



Pilot study of farm power-machinery status and custom-hiring opportunities in rice (*Oryza sativa*)-wheat (*Triticum aestivum*) cropping system

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ABSTRACT

A study was conducted in 12 blocks selected from three districts, viz. Aligarh, Hathras and Etah of Aligarh Division in order to assess the farm power machinery demand-supply gap and hence the future scope for custom hiring of farm machinery. It was found that the threshold level of land ownership for purchasing tractor-implement system in all the 12 blocks was 2 ha. In all the 12 blocks, medium category farmers owned 54-73% tractors, followed by large category 27-39% and 4-10% by semi-medium category of farmers. Khair block of Aligarh District showed highest tractor annual use hours (549 h) for different purposes, followed by Atrauli block of Aligarh (509 h) and Nidhauri Kalan block of District Etah (502 h). Tractor owners used the tractors for their own use for 70.57-79% of total working hours. Agricultural use in own farms by tractor owners ranged between 72.86- 86.50% of the working hours spent on their own uses. Cropping intensity was found to be positively correlated with tractor density. Wheat sowing machine, wheat thresher, combine harvester and rotavator were found to have a great opportunity for use as custom hiring venture, being used more than 50% of their annual use solely for the purpose of custom hiring.

Key words: Annual use, Cropping intensity, Custom hiring, Threshold level, Tractor density

Modern agriculture with increased use of commercial input has necessitated enhanced use efficiency through timely and proper applications. For this, efficient and precision machinery are must. There are seven vital inputs to agriculture production system—seed, fertilizer, irrigation water, plant protection chemicals, agro machinery, transfer of knowledge and credit. Infact, mechanization alone enhances productivity of crop by 15% and reduces crop production By 20% (Shyam 2012). Transition from subsistence farming to commercial farming can only be achieved through the transfer of the latest, most efficient and cost effective technology to the farming system (Iqbal *et al.* 2015, Nayak *et al.* 2012). Power source is one of the important farm input in determining the level of mechanization and agricultural development in any country. Farm mechanization is key for productivity and agricultural productivity has positive correlation with level of farm mechanization.

Uttar Pradesh, principally an agrarian state went rapid strides in rice-wheat production and its contribution in ensuring food security to its increasing population is

commendable. The state produced 14.41 million tonnes of rice in an area of 5.86 million ha with a productivity of 2460 kg/ha. In the case of wheat, the figures correspond to 30.30 mt in 9.73 mha with a productivity of 3113 kg/ha (DOES, MOA 2012-13). Uttar Pradesh has a tractor density of 51 per thousand hectare of net sown area, much higher than the national average of 33 tractors. One out of every four tractor is being purchased here, indicating growing demand of mechanization and mechanized transportation of agricultural goods vis-à-vis other rural commodities (Mandal and Maitry 2013). However lesser productivity of wheat and rice and increased cost of production is still a great that needs to be addressed through mechanization to allow timeliness of operations and to address the problem of labour shortage and/or increased labour wages at peak period (Goyle 2013). With the movement of labour into more industrialized urban areas, there is an emerging need to replace that labour by farm mechanization. (Garrett *et al.* 2010) Mechanization of most of the agricultural operations through custom hiring of high capacity equipment is required so that marginal, small and medium categories of farmers can also take the advantage of mechanization.

Assessment of demand and supply of farm machinery helps in proper distribution of required machinery to the needs farmers so that they can perform timely field operations at relatively low cost. The present study was to create sufficient information on mechanization gaps and

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custom hiring practices in rice-wheat cropping system and future scope of custom hiring of farm machinery.

MATERIALS AND METHODS

The study was carried out in Aligarh Division of Uttar Pradesh which comes under the Upper Gangetic Plain, one of the 15 agro-climatic zones of India. In Uttar Pradesh, Aligarh division falls under western plain zone, one of the 10 agro climatic zones of the state. Aligarh division consists of four Districts namely Aligarh, Hathras, Etah and Kasganj. Cropping intensity of the zone is 146 %. Rice, wheat, pearl millet, maize, rapeseed and mustard are the major field crops of the zone. To assess the power machinery status under rice-wheat cropping system, four stratified random sampling frame work were used to select the respondents for the study. Three Districts-Aligarh, Hathras and Etah were selected. From each District 4 blocks were selected randomly and from each block 4 villages were selected at random (Table 1).

From each village respondents were selected for interview in such a way that some of the farmers opted custom hiring and some were custom hiring service providers. The size of each sample was determined using Eq. (1) derived from Neyman technique (Yamane 1967).

$$n = (\sum N_h \sigma_h) / (N^2 D^2 + N_h \sigma_h^2) \tag{1}$$

where n is the required sample size; N is the number of holdings in target population; N_h is the number of the

population in the h stratification; σ_h is the standard deviation in the h stratification, σ²_h is the variance of h stratification; D² = d²/ z²; d is the precision ($\bar{x} - \bar{X}$); z is the reliability coefficient (1.96 which represents the 95% reliability). A total of 480 respondents were selected for detailed survey on pre-tested schedule by personal interview. Secondary data for the present study was also obtained from project documents and line departments. Information was collected from farmers of the respective study area on different crops grown during main season, area under different crops, land holding size, source of irrigation, tractor utilization for custom hiring use and non custom hiring use, operation wise use of tractor, time period of particular operation, number of tractors and different machinery available, power rating of machinery ,operating time of machinery, farm power hired, farm power and machinery ownership, ownership period, available and hired worker, non-agriculture custom hiring services etc. All the necessary information gathered was analysed in MS-Excel software to find relationship among different variables and to fulfill the study objective.

RESULTS AND DISCUSSION

The study area comprising of 12 blocks of 3 districts - Aligarh, Hathras and Etah of Aligarh Division were found to have almost same net sown area and irrigated area from 2011-14, indicating that in respect of these factors the region was almost stabilized and no major changes took place .The cropping intensity was found to vary from 187% for Shitalpur block of Etah District to 138% for Sadabad block of Hathras District (Fig 1).

Table 1 Different blocks selected from districts Aligarh,Hathras and Etah

District	Blocks
Aligarh	1. Iglas 2. Gonda 3. Khair 4. Atrauli
Hathras	1. Sasni 2. Hathras 3. Sadabad 4. Sikandar Rao
Etah	1. Aliganj 2. Nidhauri Kalan 3. Shitalpur 4. Sakit

Tractor ownership vs. land holding

The information-base on ownership of tractor machinery system for own use and also on cutom hiring was developed from the data obtained from farmers owning tractor implement system. Land owner ship pattern for the

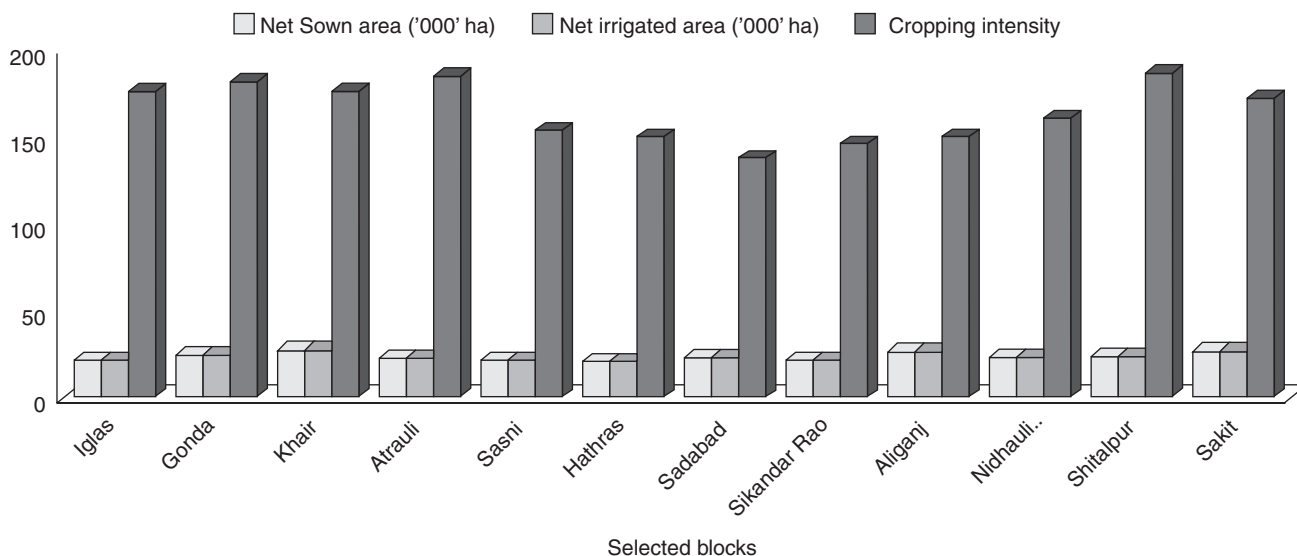


Fig 1 Cropping parameters of selected blocks of Aligarh division

selected farmers of 12 blocks of districts-Aligarh, Hathras and Etah is presented in Table 2. It could be seen that the threshold level of land ownership for purchasing tractor-implement system in all the 12 blocks was two hectares. In other words, the owning of tractor implement system by marginal and small farmers is not profitable until and unless intensive efforts on custom hiring is done. The information also confirmed that highest level of tractor owning farmers lie in medium category of farmers. In all twelve blocks, medium category farmers owned 54-73% tractors, followed by large category 27-39% and 4-10% by semi-medium category of farmers.

Horse-power wise-availability and tractor ownership is depicted in Table 3. The 31-40 hp category is still preferred (33.71%), but next higher category of 41-50 hp is also being owned (28.02%) indicating that power range is increasing in the region.

Table 2 Tractors ownership pattern

District	Block	Land holding (ha)				
		Marginal <1	Small 1-2	Semi- medium 2-4	Medium 4-10	Large >10
		Percentage tractor owners				
Aligarh	Iglas	0	0	8	65	27
	Gonda	0	0	7	72	21
	Khair	0	0	10	61	29
	Atrauli	0	0	9	63	28
Hathras	Sasni	0	0	7	73	20
	Hathras	0	0	4	62	34
	Sadabad	0	0	6	57	37
	Sikandar Rao	0	0	5	61	34
Etah	Aliganj	0	0	7	54	39
	Nidhauili Kalan	0	0	7	70	23
	Shitalpur	0	0	4	66	30
	Sakit	0	0	5	66	29

Table 3 Area and average tractor power availability

District	Blocks	Area (ha)			
		1-5	5-10	10-15	15-20
		Average tractor power			
Aligarh	Iglas	27.6	31.6	36.48	34.52
	Gonda	32.3	35.66	42.39	39.6
	Khair	33.84	35.70	40.55	37.62
	Atrauli	32.92	34.18	40.28	40.49
Hathras	Sasni	26.73	32.23	37.50	35.42
	Hathras	28.96	30.12	35.90	35.12
	Sadabad	30.4	33.28	39.63	37.59
	Sikandar Rao	32.88	34.4	41.6	40.52
Etah	Aliganj	31.20	34.28	39.60	36.83
	Nidhauili Kalan	29.6	33.12	35.20	35.82
	Shitalpur	31.4	34.87	39.9	38.86
	Sakit	28.86	30.42	33.97	35.02

Agriculture and non-agriculture use of tractors

Use pattern of tractors for custom hiring in agricultural and non-agricultural jobs in different blocks of Aligarh, Hathras and Etah Districts is presented in Table 4.

Khair block of Aligarh District showed highest tractor annual use hours (549 h) for different purposes, followed by Atrauli block of Aligarh (509 h) and Nidhauili kalan block of District Etah (502 h). Lowest annual tractor use hours of 384 h and 385 h were respectively observed for district Hathras blocks Hathras and Sadabad respectively. Tractor owners used the tractors for their own use for 70.57-79% of total working hours. Agricultural use in own farms by tractor owners ranged between 72.86- 86.50 % of the working hours spent on their own uses. Tractor owners in Iglas block had highest percentage of agricultural use as compared to other blocks. The average annual use hours of tractor were found highest in District Aligarh (489), followed by Etah (479.25) and Hathras (423.25) districts. Utilization of the machines increases the application efficiency of scarce resources as water. Adoption of higher level of machinery depends on an availability of irrigation, as had been also witnessed in the area under study.

Machinery availability and scope for custom hiring

The average number of units of different machinery available was calculated for the surveyed villages, which was scaled up with a multiplication factor of number of villages in block to get the availability information for the block. Average number of units per block was scaled up same way with number of blocks to get information for whole District and finally for whole Aligarh Division. All the results are presented in Table 5. It was observed that the mechanization of sowing and threshing of wheat has started taken pace in the recent years and owners of such machinery find a great scope of use for custom hiring purpose. Laser leveled based field leveling for increased water use efficiency was also found to be a new dimension of farm mechanization taking place in the area. However due to high initial cost of such machines, the population of such machinery was found very less in the area and was mostly used by farmers on custom hiring basis. No combine harvester was found to be owned by anyone in the area; although medium and large land holding farmers were using it through custom service providers of Punjab or Krishi smriti of Tata Chemicals. Less availability of such machinery was also found to have great effect on custom hiring rate due to monopolistic nature of owners and competition in their use by farmers. The demand needs to be fulfilled through custom hiring centres created by private, government or farmer co-operatives.

Custom hiring use of agricultural machinery

Use of cultivator and harrow(C&H), rotavator (RO), wheat sowing machine (WSM), wheat thresher (WT), laser leveler (LL) and combine harvester (CH) for own and custom hiring use by farmers in different blocks of district Aligarh (Fig 2), Hathras and Etah.

Table 4 Use pattern of tractors for agriculture, non-agriculture, own and custom hiring use

District	Block	Owned				Custom hired				Total use h
		Agri.	%age	Non.agri	%age	Agri.	%age	Non.agri	%age	
Aligarh	Iglas	282	86.50	44	13.50	74	72.55	28	27.45	428
	Gonda	274	81.31	63	18.69	96	72.18	37	27.82	470
	Khair	364	86.05	59	13.95	104	82.54	22	17.46	549
	Atrauli	334	85.64	56	14.36	88	73.95	31	26.05	509
	Average	313.50	84.88	55.50	15.13	90.5	75.31	29.50	24.70	489
Hathras	Sasni	208	76.75	63	23.25	71	62.83	42	37.17	384
	Hathras	244	78.71	66	21.29	85	66.41	43	33.59	438
	Sadabad	204	72.86	76	27.14	83	72.17	32	27.83	395
	Sikandar Rao	287	84.66	52	15.34	99	72.26	38	27.74	476
	Average	235.75	78.25	64.25	21.76	84.50	68.42	38.75	31.58	423.25
Etah	Aliganj	274	79.42	71	20.58	98	77.78	28	22.22	471
	Nidhauri Kalan	308	81.91	68	18.09	93	73.81	33	26.19	502
	Shitalpur	322	85.64	54	14.36	69	70.41	29	29.59	474
	Sakit	296	81.77	66	18.23	73	67.59	35	32.41	470
	Average	300.00	82.19	64.75	17.82	83.25	72.40	31.25	27.60	479.25
Division average		283.08	81.77	61.50	18.24	86.08	72.04	33.17	27.96	463.83

Table 5 Availability of different machinery for rice-wheat crop production

District	Block	Tractor	Harrow	Cultivator	Rotavator	Wheat sowing machine	Wheat thresher	Laser leveler
Aligarh	Iglas	1648	1648	1648	515	1339	927	2
	Khair	2014	1824	1824	480	672	576	4
	Gonda	2003	1909	1909	664	913	581	4
	Atrauli	1885	1582	1582	226	226	452	3
Hathras	Hathras	1304	1188	1296	432	432	648	2
	Sasni	1430	1380	1380	460	345	460	1
	Saddabad	923	923	923	142	213	355	2
	Sikander Rao	876	737	737	134	201	335	4
Etah	Aliganj	1580	1540	1540	420	560	980	3
	Nidhauri kalan	1453	1212	1212	202	303	303	1
	Shitalpur	2006	1920	1920	256	640	1024	4
	Sakit	1623	1575	1575	350	875	700	3

It was observed that WSM, WT, LL and CH have a great opportunity in the area for being use on custom hiring basis. The less availability of these machinery in the area and increased level of machinery use by farmers in their fields is going to further increase the market opportunity of such machinery in the future. Combine harvester was found to be used by 100% people on custom hiring basis. None of the farmer was found to own a combine and all the combine harvesters were being found to be operated in the area by private partners. On an average, rotavator was found to be used for 34.92 to 62.16% of its annual use for custom hiring purpose. Same way, the custom hiring use hours for wheat sowing machine, wheat thresher and laser leveler in different blocks of study area were found respectively varying from 53.70-72.09%, 51.85-66.67% and 63.41-87.50% of their total annual use hours.

Also the owners of such machinery have also a good

scope of increasing the custom hiring use hours of such machinery on custom hiring basis as lot of farming area is still labour dependent based and is on the verge of converting to machine based (mechanized) farming similar trend has been observed in Punjab by Sukhpal *et al.* (2013).

Agricultural mechanization and cropping intensity

The increase in farm power and machinery availability has a great scope for increasing the cropping intensity through timeliness of operations and through efficient use of other resources like water. The cropping intensity (ratio of total area sown under all crops to the net land area) as calculated from the secondary source data was found to vary greatly with tractor density. The highest cropping intensity was found for Shitalpur block of Etah District having tractor density of 84. The lowest cropping intensity of 139% was observed for block Saddabad of Hathras

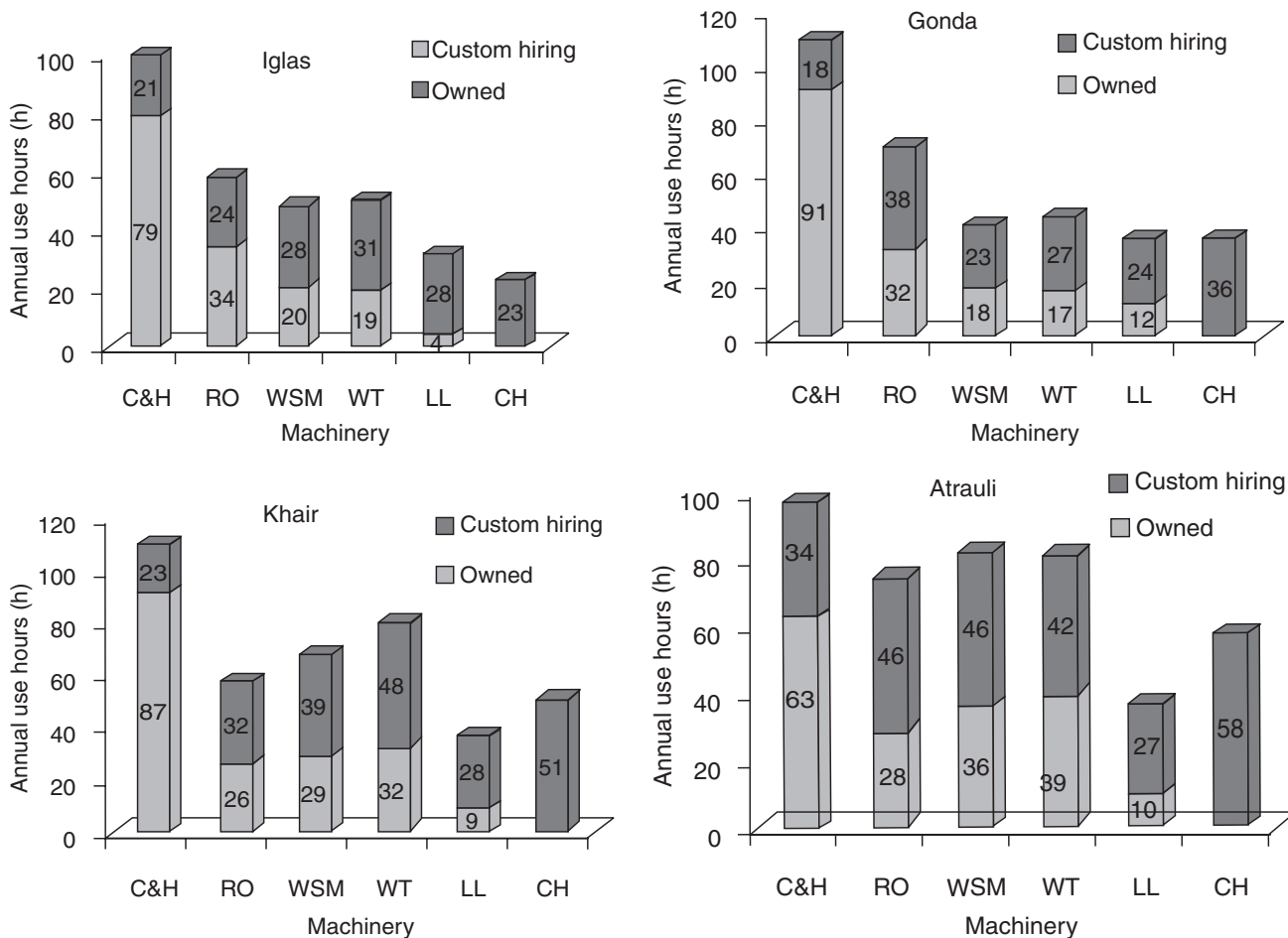


Fig 2 Annual use hours of machines in Aligarh district

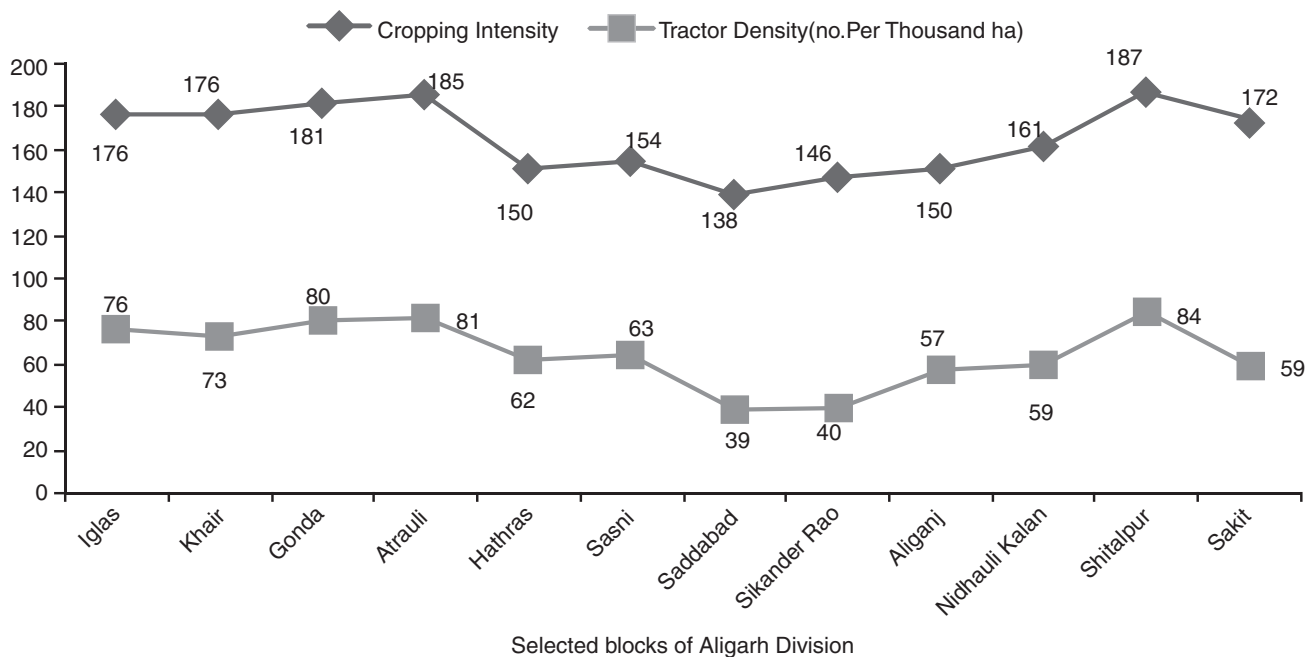


Fig 3 Cropping intensity and tractor density in Aligarh division

District with a tractor density of 39 (Fig 3).

From annual use hours of tractor and machinery, it can be concluded that tractor as well as other farm

machinery are still underutilized and there is great scope to increase the annual use hours. Mechanization policies need to be aimed at small and marginal farmers as these form the

major proportion and are further to expand with land fragmentation. Land leveling, sowing and threshing operations of rice-wheat cropping system are in great demand of farm machinery and the demand needs to be fulfilled through custom hiring of these operations. There is a need to facilitate the mechanization of agriculture for increased crop production by making availability of high cost machines through Government centers, KVKs and/or through private-public partnership .

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