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Contribution of agricultural development and irrigation in Hathras district of U.P (India)

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Abstract
Water supply is the first and foremost requirement for the successful cultivation of HYV seeds. The climate of India is characterized by hot summer and dry winter except rainfall in monsoon season. But irregularity and uncertainty are the major problems of monsoon rainfall in India. This is the reason behind the development of irrigation system which bringing out vital change in agriculture and make availability of food for such a growing population. Irrigation is the artificial means of regular and controlled supplying of water in agriculture through tube wells, canals, wells, tanks, ponds etc. It is the basic ingredients to increase agricultural productivity. The main objective of the present paper is to analyze the expansion of irrigation and levels of agricultural development in terms of cropping pattern, production and cropping intensity in Hathras district and to establish the relationship between the expansion of irrigation and productivity during 2002-2018.

Keywords: agricultural development, productivity, irrigation, hathras

Introduction
The contribution of agriculture to our national economy has declined from 43% in 1970 to 17.01 % during 2017-18, It has the largest generator of employment opportunities of more than 50% people in India. Rapidly grew population has amplified demand of food. India was 46.2% hunger population in 1992 which has reduced to 31.4% in 2018 and secured 100th rank (out of 119 countries) in the Global Hunger Index. In India, agriculture is not only the sources of employment but also enact to feed the global population by exporting more than 7% world's food grains. It was the Green Revolution in agriculture which helps to increase production by using high yielding varieties of seeds and made availability of food grains in India.

The impact of irrigation on cropping intensity stated that land productivity and cropping intensity were greatly influenced by irrigation [1]. These were revealed that modernization of agriculture is significantly low in those areas where rainfall and irrigation facility insufficient [2]. It has made a comprehensive study of the factors affecting Indian agriculture including irrigation, cropping pattern and other aspects of agriculture in India [3]. Irrigation is providing the lifeline of agricultural activities which boosts the productivity. Some have studied on some aspects of growth of Indian agriculture and suggested that irrigation is a crucial variable in the growth process considering its positive impact on crop yield and cropping intensity [4]. Irrigation has long played a key role in feeding the expanding world population and is expected to play a still greater role in the agriculture future [5]. It made an observation that the problem of low agricultural productivity can be tackled by improving irrigational facilities [6]. Differences in the provisions of irrigation facilities account for a substantial amount of variation in agricultural output between regions. It was reported that due to favorable irrigation facility, Uttar Pradesh continued to shift the cropping pattern towards rice and thus attain the top position in diversification [7]. The impact of changing land uses on cropping intensity reveals that gross cropped area were increased due to irrigation, application of fertilizers and high mechanization facilities [8]. They were also suggested that there should be need of crop intensification in the Hathras district of Uttar Pradesh.

Materials and Methods
Hathras district is situated between 77°50'E and 78°40'E longitude, and between 27°20'N and 27°50'N longitude. Hathras is a newly created district in 1997 of Uttar Pradesh state curved out from Aligarh, Agra, Mathura and Etah. It has 1840 Sq.Km. about 0.72 % of total area of the s U.P. State. The district has approximately 90 % of its total land devoted to agriculture. About 21.3% of people live in urban area which signifies that 78.7 % of rural people dependent on agriculture as means of livelihood. But the climatic character of hot summer and dry winter with unpredictable rainfall in monsoon season creates major hurdle to farmers. Hathras district of western Uttar Pradesh has come under the influence of green revolution since 1960s. Fertile alluvial soil, 100 %assured irrigation, fertilizers, high application of mechanical tools, high rural literacy etc. make this district agriculturally well developed.

The present study is based on secondary sources of data, collected from District Statistical Bulletin of Hathras district (2002-03 & 2017-18), Census of India (2002 &2011). and various published and unpublished articles, books, journals etc. The Crop has been used to manage the farm and improving farm productivity [9]. The indices of crop productivity have been calculated on the basis of this method for the year 2012-13. The expansion rate of irrigation and agriculture productivity has been determined by employing Z score statistical techniques which is expressed as follow:

$$Z = \frac{X - \bar{X}}{\sigma}$$

Where:
X = Original value of the observation
$\bar{X}$ = Mean for all the value of X
$\sigma =$ Standard Deviation of X
After Standardized the variables, all the score have been added together for each block and divided with the total number of variables which give the composite score of that block. The Composite Standard Score of Composite Z Score is expressed as follow:

$$C.S. = \frac{Zij}{N}$$

Where;
C.S. = Composite Score
Zij = Z Score of all variables i in block j
N= Number of variables

Results and Discussion
The study is carried out to examine how much irrigated cropped area under various sources of irrigation has been changed in Hathras district. In order to bring out the compound growth rates of different sources of irrigation were calculated for the period 2002-03 to 2017-18. The amount of total irrigated area has been increased by 3.39 % during 2002-2008 in the district of Hathras district. There was a paradigm shift of area under canal and public tube well irrigation towards private tube well irrigation as shown in table -1. It clearly indicates that there was huge negative growth of area under canal irrigation (-34.63 %) and public tube well (-94.44 %) in the Hathras district. This may be attributed due to paid assured irrigation facility which is the most vital factor of production. Among all the blocks, Sikandra Rao block is the only instance where canal irrigation has been increased by 16.42 %.
The expansion of irrigated area under pump sets shown in Table -2 that there were massive positive changes of 17.98 % in the district during 2002-17. It has been more pronounced in diesel run pump sets by 19.68 % rather than electricity run 15.12 %. In general, every blocks of the district has reported the positive growth in both type of pumpsets.

Table 1: Block wise expansion of irrigated area by different sources, 2002-2018 in Hathras district.

Blocks	Canal			Public Tubewell			Private Tubewell			Total Irrigated Area (hectares)		
	2002-03	2017-18	Change%	2002-03	2017-18	Change%	2002-03	2017-18	Change%	2002-03	2017-18	Change%
Sansi	678	90	86.73	663	20	96.98	20756	22322	7.54	22096	22432	1.52
Hathras	1945	240	87.66	0	23	0.00	19127	20820	8.85	21072	21083	0.05
Mursan	812	74	90.89	156	0	100.00	18731	18691	5.13	19699	19765	0.34
Sadabad	358	0	100.00	0	0	0.00	23274	24553	5.50	23632	2455.3	3.90
Sahapao	915	239	73.88	50	0	100.00	13756	14876	8.14	14721	15115	2.68
Sikandra Rao	4688	5458	16.42	772	21	97.28	14975	19564	10.61	20435	22043	7.87
Hasayan	7667	5053	34.09	645	63	90.23	14425	19176	32.94	22737	24292	6.84
Total	17063	11154	34.63	2286	127	94.44	125043	138002	10.36	144392	149283	3.39

The maximum positive growth of electricity run pumpsets is observed in Sasni block (52.21%) while the minimum positive changes is found in Sadabad block (7.48%). On the other hand, the highest positive growth rate of pumpsets run by diesel has recorded in Hasayan (32.82%) while the lowest growth is traced is Sadabad block (10.31%).
The highest total number of pump sets growth is revealed is Hasayan block, while the lowest is observed is Sadabad block during 2002-2008.

Table 2: Block wise expansion of Pump sets, 2002-2018.

Blocks	Electrical run			Diesel run			others			Total		
	2002-03	2017-18	Change%	2002-03	2017-18	Change%	2002-03	2017-18	Change%	2002-03	2017-18	Change%
Sansi	339	516	52.21	2036	2528	24.17	95	95	0	2470	3139	27.09
Hathras	867	993	14.53	3148	3543	12.55	60	60	0	4075	4596	12.79
Mursan	1085	1367	25.99	2915	3752	28.71	85	85	0	4085	5204	27.39
Sadabad	1458	1567	7.48	3561	3928	10.31	78	78	0	5097	5573	9.34
Sahapao	1870	2068							0	5437		13.92
Sikandra Rao	2510	2772	10.44	4315	5154	19.44	97	97	0	6922		15.91
Hasayan	1210	1468	21.32	2581	3428	32.82	93	93	0	3884		28.45
Total	9339	10751	15.12	22036	26372	19.68	595	595	0	31970		17.98

Hathras district has reported gradual increase of cultivated land, where net shown area and gross cropped area increased 2.52% and 3.51% respectively in the district during 2002-18 and result are shown in Table -3. A significant increase in gross irrigated area of the district is revealed during the period of 2002-03 to 2017-18 i.e. 15.55% There is also a substantial increase in net irrigated area by 3.28% The spatial analysis reveals that the growth rate in net irrigated area at block level is varied and the highest percentage is found in Sikandra Roa block (7.29%), while the lowest one is Hathras (0.05%). It is more pronounced in gross irrigated area where highest percentage observed in Sikandra Rao (22.75%) and lowest in Sadabad (0.33%).

Levels of agricultural development
This part is arranged to discourse what amount of changes occurred in cropping pattern and production of district level,

cropping intensity and productivity in block level, Finally, the vis-à-vis map has been prepared to establish the relationship between irrigation expansion and productivity for the period 2002-2018.

Table 3: Expantion in net shown area, net irrigated area, gross cropped area and gross irrigated area. (2002-2018).

Block	Net sown area			Net Irrigated Area			gross croppen area			gross irrigated area (hectare)		
	2002-03	2017-18	Change%	2002-03	2017-18	Change%	2002-03	2017-18	Change%	2002-03	2017-18	Change%
Sansi	22323	22299	-0.11	22096	22432	1.50	34320	37880	10.37	27274	31784	16.54
Hathras	21245	21005	-1.13	21072	21083	0.05	32586	34546	6.01	25962	29895	15.15
Mursan	19949	19701	-1.24	19699	19765	0.33	33823	33639	-.054	22824	27512	20.54
Sadabad	24606	24494	-0.46	23632	24553	3.75	41064	32840	20.03	27402	27493	0.33
Sahapao	14851	15055	1.37	14722	15115	2.60	24257	23426	-3.43	16518	17620	6.67
Sikandra Rao	20195	21995	8.91	20435	22043	7.29	34327	39122	13.97	31784	38561	21.32
Hasayan	22467	24754	10.18	22737	24292	6.40	38589	45889	18.92	34772	42682	22.75
Total	145636	149303	2.52	144393	149283	3.28	238966	247342	3.51	186536	215547	15.55

Cropping pattern and production

Hathras district has witnessed both changes positive as well as negative growth. The most remarkable finding of this section is that higher the growth of cropping pattern, lowering the levels of production. The area under rice has been increased(168.89%), but it has reduced production by 10.53% during 2002-18. Similerly, area under till and potato have been registered 118.33% and 291.08% growth, where Production level reduces to 19.83% and 21.98% respectively as shown in Table- 4. It is observed that only three crops potato, rice and till (out of 19 crops) were recorded positive growth and rests are in the reverse gear of growth.

On the other hand, production of food grains like millet, maize, jwar, urad and moong, and oil seeds like sarson and sunflower, and sugarcane and cotton were recorded positive growth. Remaining ten crops have been shows negative growth of production.

Table 4: Expansion in area and production of major crops in Hathras district (2002-2018).

Major Crops	Area (hectare)		Change%	Production (quintal/hectare)		Change%
	2002-03	2017-18		2002-03	2017-18	
Rice	9989	26859	168.89	21.47	19.21	-10.53
Wheat	99205	81770	-17.57	34.49	23.34	-34.33
Barley	9968	1757	-82.37	27.52	25.04	-9.01
Millet	47279	42894	-9.27	17.72	21.91	23.65
Maize	8628	3029	-64.89	19.9	20.57	3.37
Jwar	27	3	-88.89	8.19	8.85	8.06
Total Crops	175096	156312	-10.73	28.1	31.48	12.02
Urad	170	122	-28.24	4.18	6.39	52.87
Moong	3310	1622	-51	3.72	5.55	49.19
Masur	704	308	-56.25	8.12	6.33	-22.04
Gram	546	3	-99.45	11.15	3.01	-73
Pea	932	52	-94.42	19.07	12.96	-32.04
Arhar	6983	3756	-46.21	8.7	11.83	35.98
Total Pulses	12645	5863	-53.63	8.19	17.67	115.67
Total Food Grains	187741	162175	-13.62	26.76	30.98	15.76
Sarson	10935	6316	-42.24	10.51	13.47	28.16
Till	60	131	118.33	2.32	1.86	-19.83
Sunflower	11049	6448	-41.64	10.45	17.91	71.36
Potato	12544	49057	291.08	295.51	233.03	-21.14
Cotton	1519	806	-46.94	1.36	2.84	108.82
Fodder	14571	10977	-24.67	-	-	-
Total Cropped Area	227892	229666	0.78	-	-	-

Cropping intensity

Cropping intensity implies the high proportion of net sown area is being cropped more than once during one agricultural year and applied more and more modern technologies, irrigation and chemical fertilizers and enhanced land productivity. Cropping Intensity of the Hathras district was 164.08% in 2002-03 which is increased to 165.66%. But there are uneven enhancement of cropping intensity depend upon net sown area and area sown more than once at block level. It has been observed that the growth of cropping intensity is highest in Sasni block (10.49%) followed by Sikandra Rao (7.93%), Hathras (7.23%), Hasayan (4.64%) and Mursan (0.71%) during 2017-18. On the other hand, highest decline of cropping intensity is found in Sadabad block (19.66%) followed by Sahapao (4.74%). This may be attributed due to increase and decrease of gross cropped area in the respective block which is largely influenced by irrigation followed by chemical fertilizers and modern inputs.

Productivity

The composite index of agricultural productivity comprise cereals (rice, wheat, maize, barley and millet), pulses (masur, gram, pea, arhar, uard, moong) oil seeds (sarson and till) and other crops (potato, sugarcane and cotton) for the year 2002-03 & 2014-18 indicates that there were large

variations of productivity in each group of crops in Hathras district. It is found that the Sahapau block has maintained its pick position by increase of 11.03 %, while Sasni block dropped to medium category by declining 3.50 % of agricultural productivity during 2002-18. Hathras and Sikandra Rao block have gained their productivity and attained medium position. and other three blocks i.e. Hasayan, Mursan and Sadabad have continuing their previous position.

Irrigation vis-à-vis productivity

The expansion rate of irrigation has been accounted by considering net irrigated area (NIA)and total number of pump sets of each block in the Hathras district. Indices of productivity have been calculated by considering of cereal, pulses, oil seeds and others crops through the application of Z score technique. In order to bring out the expansion rate of irrigation and productivity, the index value of composite Z score were considered during 2002-18. The study of inter-block variation between irrigation vis-à-vis productivity regions of Hathras has been illustrated. The X axis of the map represents irrigation and Y axis for productivity. The study reveals that there were four blocks Sasni, Mursan, Sahapao and Hasayan which have been the positive relationship between irrigation with productivity where high application of irrigation leads to high productivity and vice-versa. On the other hand, medium irrigation escorts to high productivity in two blocks, Hathras and Sadabad. This may attributed due to other productivity factors like chemical fertilizers, mechanization and infrastructure facilities. The only block Sikandra Rao has dropped its productivity as the relation is found medium irrigation and low productivity.

Conclusion

The present investigation has viewed that expansion in irrigation sector holds greater prospects for large scale production and productivity in the district of Hathras. This study focuses especially on number of pumpsets run by electricity and diesel. This is due to the fact that pumpsets are capable to provide assured amount of water to the crop at a particular time. The finding of the paper indicate that there were high strong positive relationship between irrigation and productivity in the study region. This means that irrigation is the one and only predetermined factor which boost up agricultural productivity. The approach to provide assures irrigation rather dependent only rainfall helps to achieve the sustainable development goals 1 and 2, which intend to end poverty and ensure zero hunger respectively. Although, there is a need to transform the uncultivated to cultivated land which enables to increase agricultural production. Cropping pattern must be shifted from low value to high value crops. There were decline of area under those crops which have shown significant increase in production. The high value crops like urad, moong, sunflower and cotton which have shown considerable increase in production but the area under these crops was reduced. Thus, attention should be given to increase the area under such high value crops in the Hathras district of Uttar pradesh.

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