown area loss from 58.29 lakh ha in 2000-01 to 53.62 lakh ha in 2018-19 due to urbanization and more area has been coverts to non-agricultural use. The majority of farmers are small and marginal having average size of land holdings is 0.95 ha (Odisha Agriculture Statistics, 2018-19). The location of study area is shown in Fig.1.

Dynamics of land holding pattern in Odisha :

Land holding pattern plays a crucial role in deciding the use of farm power and machinery in agriculture.There are five kinds of land holdings in India, depending on various sizes are shown in Table 1. During the year 2000-01 and 2015-16, there has been consistently increase in operational land holding of marginal farmer's category in Odisha as well as India.The increase of marginal farmers land holdings in Odisha (32.45%) is almost four times more than the national average (9.87%). This is the indication of acceleration of more fragmented or segmented lands in Odisha as compared to India. From Table 1, it is clear the marginal and small farmers share more contribution of operational land holding than others.

Dynamics of agricultural labors in Odisha :

A person who works on another person's land for wages in form of money or share is regarded as an agricultural labor or workers. The availability of agricultural workers has great impact on agricultural farm activities. According to Gupta (2016), the number of cultivators in India is declined by 6.77% from 2001 to 2011 and number of agricultural labours is increased by 35.17% from 2001 to 2011. The main reason for this phenomenon is the decreasing size of operational land holdings. Moreover, agriculture is increasingly becoming infeasible and workers engaged in agriculture are shifting towards non-agricultural activities (Gupta, 2016).In Odisha, the number of agricultural workers per 1000 net sown area (NSA) is increased from 1512 in 2014 to 2169 in 2017 (Table 2). During the year 2014, the maximum agricultural labour density was in Jagatsinghpur whereas in the year 2017, the maximum agricultural density was in Balasore. The lowest density was in Nuapada district

Table 1: Changes in pattern of number of operational land holdings (%) in Odisha and India

	Odisha			India		
Category of land holdings	2000-01	2015-16	Percentage change	2000-01	2015-16	Percentage change
Marginal (Less than 1 hectare)	56.43	74.74	32.45	62.30	68.45	9.87
Small (1.0 to 2.0 hectares)	27.39	18.23	(-) 33.44	19.00	17.62	(-) 7.24
Semi-Medium (2.0 to 4.0 hectares)	12.32	5.90	(-) 52.11	11.80	9.55	(-) 19.07
Medium (4.0 to 10.0 hectares)	3.57	1.04	(-) 70.87	5.50	3.81	(-) 30.73
Large (10.0 hectares and above)	0.32	0.08	(-) 75.00	1.03	0.57	(-) 44.66

(Source: Agricultural Census Division, Ministry of Agriculture, New Delhi)

Table 2 : Dynamics of different farm power sources in Odisha during 2014 and 2017

Particulars	Year		Percentage increase
	2014	2017	
Agricultural workers density	1512	2169	43.45
Draught animal density	719	690	(-) 0.04
Tractor density	25	27	8
Power tiller density	14	23	64.29
Electric motor density	71	87	22.54
Diesel engine density	19	21	10.53
Farm power availability (kW/ha)	1.44 (Odisha)	1.65	14.55
	1.84 (India)	2.03	10.33

in both the years (Table 3).

Dynamics of draught animal in Odisha :

Traditionally, draught animal power is the main source of power in agriculture (Netam and Jaiswal,2018). Draught animals are used for many farm operations like tillage, seedbed preparation, sowing, weeding, harvesting and threshing, respectively (Netam and Jaiswal, 2018). Animal power is also used for water lifting, milling and transporting the crops. Further, the draught animal also assists in reducing drudgery, eliminating poverty, and creation of health. Small and marginal farmers are the major user of animal power. It is estimated that about 60% of the total draft power used in agriculture is still contributed by animal power (Netam and Jaiswal, 2018). Among the draught animals the buffaloes, bullocks, and camels are extensively used for draft purposes whereas horses, mules, donkeys and camels are employed for pack animals. However, with the introduction of mechanical farm power, the densities of draught animals are decreasing gradually. The draught animal's density is decreased by 0.04% from 2014 to 2017 (Table 2). Similar decreasing trends were also observed in top and bottom districts of draught animal density which is shown in Table 4. The maximum draught density was in Phulbani district followed by Gajapati, Deogarh, Nabarangpur and Keonjhar during the year 2017. Kendrapara district recorded the minimum draught density during 2014 and 2017.

Dynamics of tractor density in Odisha :

Tractor is the major and most widely used mechanical power in Indian farms.Indian tractor market is the second biggest market worldwide which accounts to one third of the global production. China and United States of America are the other major tractor markets in the world. Sales within India closed at 802,670 units in 2020, 11 % higher than 2019 volumes and 1 % more than the previous all-time record, set in 2018 during a pandemic year. The sale of tractor in India was 697

Table 3 :Top and bottom district of Odisha in agricultural labors density (No. per 1000 ha net sown area)

Top districts				Bottom district			
2014		2017		2014		2017	
Districts	Agricultural labors density	Districts	Agricultural labors density	Districts	Agricultural labors density	Districts	Agricultural labors density
Jagatsinghpur	2746	Balasore	3956	Mayurbhanj	1115	Deogarh	1572
Puri	2615	Cuttack	3940	Balangir	1088	Sambalpur	1532
Gajapati	2579	Puri	3931	Kalahandi	1020	Angul	1528
Cuttack	2556	Jagatsinghpur	3646	Sundargarh	979	Sundargarh	1408
Balasore	2356	Jajpur	3404	Nuapada	962	Nuapada	1138

Table 4 : Top and bottom district of Odisha in draught animal density (No. per 1000 ha net sown area)

Top districts	2014	2017	Bottom district	2014	2017
Phulbani	2136	2051	Ganjam	452	434
Gajapati	1107	1063	Bhadrak	451	433
Deogarh	1103	1059	Kalahandi	442	425
Nabarangpur	985	946	Bargarh	436	419
Keonjhar	985	946	Kendrapara	368	353

Table 5:Top and bottom district of Odisha in tractor density (No. per 1000 ha net sown area)

Top districts				Bottom district			
2014		2017		2014		2017	
Districts	Tractor density	Districts	Tractor density	Districts	Tractor density	Districts	Tractor density
Cuttack	135	Cuttack	141	Deogarh	6	Sonepur	8
Khordha	87	Khordha	95	Malkangiri	5	Deogarh	7
Bargarh	47	Bargarh	41	Boudh	4	Malkangiri	7
Jagatsinghpur	35	Jagatsinghpur	39	Sonepur	2	Boudh	6
Balasore	34	Balasore	36	Jajpur	0	Jajpur	3

thousand units in 2013-14 and 890 thousand units in 2018-19 (Anonymous, 2019b).The tractor density was calculated by dividing the number of tractors by respecting net sown area of the districts. The overall tractor density of Odisha in the year 2017 was 27 which are lower than the national average of 33 (Mehta *et al.*, 2019). The tractor density is increased by 8% during 2014 to 2017 (Table 2). The tractor density was increased from 135 in 2014 to 141 tractors per 1000 net sown area in 2017.The maximum tractor density was in Cuttack district followed by Khordha, Bargarh, Jagatsinghpur and Balasoreduring 2014-17 (Table 5). Jajpur district recorded the lowest tractor density during 2014-17. The Government should focus on these districts to increase the farm mechanization level in this state.

Dynamics of power tiller density in Odisha :

Power tiller is a multipurpose walking type hand tractor designed for tilling the land, both dry and wet cultivation and other farm operations. Further, the power tiller helps in preparing the soil, sowing seeds, planting seeds, adding and spraying the fertilizers, herbicides and water. A power tiller is ideally suitable for the small lands. The enthusiasm of farmers for purchasing the power tiller over tractor is more than tractors. From Table 2, the tractor density is increased 8% from 2014 to 2017 while the power tiller density is increased 64.29 % from 2014 to 2017 which mean that farmers are taking more interest on power tiller than tractors. The top and bottom five districts of power tiller density are shown in Table 6. In the year 2014, the Cuttack district had the highest number of power tiller density of 53 which was reduced by 46 (13.20%) in the year 2017. The Kendrapara, Jharsuguda, Balasore, Sambalpur districts has recorded increased power tiller density from 2014 to 2017 (Table 6). Gajapati district recorded the lowest power tiller density during 2014-17.

Dynamics of electric motors and diesel engine density in Odisha :

Electric motor is the one of the important source of farm power in India. Electric motors are used for stationary operation in agriculture. Electric motors are used for many purposes such as for driving the barn machinery, chaff cutters, root cutters, grain crushers and water pumps.Electricity's ease of operation and low maintenance showed savings in time and labour.According to Singh and Singh (2021), there is increasing trend of electric motor availability in the country and the power available from electric motor is 0.54kW/ha. Further, the annual growth rate of electric motor is 7.47%. During 2014-17, the increase in number of electric motors in Odisha was 22.54% (Table 2). It grew from 71 to 87 electric motors per 1000 net sown area during 2014-17. Jagatsinghpur district had the maximum number of electric motor density followed by Cuttack, Jajpur, Puri and Balasore (Table 7). The minimum electric motor density was recorded in Koraput district during 2014-17.

Diesel engine is commonly used as a stationary

Table 6 : Top and bottom district of Odisha in power tiller density (No. per 1000 ha net sown area)

Top districts				Bottom district			
2014		2017		2014		2017	
Districts	Power tiller density	Districts	Power tiller density	Districts	Power tiller density	Districts	Power tiller density
Cuttack	53	Kendrapara	65	Angul	2	Phulbani	4
Kendrapara	41	Jharsuguda	62	Nuapada	2	Angul	3
Jharsuguda	33	Balasore	53	Phulbani	2	Nabarangpur	3
Balasore	31	Sambalpur	52	Nabarangpur	1	Nuapada	3
Sambalpur	30	Cuttack	46	Gajapati	0	Gajapati	1

Table 7: Top and bottom district of Odisha in electric motor density (No. per 1000 ha net sown area)

Top districts	2014	2017	Bottom district	2014	2017
Jagatsinghpur	304	352	Rayagada	35	43
Cuttack	296	348	Kalahandi	31	40
Jajpur	213	249	Malkangiri	31	34
Puri	170	203	Nabarangpur	25	33
Balasore	148	187	Koraput	22	27

power source in agriculture for irrigation, operating threshers, and other farm machineries. Singh and Singh (2021) reported that availability of diesel engine is following an increasing trend with compound annual growth rate of 6.54% per annum. During 2014-17, the increase in number of diesel engine in Odisha was 10.53% (Table 2). The diesel engine density if increased from 19 in 2014 to 21 in 2017 (Table 2). Puri district had the maximum number of diesel engine density followed by Jharsuguda, Balasore, Jagatsinghpur and Boudh (Table 8). Bhadrak district has recorded the lowest diesel engine density during 2014-17.

Farm power availability in Odisha :

The availability of mobile farm power sources, such as tractors, draught animals, power tillers, combine harvesters, agricultural workers, as well as stationary power sources, such as diesel engines and electric pump sets/motors, is taken into consideration when determining the production and productivity of food grains. Farm power must be upgraded in order to raise cropping intensity, which is necessary to increase agricultural productivity.The total farm power availability in India was2.03kW/ha in 2017, 2.50kW/ha in 2022 and projected to be 4.00kW/ha in 2030 (Anonymous, 2018) (Table 9 and10). Similarly, in Odisha the farm power availability was 1.65 kW/ha in 2017, 1.96 kW/ha in 2022 and projected to be 2.93 kW/ha in 2030 (Anonymous, 2018). The top and bottom district of farm power availability in Odisha state during 2013-14 and 2016-17 are presented in Table 11. In 2017, the top five districts with maximum farm power availability (kW/ha) were Cuttack (5.81),

Table 8: Top and bottom district of Odisha in diesel engine density (No. per 1000 ha net sown area)

Top districts	2014	2017	Bottom district	2014	2017
Puri	108	114	Kalahandi	6	6
Jharsuguda	45	47	Koraput	4	4
Balasore	44	47	Malkangiri	4	4
Jagatsinghpur	44	46	Gajapati	3	3
Boudh	34	36	Bhadrak	1	1

Table 9: Dynamics of farm power availability

State/Country	Farm power availability (kW/ha) 2013-2014	Farm power availability (kW/ha) 2016-2017	Farm power availability (kW/ha) 2030	Per cent change
Odisha	1.44	1.65	2.93	14.2
India	1.73	2.03	4.00	17.3

Table 10: Present farm power availability and requirement of farm power by 2030

State/Country	Farm power availability (kW/ha) 2022	Farm power availability (kW/ha) 2030
Odisha	1.96	2.93
India	2.50	4.00

Table 11: Top and bottom district of Odisha in farm power availability (kW/ha)

Top districts				Bottom district			
2014		2017		2014		2017	
Districts	Farm power availability (kW/ha)	Districts	Farm power availability (kW/ha)	Districts	Farm power availability (kW/ha)	Districts	Farm power availability (kW/ha)
Cuttack	5.46	Cuttack	5.81	Kalahandi	1.00	Deogarh	1.13
Khordha	3.26	Khordha	3.62	Koraput	0.98	Koraput	1.13
Jagatsinghpur	2.75	Jagatsinghpur	3.16	Sonepur	0.80	Sonepur	1.09
Puri	2.50	Puri	2.74	Nuapada	0.74	Nuapada	0.80
Balasore	2.23	Balasore	2.65	Malkangiri	0.68	Malkangiri	0.79

Khordha (3.62), Jagatsinghpur (3.16), Puri (2.74) and Balasore (2.65). Malkangiri district had the lowest farm power availability of 0.79 kW/ha in 2016-17. The spatial representation of farm power availability over Odisha during 2014 and 2017 are shown in Fig. 2. Out of 30 districts, only five districts have farm power availability more than the national average of 2.03 kW/ha (Table 12 and Fig. 2). Now Govt. of Odisha should focuson 25 districts to increase farm power availability to national average. In Odisha, there is fragmented land holdings areincreasing; consequently the numbers of small and marginal farmers are also increasing. As per the number of marginal farmers are increasing, the government should focus on small machinery like power tillers along

Table 12: Dynamics of farm power sources in different district of Odisha during 2013-14 and 2016-17

Districts	Tractors		Draught animals		Agricultural laborers		Electric motors		Diesel engines		Power tiller		Farm power availability (kW/ha)	
	2013-14	2016-17	2013-14	2016-17	2013-14	2016-17	2013-14	2016-17	2013-14	2016-17	2013-14	2016-17	2013-14	2016-17
Angul	3,905	4,406	141,959	136,370	212,922	275,844	10,646	13,645	3,508	3,720	310	594	1.259	1.414
Balasore	6,662	7,169	137,741	132,318	467,738	785,476	29,409	37,078	8,785	9,315	6,164	10,561	2.227	2.645
Bargarh	15,239	13,158	139,989	134,477	400,934	651,868	14,706	21,688	8,584	9,102	6,394	10,437	1.897	1.920
Bhadrak	3,402	4,104	75,455	72,484	280,917	411,834	10,694	12,146	96	102	2,597	4,206	1.112	1.339
Balangir	4,709	5,845	173,089	166,274	316,065	482,130	14,318	19,534	7,083	7,511	849	1,333	1.040	1.245
Boudh	353	512	83,881	80,579	163,370	176,740	5,763	6,923	2,908	3,083	356	551	1.037	1.153
Cuttack	17,309	17,985	78,149	75,072	326,818	503,636	37,834	44,459	3,841	4,073	6,804	5,826	5.455	5.812
Deogarh	423	519	79,301	76,179	131,546	113,092	4,731	5,544	1,209	1,282	474	918	1.038	1.126
Dhenkanal	2,126	2,495	102,227	98,202	201,511	253,022	8,267	10,003	1,345	1,426	1,572	2,750	1.093	1.267
Gajapati	1,233	1,414	84,406	81,082	196,691	243,382	4,178	4,067	208	220	37	83	1.192	1.267
Ganjam	10,276	12,516	166,482	159,928	494,081	838,162	17,843	20,629	6,715	7,121	5,198	8,735	1.328	1.614
Jagatsinghpur	2,872	3,209	40,450	38,857	223,113	296,226	24,712	28,576	3,538	3,751	1,866	2,997	2.747	3.162
Jajpur	53	343	82,226	78,989	287,486	424,972	26,626	31,087	3,725	3,950	1,921	3,120	1.419	1.721
Jharsuguda	1,391	1,540	60,485	58,104	128,764	107,528	5,479	6,041	2,928	3,105	2,163	4,055	1.743	1.980
Kalahandi	6,781	7,405	143,861	138,197	331,770	513,540	10,233	13,009	1,942	2,059	4,765	7,687	0.996	1.151
Kendrapara	1,397	2,028	44,790	43,026	268,111	386,222	12,280	13,820	3,485	3,696	4,946	7,925	1.309	1.680
Keonjhar	4,058	4,703	247,584	237,836	318,476	486,952	12,785	16,603	2,213	2,346	2,687	5,314	1.156	1.360
Khordha	8,824	9,608	58,035	55,750	218,865	287,730	13,824	16,082	1,396	1,481	1,373	2,262	3.255	3.618
Koraput	4,287	5,064	205,610	197,514	324,932	499,864	5,182	6,358	838	888	864	1,548	0.984	1.129
Malkangiri	706	1,092	127,149	122,142	218,845	287,690	4,666	5,140	623	661	680	1,378	0.676	0.792
Mayurbhanj	6,071	6,932	323,696	310,952	391,665	633,330	20,976	30,810	3,878	4,112	4,708	8,851	1.215	1.473
Nabarangpur	3,975	4,365	191,144	183,618	282,363	414,726	4,893	6,368	4,123	4,372	274	600	1.202	1.318
Nayagarh	2,686	2,900	85,353	81,992	203,243	256,486	10,730	12,194	1,542	1,635	796	1,323	1.494	1.637
Nuapada	2,146	2,313	105,094	100,956	183,441	216,882	7,038	8,603	1,337	1,418	428	633	0.740	0.802
Phulbani	1,662	1,783	163,028	156,609	177,893	205,786	3,766	4,139	1,352	1,428	133	322	1.788	1.853
Puri	3,659	3,487	65,500	62,922	301,907	453,814	19,603	23,381	12,415	13,165	2,055	3,311	2.504	2.741
Rayagada	3,431	3,825	124,277	119,384	217,728	285,456	4,905	5,948	768	814	368	633	1.234	1.358
Sambalpur	5,976	6,456	126,333	121,359	220,707	291,414	7,601	10,128	1,498	1,588	5,768	9,842	1.492	1.738
Sonepur	301	1,083	71,179	68,376	191,565	233,130	7,594	9,059	2,604	2,761	2,843	4,439	0.802	1.087
Sundargarh	4,590	5,798	252,418	242,480	266,842	383,684	9,444	13,172	6,117	6,487	3,174	6,224	1.159	1.404
Total	130,505	144,057	3,780,891	3,632,031	7,950,309	11,400,618	370,726	456,234	100,602	106,674	72,565	118,456	1.442	1.647

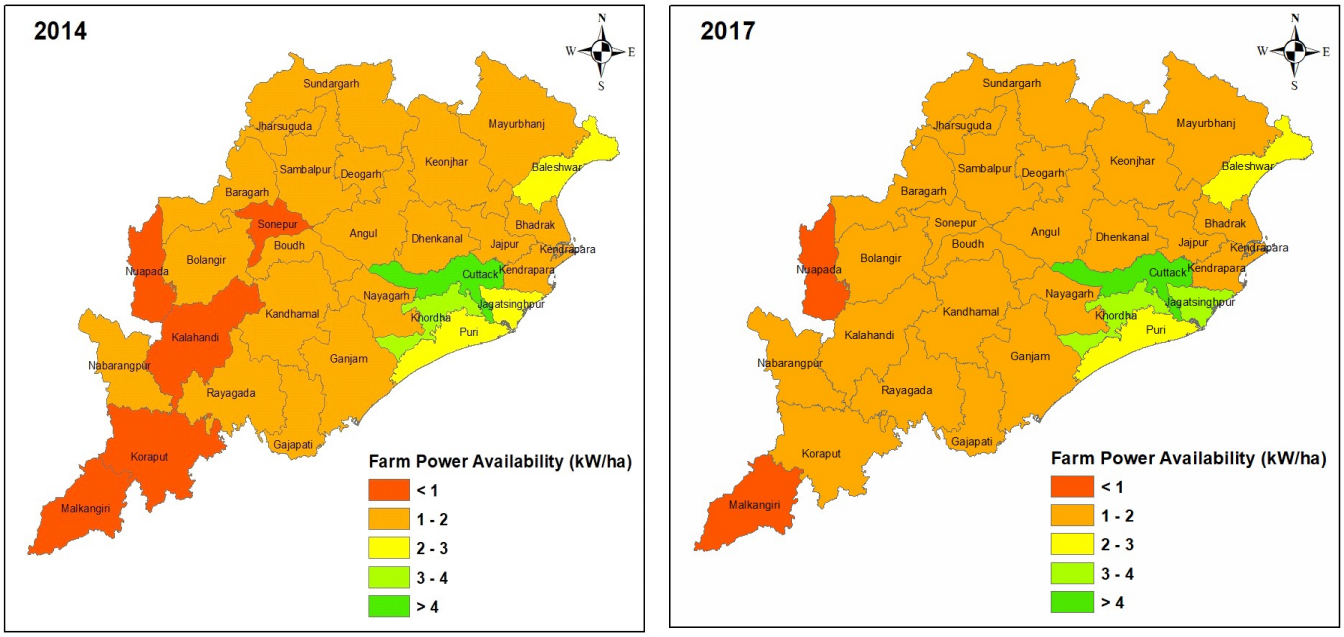

Fig. 2: Spatial representation of farm power availability dynamics in Odisha

with suitable implements. The state government initiatives in form of subsidy to various farm power machines surely will increase the farm mechanization in the state. Further, there is also scope to develop solar based irrigation system to reduce the diesel fuel and motor electricity to ensure environmental sustainability.

Conclusion :

The Odisha state is showing considerable progress in farm mechanization over the last decade.The population dynamics of different farm power sources (tractors, power tiller, electric motors and diesel engine) are showing increasing trend except animate power (human and draught animal).The farm power sources like tractor, power tiller, electric motors and diesel engines are increased by 8, 64.29, 22.54 and 10.53%, respectively, during the year 2014-17. The major challenges of farm mechanization in Odisha areincreasing the number of small and marginal farmers. As the farm mechanization is gradually increasing in the state therefore the programme such as demonstration, extension works, training, visits etc. should be organized to create more awareness about the machinery, their availability and cost, and benefits over traditional practices.

REFERENCES

Anonymous (2018). SMAM operational Guidelines, Mechanization and Technology Division, Final Report on Monitoring, Concurrent Evaluation and Impact Assessment of Sub-Mission on Agricultural Mechanization Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare, Government of India.

Anonymous (2019). Agriculture Census 2015-16 (Phase I) All India Report on Number and Area of Operational Holdings, Agriculture Census Division, Department of Agriculture, Co-Operation and Farmers Welfare Ministry of Agriculture and Farmers Welfare, Government of India.

Anonymous (2019b). Agricultural statistics at a glance 2019.Government of India Ministry of Agriculture and Farmers Welfare Department of Agriculture Cooperation and Farmers Welfare Directorate of Economics and Statistics. pp. 257.

Farm Tractor Market in India (2022). Sizes, forecasts, risks, trends, opportunities till 2027.https://mobilityforesights.com/product/farm-tractor-market-in-india/ (Accessed on 19th October, 2022).

Ghosal, S., Ghosal, S., Rath, J. R. and Ghosal, M.K. (2021). Farm mechanization: Its status in the state of Odisha, India. *International Journal of Chemical Studies,* **9** (2) : 87-92.

Gupta, N. (2016). Decline of cultivators and growth of agricultural labourers in India from 2001 to 2011. *International Journal of Rural Management,* **12** (2) : 179–198. doi:10.1177/0973005216665939.

https://eands.dacnet.nic.in/At_Glance_2008/ac_new.htm (Accessed on 11th October, 2022).

Mehta, C. R.,Chandel, N. S. and Senthilkumar, T. (2014).

Status, challenges and strategies for farm mechanization in India. *Agricultural Mechanization in Asia, Africa & Latin America,* **45** (4) : 43-50.

Mehta, C. R., Chandel, N. S., Jena, P. C. and Jha, A. (2019). Indian agriculture counting on farm mechanization. *Agricultural Mechanization in Asia, Africa & Latin America*, **50** (1) : 84-89.

Netam, A. and Jaiswal, P. (2018). Role of animal power in the field of agriculture. *International Journal of Avian & Wildlife Biology*, **3** (1) : 62-63. DOI: 10.15406/ijawb.2018.03.00055.

Rao, G. G. (2016). Trends and pattern of mechanization in agriculture and its impact on production in Odisha. *Editor's Note*, 54.

Singh, S. P. and Singh, S. (2021). Farm power availability and its perspective in Indian agriculture. *RASSA Journal of Science for Society*, **3** (2) : 114-126.

Sundaram, P. K., Sarkar, B., Jeet, P., Patel, S. K., Anurag, A. P., and Upadhyaya, A. (2020). Dynamics of farm power sources and their availability in Bihar: Farm power availability in Bihar. *Journal of Agri. Search*, **7** (3) : 128-133.

Swain, S. (1996). Present status and future prospects of power tiller industry in Orissa, India. In : *Proceedings of the Korean Society for Agricultural Machinery Conference* (pp. 2-5). Korean Society for Agricultural Machinery.

Swain, S., Sahu, N. K., Barik, A. and Padhi, P. K. (2022). Study on recent farm mechanization trend in Odisha. *International Journal for Research Trends & Innovation,* **7** (5) : 373-380.