SUMMARY AND CONCLUSION
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The present study attempts to analyse the physical and cultural factors which influence the agricultural growth over space and time; the trend and growth in means of irrigation and irrigation orientation; irrigation intensity; the land use pattern; crop irrigated area; crop diversification; cropping intensity; level of agricultural mechanization; use of chemical fertilizers and HYV seeds; the agricultural productivity and to suggest the measures for overcoming the irrigation problems and better management of irrigation system.

The study region covering an area of 6358 km$^2$ (23°51'22" N to 24°53'16" N latitude and 82°31'55"E to 83°33'45" longitude) has been divided into two distinct physiographic units: (I) The southern Son valley (ii) The Son par uplands. The Southern Son valley incorporating the northern part of Sonbhadra district is exclusively plateau area. The Son par upland consists of the Southern portion of the study area. Geographically this area belongs to the most stable ancient landmass and has been subjected to extensive erosion since its formation. The substantial variation in soil types and natural vegetation has been observed in Sonbhadra district.

The urban areas of the district are endowed with top water supply but rural people depend on wells, hand pumps, ponds and
rivers for fulfilling their water need. About 57.0% villages of the study region are electrified exhibiting considerable variation at development block level. In 2001-02 there were 1095 primary schools, 163 senior basic schools, 55 higher secondary schools and 4 degree colleges in the district but there is still the need of more schools and teachers.

As far as the means of transport and communications are concerned, the valley area has better network than the southern upland.

In the study area the period 1951-61 has been a period of moderate population growth. While the 1971-2001 may be regarded as the period of tremendous population growth because the population during 1971-81 (37.95%), 1981-91 (37.37%) and 1991-2001 (37.19%) had increased by around 35 percent per decade. It is remarkable to mention that the study area possesses only 18 percent of the total population (1463468) of the district as urban, leaving majority (81.18%) as rural. The areas/ blocks falling in the Southern Son valley area are densely populated. As per 2001 census, the average density of population of Sonbhadra district has been computed as 214 persons /km², which is lower than the national average of 274 person/km² and the state average (689 persons /km²). The density happens to be more than 300 persons per km² in Robertsganj (438) and Chatara (339) development blocks. Remaining five other blocks recorded lower
density due to poor resources as well as inhospitable terrain. The sex ratio in the study area shows unhealthy condition as it fell down drastically from 967/1000 males in 1951 to 896/1000 males in 2001.

In the study area, major sources of irrigation are canals, tube-wells, wells, tanks and others. The total length of canals and their distributaries comes to 260 km in 2001. The canal mostly distributed in southern Son valley blocks contributes 96.11% of the net irrigated area of Sonbhadra district. Tube-wells are the latest and important means of irrigation. At present Sonbhadra district possesses 8793 tube-wells. They share 0.30 percent of the net irrigated area. Although accepting Ghorawal block all other blocks are endowed with tube-well facility yet their maximum concentration is found in the northwestern plateau blocks. Irrigation by wells is still prevalent in some areas and is the third important means of irrigation. Due to low cost of construction wells are suitably preferred by the poor and marginal farmers. The study area contains 1232 wells, which provide irrigation to 2.46 percent cultivated area.

Since the size of development blocks is not uniform, hence, the density analysis of irrigation sources seems to be of utmost importance. The low density of canal (below 5 km/1000ha) in 2001 has been found in all the study area. This area is endowed with high density of wells. Five development blocks of the study
area have canal irrigation orientation (C4). Dudhi block possesses pre-dominant canal orientation (C3, W1) where accompanying role of well irrigation is available to cope with the irrigational requirement of the Rabi crops. Two blocks namely Meyorpur and Babhani (C2 W1 and C1W3) reveal canal irrigation orientation where accompanying role is of well irrigation. This block has semi dominant well irrigation orientation along with the canal irrigation.

The intensity of irrigation from all sources varies substantially in different parts of the Sonbhadra district. The physiographic, social and economic conditions are responsible for existing regional imbalances in the intensity of irrigation. Medium intensity of irrigation (above 50%) in 2001 has been found in three north western blocks namely in Ghorawal, Robertsganj and Chatara where along with good irrigation networks, farmers are socio-economically well off. Five blocks form the very low irrigation intensity category (below 25%). The intensity of irrigation for Kharif and Rabi seasons has also been computed. Also the growth in irrigation intensity has been worked out in percentage terms, which exhibits a continuous increase. This indicates man's effort to overcome the physical constraints of the agricultural sector in terms of irrigation. The highest growth was recorded during 1971-81 while moderate and slow growth was observed during 1981-91 and 1991-2001.
period. As such the study of growth in intensity of irrigation at block level reveals substantial variation during each decade.

At present (2001) different land use categories account for 38.36 percent forests, 01.85 percent land not available for cultivation, 4.49 percent cultivable waste land, 6.70 percent culturable wasteland, 20.32 percent net cultivated area and 28.28 percent total cropped area. The expansion in irrigation facilities has led to substantial increase in net and gross cropped area. The total cropped area in 2001 varies between 16.77 percent in Nagawa block and 99.84 percent in Robertsganj block. This variation can be correlated with magnitude of irrigation facilities available in these blocks. Rice and wheat are the two important cereal crops of the study area sharing about 90 percent of the total cropped area of the district. About 56.25 percent and 34.55 percent of rice and wheat cropped area is irrigated. One block Dudhi got the lowest degree crop diversification of dynamism as occupied by only rice crop. Remaining blocks are characterised with 2 crops diversification by rice, wheat rice, Barley and rice and sawan. In this sequel it is important to mention that in the study area the irrigation has played more significant role in concentration of crops than diversification of crops.

In 2001 no block forms very high intensity category (above 180%). Two blocks namely Dudhi and Babhani still fall in very low category (below 120%) of cropping intensity. The causative
factor for slight downfall in cropping intensity in 2001 in general as well as in some blocks in particular is due to the considerable reduction in the total cropped area on account of increase in forests and culturable wastes. In Sonbhadra district the cropping intensity ranges from 112.19 percent in Babhani to 160.32 percent in Nagawa block in 2001. In order to show the impact of irrigation on cropping intensity, the coefficient of correlation between these variables has been calculated. This coefficient value amounts to 0.60, which indicates moderate degree of positive relationship.

In general, about half energy in Indian agricultural activity is supplied by draught animals. But in Sonbhadra district only 43.52 percent form draught animals supplied power in 1971, which dramatically declined from 43.52 percent in 1971 to 14.66 percent in 2001. The importance of manpower has not lessened. It accounts for 26.31 percent of the total horsepower used in 2001, which is slightly higher than 1971 figure. On the contrary, the use of machines has increased rapidly in Sonbhadra district. The variation in farm power in spatial terms ranges from 0.77 hp/ha in Chopan block to 1.34 hp/ha in Nagawa blocks in 2001. An average farm power computed for 1971 accounted for 0.39 hp/ha, which enhanced to 1.01 hp/ha in 2001. The per hectare use of chemical fertilizers has also increased from 10.30 kg/ha in 1971 to 35.89 kg/ha in 2001. This trend has also been marked in the area under HYV seeds which rose from 3.40 percent in 1971
to 49.47 percent to total cropped area in 2001. At present about 54 percent of the area under paddy is cropped with HYV seeds. An increase in mechanization and use of chemical fertilizers and HYV seeds has also been verified with the result of opinion survey conducted for this purpose. The coefficients of correlation assessed between irrigation and the three aspects of modernization certify the positive role of irrigation in increasing use of farm power, chemical fertilizers and HYV seeds.

Usually agricultural productivity is measured by the output per hectare. On an average the total agricultural productivity in 1971 accounted for 8.00 quintals per hectare, which rose to 15.46 quintals per hectare in 1981 and 18.02 quintals per hectare in 2001. The block level variation in productivity has been substantial. Very low agricultural productivity (below 20 quintals /hectare) has been found in Nagawa and Meyorpur blocks; due to poor irrigational as well as input facilities. Ghorawal, Robertsganj, Chatara and Chopan Blocks show high agricultural productivity (above 30 quintals /hectare) on account of better irrigation facilities and modernization of agricultural practices. But on an average the study area exhibits lower productivity than the national average of 34.71 quintals per hectare. This draws the attention of planners for better management of irrigation and other input facilities. In Sonbhadra district 87.42 percent of the total cropped area is put under cereals crop cultivation and out of the total production, 89.04
percent is contributed by the cultivation of cereals crops in 2001. Thus, the cereal productivity plays a dominant role in the total agricultural productivity. Productivity of pulses, oil seeds and cash crops has also been calculated. In the area under study the productivity of pulses has been found higher than the national average (9.64 quintals per hectare) but oilseeds productivity is lower. The high degree of positive correlation between irrigation intensity and agricultural productivity indicates a high interdependence of productivity on irrigation.

The present study points out that Sonbhadra district lacks in adequate and even distribution as well as the certainty of rainfall. The calculated value of variability of rainfall (18.46 percent) coupled with the above mentioned uncertain characteristics of rainfall necessitates assured irrigation for removing regional inequalities in cropping intensity, mechanization, use of chemical fertilizers and HYV seeds and the agricultural productivity at the block level for sustainable agricultural development.

In order to promote agricultural productivity, assured irrigation is the most important input. Hence, the provision for development of assured irrigation must be made on priority basis. Another essential step has to be raised regarding the most efficient use of irrigation by minimizing water losses and by deriving scientific irrigation techniques in properly prepared
fields. For instance, the sprinkler irrigation for Rabi Crops in blocks of Meyorpur and Chatara may be adopted as one such method.

There is need of preparing and following the irrigation calendar and raising irrigation water charges (water cess) to control its loss. Besides, the problems and measures relating to irrigation management as opined by respondents need be carefully addressed by involving farmers of the concerned area.