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Dynamics of Farm Power Sources and their Availability in Bihar

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ABSTRACT

The production levels of agriculture have remained low in eastern region of India mainly due to lack of location-specific production technologies, natural calamities like floods, water logging, drought, inadequate timely supply of critical inputs and social constraints. Bihar is one of the important agrarian states of Eastern India. The crop yields are low and almost stagnating in Bihar compared to the north-western and other parts of the country. To improve the productivity in this region mechanization of farms is of critical importance. The farm power availability in Bihar in 2017 is 2.80 kW/ha and is more than the national average of 2.03 kW/ha. Still there are 14 districts in Bihar which is below national average. The number of marginal farmers has increased from 84.18 to 91.21 during 2014-17, an increase of 7.03 percent. Increase in Small and fragmented land will further hindrance the farm mechanization process. The present study was conducted to understand dynamics of farm power availability in Bihar, so as to take substantial measures for improved mechanization and in turn crop productivity in the region.

KEYWORDS

Dynamics, Farm Power availability, Tractor, Bihar

INTRODUCTION

Bihar is located in the eastern part of the country (between 83°-30' E ~ 88°-00' E longitude&24°-20' N ~ 27°-31' N Latitude (Fig.1). Bihar falls in the Agro-Climatic Zone–IV, which is called "Middle Gangetic Plains Region". The small and scattered land holdings, poor groundwater utilization and lack of infrastructure are some of the major constraints preventing enhanced crop production in this state (Bhatt *et al.*, 2012). Agriculture productivity is greatly influenced by power availability and its optimum use on the farms (Singh *et al.*, 2015). The farm power availability is an indicator of the health of the agrarian situation in a state (Sundaram *et al.*, 2019). Over the last few years, there has been considerable progress in agriculture mechanization in India. During last 5 decades farm power availability in India has increased considerably from 0.25 kW/ha in 1951 to 2.24 kW/ ha in 2017. In Bihar it has increased from 0.80 kW/ha in 2001 to 2.80 kw/ha in 2017 (Mehta *et al.*, 2019). Empirical evidence confirms that there is a strong correlation between farm mechanization and agricultural productivity. States with a greater availability of farm power show higher productivity as compared to others (Singh *et al.*, 2011).

The purpose of this study was to comprehend about the changes in farm power sources and farm power availability over years in Bihar. The first Green Revolution in India was to ensure food security as there was severe scarcity of food in the country. The second Green Revolution aimed at creating sustainable agriculture by leveraging advancements in technology has to come from Eastern India as its potential has yet to be exploited. The focus is on Eastern India as Second Green Revolution has to come from this region. Bihar is one of the important agrarian states of Eastern India. The crop yields are low and almost stagnating in Bihar compared to the north-western and other parts of the country. For example, average yield of rice is around 2-2.5 tons/ha in Bihar compared to 5 tons/ha in Haryana and 6 tons/ha in Punjab. In the case of wheat, the yield is around 2.5 tons/ha in Bihar, much below the yield levels in Punjab and Haryana (4.5-5 tons/ha) (Joshi and Khan, 2017).This study has been carried out by collecting information by analyzing mission documents like Sub-Mission on Agricultural Mechanization (SMAM) (Anonymous, 2018). Out of 38 districts of Bihar data for 4 districts namely Bhabhua, East &West Champaran and Saran were not available.

Dynamics of Land-owning pattern in Bihar

Land holding pattern is crucial factor in deciding use of farm power and machines. Costly machines become uneconomical for small sized farms. In India, on the basis of area of land holding, farmers are divided into five major size groups (Table 1). During 2001-2016, there has been consistent increase in number of land holdings in marginal farmers category (< 1ha), both in Bihar as well as in India. However, in Bihar the increase is more (7.03%) compared to national average of 5.57 per cent. This is indicative of the fact that fragmentation of land in Bihar is more accelerated as compared to India. From table 1, it may also be conferred that fragmentation of small farmers land (1-2 ha) is the major contributor in increasing the percentage of land holding of marginal farmers in Bihar. However, in case of whole country, semi-medium farmers (2-4ha) is the major contributor.

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Fig. 1: Location of Bihar in India

Table 1: Changes in pattern of number of operational holding (%) by major size groups in Bihar and India

Major Size group	Bihar			India		
	2001	2016	Change	2001	2016	Change
Marginal farmers (<1 ha)	84.18	91.21	7.03	62.88	68.45	5.57
Small farmers (1-2 ha)	9.24	5.75	(-)3.49	18.92	17.62	(-)1.3
Semi-Medium farmers (2-4 ha)	5.09	2.52	(-)2.57	11.69	9.55	(-)2.14
Medium farmers (4-10 hectare)	1.42	0.49	(-)0.93	5.48	3.8	(-)1.68
Large farmers (>10 hectare)	0.08	0.02	(-)0.06	1.02	0.57	(-)0.45

(Source: http://agcensus.dacnet.nic.in/stateholdingsizeclass.aspx)

Farm power sources and availability

Agricultural workers, draught animals, tractors, power tillers, diesel engines and electric motors are major sources of farm power in Indian agriculture. The pace of mechanization in Eastern region of India is slow due to constraints like fragmented lands, hilly topography, socio-economic conditions, high cost of transport, lack of institutional financing and lack of farm machinery manufacturing industries (Mehta *et al.*, 2014). However, Government of Bihar has taken progressive steps in increasing the level of farm mechanization (Table 2) through various schemes viz. subsidization of farm power and implement through state plans, SMAM, RKVY etc. Apart from the individual farmer subsidies, financial assistance is also offered on packages of machinery to enable the setting up of custom hiring centers (CHC) for the benefit of small farmers. The limited success of CHC, coupled with high rental rates for machinery in the region, has precluded small farmers from benefiting from these enterprises (Saini *et al.* 2020). To compare it across districts of Bihar, the numbers of farm power sources were divided by the respective net sown area (NSA) of the districts and density term is used for this purpose. Overall, except draught animal density all other farm sources have increased significantly over the span of 3 years (Table 2).

Table 2: Dynamics of different farm power sources in Bihar (2014-17)

Particulars		Year		Percentage increase
		2014	2017	
Agriculture worker density		2081	2166	4.04
Draught Animal density		118	113	(-)3.94
Tractor Density		28	38	33.8
Power tiller density		8.95	9.25	3.4
Electric motor Density		47	48	10.16
Diesel engine density		159.2	160.0	0.52
Farm Power Availability (kW/ha)	Bihar	2.47	2.80	13.36
	India	1.84	2.03	10.33

Source: Anonymous (2018)

Dynamics of agricultural workers

A person who works on another person's land for wages in money or share is regarded as an agricultural worker/labourer. The availability of workers in agriculture is crucial for sustaining agricultural production system. All over India, the agricultural workers have grown consistently since 1951 (Gupta, 2016).In Bihar, the number of workers per 1000 NSA has increased from 2081 in 2014 to 2166 in 2017. The maximum density in both the years was in Jamui followed by Patna, Munger, Vaishali and Sheohar districts. The lowest density was in Rohtas district in both the years (Table 3). Rohtas, Buxar and Bhojpur districts are major paddy and wheat growing areas. The agriculture workers density is less, but is supported by the good tractor density (Table 9).

Table 3: Top and bottom districts of Bihar in Agricultural workers density (No. per 1000 ha NSA) (2014-17)

Top districts	2014	2017	Bottom districts	2014	2017
Jamui	4438	4618	Bhojpur	1555	1617
Patna	3872	4029	Lakhisarai	1456	1514
Munger	3218	3348	Aurangabad	1380	1436
Vaishali	2930	3049	Buxar	1306	1359
Sheohar	2777	2890	Rohtas	1254	1304

Draught Animal dynamics

Animals assist in eliminating poverty, reducing drudgery and

creation of wealth. Animal traction is used for food security in smallholder farming systems. Animals assist in crop production (ploughing, planting, and weeding). Food production, distribution and rural trade are also assisted through animal-powered transport. Animals save household time and effort by carrying water and fuel wood. Animal power is also used for water-lifting, milling and transporting crop. Many different types of draught animal are employed, particularly cattle (oxen, bulls and cows), buffaloes, horses, mules, donkeys and camels in Indian farms. However, with the introduction of mechanical farm power, their population is slowly decreasing. Also, availability of fodder round the year is a major bottleneck for their adoption. Each district of Bihar also showed similar decreasing trends in number of draught animals over the years (2014-17). The maximum draught animal density in 2017 was in Jamui (868) followed by Banka (476), Kishanganj (450),Araria (299) and Madhubani (278). Arwal district recorded the minimum draught animal density of 3 in both the years (Table 4).

Table 4: Top and bottom districts of Bihar in drought animal density (No. per 1000 ha NSA) (2014-17)

Top districts	2014	2017	Bottom districts	2014	2017
Jamui	903	868	Vaishali	11	11
Banka	496	476	Buxar	7	7
Kishanganj	469	450	Rohtas	6	6
Araria	311	299	Bhojpur	5	4
Madhubani	289	278	Arwal	3	3

Dynamics of tractors in Bihar

Tractor is the major mechanical power source used on Indian farms. India has one of the largest tractor industries in the world. The Indian tractor industry is witnessing a double-digit growth. The sale of tractors in India was 217,456 in 2002, 661,431 in 2013 and 8,78,476 units in 2019 (Mehta *et. al.* 2014; Mishra, 2019). The average tractor use in India is still lower by the world standard, and a huge disparity exists on its uses across states (regions) in the country.

To compare tractor population among different districts, tractor density was calculated. Tractor density was calculated by dividing the number of tractors by respective net sown area of the districts. The overall tractor density of Bihar in 2017 was 38 which is above the national average of 33 (Mehta *et. al.*, 2019). The tractor density increased by 33.8 per cent during 2014-17 in Bihar (Table 2). The main reason may the subsidy provided by Government of Bihar on tractor which catapulted the sale of tractors among farmers. The maximum tractor density was in Munger districts during 2014-17. It increased from 117 in 2014 to 157 tractors per 1000 ha NSA in 2017. It was followed by Purnea, Begusarai, Patna and Rohtas during 2014-17 (Table 5). Arwal recorded the lowest number of tractors per thousand ha NSA. Madhepura, Lakhisarai, Sheohar, Banka, Arwal districts had very less tractor density. The Government should focus on these districts to increase the farm mechanization level.

Dynamics of power tillers in Bihar

The market for power tillers in India was estimated at 49,000 numbers during 2016-17 (Anonymous, 2017). The market for power tillers in India is mainly concentrated in the eastern and southern parts of the country owing to the higher percentage of marginal and small farmers in these regions. It is useful for small farm land holdings as it is available at low price compared to tractor. However, it has many limitations viz. seldomly used for transportation purpose, speed of operation is slow, difficulty in attaching different farm implements.

Table 5: Top and bottom districts of Bihar in Tractor density (No. per 1000 ha NSA) (2014-17)

Top districts	2014	2017	Bottom districts	2014	2017
Munger	117	157	Madhepura	5	6
Purnea	86	116	Lakhisarai	5	6
Begusarai	82	109	Sheohar	5	6
Patna	81	109	Banka	1	1
Rohtas	81	108	Arwal	1	1

The enthusiasm of farmer towards purchasing power tiller is less as compared to tractors. It is evident from table 2 that there was only 3.4 per cent increase in power tiller population during 2014-17, while for tractor it was 34 percent during the same period. Patna had the maximum power tiller density among all the 34 districts of Bihar during 2014-17. It was followed by Nalanda, Buxar, Jehanabad and Aurangabad. Kishanganj, Banka, Katihar, Saharsa and Nawada had the lowest power tiller density. It was 1.35, 1.57, 1.80, 1.82 and 2.46 power tillers per 1000 ha NSA, respectively in 2017 (Table 6).

Table 6: Top and bottom districts of Bihar in power tiller density (No. per 1000 ha NSA) (2014-17)

Top districts	2014	2017	Bottom districts	2014	2017
Patna	80.98	83.70	Nawada	2.39	2.46
Nalanda	66.65	68.89	Saharsa	1.75	1.82
Buxar	36.43	37.65	Katihar	1.75	1.80
Jehanabad	21.32	22.05	Banka	1.52	1.57
Aurangabad	12.37	12.79	Kishanganj	1.31	1.35

Electric motors and diesel engine dynamics

Electric motors are used in irrigation, threshing, milling, hulling and other activities. In recent years, the availability of electricity and its uninterrupted supply in Bihar has led to the increase in sale of electric motors. Between 2014 and 2019, the average hours of supply in Bihar rose from 12 hours to 18 hours (Sudarshan, 2019).During 2014-17, the growth in number of electric motors in Bihar state was 10.16 percent. It grew from 47 to 48 electric motors per 1000 ha NSA during 2014-17. Nawada district with 395 electric motors per 1000 ha NSA topped the list. It is followed by Jehanabad, Gaya, Jamui and Nalanda. The bottom five districts were Saharsa, Madhubani, Kishanganj, Darbhanga and Sheohar.

Table 7: Top and bottom districts of Bihar in electric motor density (No. per 1000 ha NSA) (2014-17)

Top districts	2014	2017	Bottom districts	2014	2017
Nawada	387	395	Saharsa	6.46	6.60
Jehanabad	331	338	Madhubani	4.31	4.40
Gaya	222	226	Kishanganj	4.17	4.27
Jamui	209	213	Darbhanga	3.92	4.01
Nalanda	183	187	Sheohar	2.76	2.80

The numbers of diesel engines are more as compared to numbers of electric motors in Bihar. Before 2005, the electricity supply and its availability were in grim situation in Bihar (Siddiqui, 2017). Farmers used to rely on diesel engines. Low horsepower diesel engine was easily carried on shoulders to the specific location for irrigation purposes. However, due to increase in electricity supply hours the demand for diesel engine increaser merely by 0.52 percent during 2014-17. During the same period, the growth of electric motor was 10.16 per cent. The diesel engine density increased from 159.2 to 160 during 2014-17 (Table 2). The maximum diesel engine density (659) was of Jehanabad while lowest was of Madhubani district (62) in 2017 (Table 8).

Farm Power Availability in Bihar

The total farm power availability in India in 2000-01 was at 1.35 kW/ha while the same in 2016-17 was at 2.03 kW/ha. In Bihar, the power availability increased by whopping 250 percent i.e. from 0.8 kW/ha (2001) to 2.8 kW/ha (2017), owing to the initiative taken by state Government in the form of subsidies to various farm power machines, popularization of farm machines, mechanization fair in each districts of Bihar. In 2017, the top five districts with maximum farm power availability (kW/ha) were Patna (6.34), Jehanabad (5.73), Munger (5.42), Nalanda (4.89) and Gaya (4.62). Supaul district had the lowest farm power availability of 1.03 kW/ha in 2017 (Table 9). The spatial representation in change in farm power availability during 2014-17 is shown in Fig. 2. Out of 34 districts of Bihar, 20 districts have farm power availability more than the national average of 2.03 kW/ha

Table 8: Top and bottom districts of Bihar in diesel engine density (No. per 1000 ha NSA) (2014-17)

Top districts	2014	2017	Bottom districts	2014	2017
Jehanabad	655	659	Supaul	110	111
Nalanda	460	462	Araria	103	104
Gaya	455	457	Kishanganj	102	103
Patna	404	406	Sitamarhi	97	97
Jamui	299	301	Madhubani	62	62

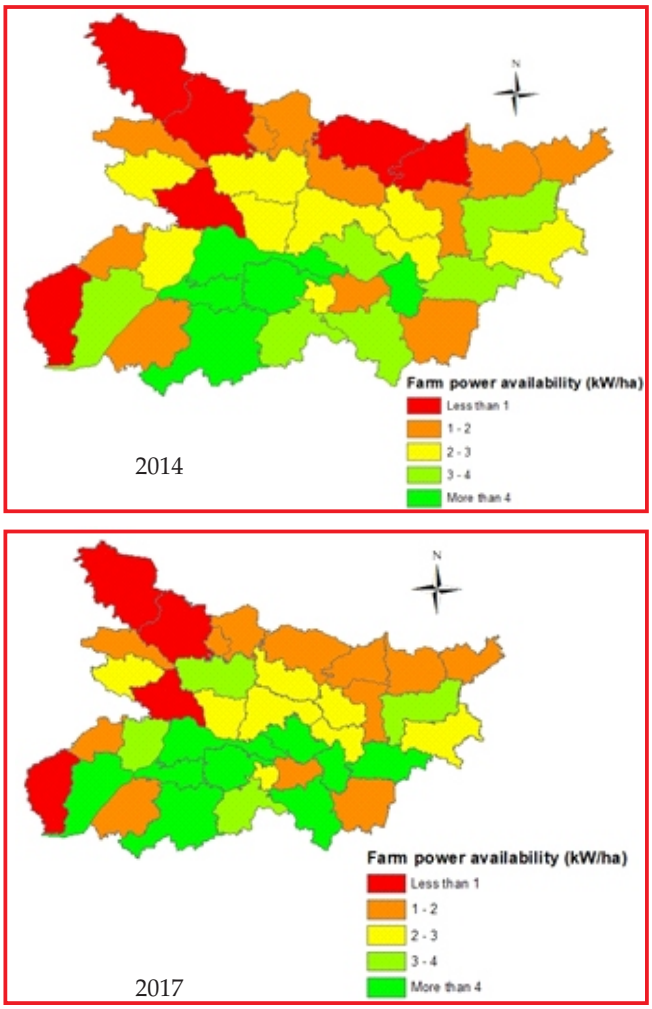

Fig. 2: Spatial representation of farm power availability dynamics in Bihar (2014-17)

Table 9: Top and bottom districts of Bihar in farm power availability (kW/ha) (2014-17)

	Top districts				Bottom districts			
	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)
Patna	5.58	Patna	6.34		Lakhisarai	1.13	Arwal	1.20
Jehanabad	5.54	Jehanabad	5.73		Sitamarhi	1.13	Lakhisarai	1.18
Nalanda	4.56	Munger	5.42		Kishanganj	1.09	Kishanganj	1.17
Munger	4.36	Nalanda	4.89		Madhubani	0.99	Madhubani	1.13
Gaya	4.33	Gaya	4.62		Supaul	0.98	Supaul	1.03

(Table 10). Now the Government of Bihar should focus of the remaining districts namely Darbhanga, Buxar, Gopalganj, Aurangabad, Madhepura, Araria, Sheohar, Banka, Sitamarhi, Arwal, Lakhisarai, Kishanganj, Madhubani and Supaul, and try to at least increase their farm power availability to national average.

There is accelerated fragmentated of land holdings in Bihar. This will lead to further increase in number of small and marginal farmers. Thus, for second green revolution to take place, small farm mechanization will be the key. There has been increase in tractor density in all the districts of Bihar. The growth in tractor sales was more as compared to power tiller. As the number of marginal farmers is increasing, the Government should focus on popularizing power tiller along with matching equipment. State Government initiatives in the form of subsidies to various farm power machines, popularization of farm machines, mechanization fair in each district of Bihar has resulted in increased mechanization in the eastern region. However, there is need to develop and popularize solar based technologies especially for community irrigation to reduce dependency on diesel fuel and ensure

Table 10: Dynamics of farm power sources in different districts of Bihar (2014-17)

Districts	Ag. Worker density		Draught Animal density		Tractor density		Power tiller density		Electric Motor density		Diesel Engine density		Farm Power availability (kW/ha)	
	2014	2017	2014	2017	2014	2017	2014	2017	2014	2017	2014	2017	2014	2017
Araria	1,615	1,680	311	299	19	25	7	8	8	8	103	104	1.34	1.51
Arwal	1,755	1,826	3	3	1	1	4	4	34	35	166	167	1.18	1.20
Aurangabad	1,380	1,436	22	21	15	19	12	13	87	88	143	143	1.65	1.79
Banka	1,821	1,895	496	476	1	1	2	2	21	21	159	160	1.28	1.29
Begusarai	2,674	2,782	24	23	82	109	4	5	27	28	186	187	3.44	4.17
Bhagalpur	2,550	2,653	78	75	76	102	5	5	55	56	176	177	3.35	4.04
Bhojpur	1,555	1,617	5	4	60	81	8	8	24	24	147	148	2.61	3.15
Buxar	1,306	1,359	7	7	18	24	36	38	43	44	151	152	1.75	1.92
Darbhanga	2,660	2,768	85	82	30	40	4	4	4	4	136	136	1.74	2.01
Gaya	2,738	2,849	137	131	29	38	5	5	222	226	455	457	4.33	4.62
Gopalganj	1,827	1,901	71	68	17	23	5	6	8	8	181	182	1.64	1.80
Jamui	4,438	4,618	903	868	32	43	9	9	209	213	299	301	3.91	4.22
Jehanabad	2,177	2,265	26	25	16	21	21	22	331	338	655	659	5.54	5.73
Katihar	1,770	1,841	139	133	10	14	2	2	7	8	287	289	2.06	2.16
Khagaria	1,910	1,988	19	18	38	50	5	5	8	8	170	171	2.10	2.44
Kishanganj	1,664	1,731	469	450	9	12	1	1	4	4	102	103	1.09	1.17
Lakhisarai	1,456	1,514	12	11	5	6	4	4	29	30	143	144	1.13	1.18
Madhubani	2,068	2,152	289	278	15	20	5	5	4	4	62	62	0.99	1.13
Medhepura	1,616	1,681	240	230	5	6	2	3	16	16	209	210	1.54	1.59
Munger	3,218	3,348	25	24	117	157	9	9	77	78	142	143	4.36	5.42
Muzaffarpur	2,306	2,399	54	52	69	92	5	5	7	7	168	169	2.93	3.55
Nalanda	1,996	2,077	25	24	32	42	67	69	183	187	460	462	4.56	4.89
Nawada	2,186	2,274	46	44	6	8	2	2	387	395	295	296	3.38	3.48
Patna	3,872	4,029	14	14	81	109	81	84	146	149	404	406	5.58	6.34
Purnea	1,912	1,989	179	172	86	116	4	4	9	10	114	115	3.12	3.89
Rohtas	1,254	1,304	6	6	81	108	5	5	146	149	155	156	3.61	4.34
Saharsa	1,775	1,847	185	178	47	63	2	2	6	7	126	126	2.13	2.56
Samastipur	2,600	2,705	28	27	28	38	7	7	17	17	214	215	2.18	2.44
Sheikhupura	1,653	1,720	48	46	10	13	9	9	98	100	277	278	2.32	2.42
Sheohar	2,777	2,890	173	166	5	6	4	4	3	3	179	180	1.36	1.41
Sitamarhi	2,611	2,716	103	99	13	18	7	7	10	10	97	97	1.13	1.25
Siwan	2,044	2,127	35	34	35	47	8	8	13	13	213	214	2.31	2.64
Supaul	1,600	1,665	170	163	6	8	6	7	7	7	110	111	0.98	1.03
Vaishali	2,930	3,049	11	11	21	29	8	8	19	19	271	273	2.34	2.55

*Data for 4 districts namely Bhabhua, East &West Champaran and Saran were not available

environmental sustainability. Fourteen districts are having farm power availability less than the national average. These districts should be provided with more budgetary allocation for farm mechanization subsidies. The small and fragmented land make use of farm machines less economical, hence, custom hiring models should be more facilitated in each district.

CONCLUSIONS

Bihar has achieved considerable progress in farm mechanization during last one and half decades. The farm power availability grew by whopping 250 per cent during 2001-17. This has been possible due to combined effort of central and state governments through various schemes. The use of various farm power resources has increased. The use of tractor, power tiller and electric engines grew by 33.8, 3.4 and 10.16 per cent respectively during 2014-17. The major challenge in Bihar is the increase in number of small and marginal farmers. They are increasing mainly due to breakdown of landholding to smaller, unviable and uneconomical tracts of lands due to inheritance laws. The farmer should be made aware of the farm power and implements suited for their farm. They should not be forced unnecessarily to purchase heavy machineries which is uneconomical to them. Government should encourage more number of custom hiring centre at block/district level to increase the availability of costly/heavy machinery

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