CONCLUSION AND SUGGESTIONS

The present research work has enlisted various sources of irrigation and management of water for agricultural development in the state of Uttar Pradesh. From the analysis, it can be concluded that, there has been a considerable increase in gross irrigated area from 17.69 million ha. (67.59 per cent) to 19.24 million ha. (76.62 per cent) in the state during the periods of 1995-2000 and 2005-10. Central region of the state recorded the highest positive growth in gross irrigated area, whereas its growth in western region has been negative. The number of districts almost doubled, having 85 per cent of gross irrigated area during 1995-2000 to 2005-10, and most of the growth was confined to Awadh and Purvanchal regions of the state. It is evident from the study that, net irrigated area was high in almost all the districts, except some districts of Bundelkhand and northeastern tarai belt of the state. Net irrigated area has been positive with a growth of 3.88 and 2.33 per cent during the periods of 1995-2000 to 2000-05 and 2000-05 to 2005-10, respectively. The Bundelkhand and central regions of the state have also shown a high positive growth in net irrigated area in the respective periods. Area irrigated more than once acquired a strong hold, to become almost doubled with a growth of 99.57 per cent during 1995-2000 to 2000-05. The districts belonging to eastern region of the state achieved the highest growth in area irrigated more than once, as against the Bundelkhand region which was characterized with negative growth during both the periods.

While examining the sourcewise growth in irrigated area, it was observed that, it has been significant in groundwater (tubewell) development in the state because of inherent weaknesses in maintenance and operational efficiencies of the surface water (canal) irrigation. Evidently, water conveyance loss in irrigation through canal is twice that of tubewell irrigation. Among different sources of irrigation, tubewells play a significant role in enhancing the extent of net irrigated area. Tubewells have become the most important source of irrigation as they irrigate more than 70 per cent of cultivated area in the state. Above 90 per cent of area was irrigated through tubewells in the districts of Baghpat, Farrukhabad, Bahraich, Gorakhpur and Shahjahanpur. The districts of Bundelkhand region and Soubhada of Purvanchal show a remarkable progress in tubewell irrigation and achieved a growth of above 20 per cent during the period of 2000-05 to 2005-10. In spite of the
achievements, Bundelkhand still considered to be backward region in respect to irrigation, as only 40 per cent of its total cropped area receives irrigation.

Area irrigated through canal was very high in the districts of Chandauli, Sonbhadra and Mirzapur of Purvanchal region, and Jalaun of Bundelkhand region. The districts belonging to central part and Bundelkhand region of the state registered a negative growth of -14.98 and -8.32 per cent, respectively in canal irrigated area. With the exception of Bundelkhand region, there has been a rapid decrease in area irrigated by government tubewells in all other regions of the state. These tubewells share a low percentage (about 3 per cent) in net irrigated area in the state. Irrigated area by other wells recorded a significant growth to the tune of 122.64 and 57.23 per cent in central and western regions, respectively during the period of 1995-2000 to 2000-05.

Annual growth rates calculated for the last 15 years from 1995-96 to 2009-10 show a positive growth of 0.96 and 0.85 per cent/annum in gross and net irrigated area, respectively of the state. Highest positive growth was seen in the districts of Ambedkar Nagar, followed by Kanpur Nagar, Sitapur and Bahraich, whereas lowest negative growth was recorded by the districts of Sonbhadra, Varanasi, G.B.Nagar and Etah. The districts possessing high growth rate per annum in area irrigated more than once mainly belonged to Purvanchal region of the state, including the districts of Jalaun and Jhansi of Bundelkhand. Area irrigated through canal recorded a negative growth of -1.57 per cent per annum in the state. Highest positive growth in canal irrigated area was recorded in the districts of Gonda and Ambedkar Nagar in contrast to a negative growth achieved by the districts of Varanasi, Rampur, Baghpat, Bareilly and Basti. Very high growth in tubewell irrigated area was noticed in the districts of Bundelkhand region namely, Lalitpur, Mahoba and Chitrakoot, and also including Ambedkar Nagar of Awadh plains.

As regards the growth in cropwise irrigated area, cash crops and cereals were highly irrigated crops to the extent of about 94 and 82 per cent of area sown under these crops, and showed a growth of 1.13 and 1.04 per cent per annum, respectively during the period of study. The districts representing Awadh and Purvanchal regions along with Kanpur Nagar of lower doab recorded a high growth per annum in irrigated area under cereal crops. High percentage of growth in area irrigated under cash crops was seen in the districts of middle-lower doab and Awadh plains of the state. For state as a whole, the growth in area irrigated under pulses and oilseeds was
in negative order. For pulses, the growth was high in the districts of lower doab and the Bundelkhand region. The districts of Lalitpur and Bijnor showed the highest growth in irrigated area under oilseeds. The analysis indicates that, average irrigation intensity for the whole state was nearly 145 per cent during 2005-10. Western districts of the state were fortunate to have high irrigation development. Consequently, the districts of Rohilkhand plains and upper doab region showed very high irrigation intensity. Very low irrigation intensity was observed in the districts of Bundelkhand region.

It is evident from the results of the analysis that, the levels of irrigation development have not been uniform and wide disparities exist in different regions. The districts of western part were much benefitted during the green revolution phase and show very high and high levels of irrigation development whereas, all the districts of Bundelkhand region, and Trans-Ghaghara plain including a detached district of Sonbhadra lying in southeastern corner of the state showed a contrasting picture, with low and very low irrigation development need special attention.

It is a fact that, due to increased pressure of population on land, area and number of marginal land holdings increased during the period of 2000-01 to 2005-06. This has been due to a decrease in area and number of other categories of holdings. It further shows that, there is a dominance of marginal holdings in eastern part of the state. Marginal holdings make farm mechanization rather uneconomical, hence the farmers of the eastern districts are unable to realize the full benefits of modern farm technology in spite of having fertile agricultural lands and adequate potentials of underground water resources. Comparatively, farmers of Bundelkhand region possess enormous area under large holding category possibly due to low population base and consequently, lesser land division resulting in a high man-land ratio. But owing to poor quality of land in this region, the cultivation remains uneconomic.

Use of inputs in agriculture records significant variations in the state. Fertilizers distribution and consumption have recorded a considerable increase. The districts of middle doab, Awadh and Purvanchal regions show a significant increase in consumption of fertilizers, which has been possible due to an increase in irrigated area. The districts of upper doab and Rohilkhand plains are seen highly mechanized, having tractor density of above 45 (tractors per thousand hectares of gross cropped area). Fertilizers consumption and tractor density show a strong positive relationship.
with irrigated area. In areas where irrigation development has been high, both fertilizers and tractor use was quite high than that of the districts marked with low irrigation development.

During the period of 1995-96 to 2009-10, there have been considerable changes in agricultural land use pattern in the state. Gross and net cropped areas were high in the districts of Rohilkhand and doab regions, including some districts of Purvanchal region, these was above 75 per cent of area cropped more than once. The extent of gross cropped area was lowest in the districts of Sonbhadra, Mirzapur, Lalitpur and Chitrakoot, because of low irrigation development, and a very small area brought under multiple-cropping. Area cultivated more than once was high in the districts of upper-middle doab, Rohilkhand, Barabanki of Awadh plains, and some districts of Purvanchal region because of high irrigation development.

With regard to cropping patterns, cereals were dominant among all crops covering about 70 per cent of area to gross cropped area of the state, and the share of pulses was about 10 per cent, which acquired the largest share in cultivated land, mainly in the districts of Bundelkhand region. Oilseeds covered the highest area in cultivation in the districts of Jhansi, Agra, Jalaun and Mathura because of a considerable area devoted to mustard and rapeseeds, and til in cultivation. Cash crops covered an area equal to the area under pulse crops. Wheat dominates among cereals throughout the region, and rice is the second important crop which dominates in the Trans-Ghagharra region and Purvanchal region. With respect to growth in area, production and yield, cash crops have shown a positive growth in area at the expense of negative growth in pulses and oilseeds. Among cereal crops, wheat, rice and bajra recorded an increase in area, production and yield. Negative growth was observed in area, production and yield of other cereal crops (maize, jowar and barley). An impressive increase in area and production of wheat and rice crops have been due to technological breakthrough in cultivation of these, combined with price support, market infrastructure and less yield risks. These factors altogether have made rice and wheat more profitable in comparison to other crops. Among pulses, urad and masoor showed an increasing trend. Growth in yields of soyabean, til, mustard and rapeseed was positive among oilseed crops. Sugarcane dominates in cultivation, mainly in the districts of upper Ganga-Yamuna doab and Rohilkhand plains showing positive growth in area and production, but a marginal decrease in yield per annum. Growth in area, production and yield of potatoes was positive.
A complex picture of crop-combinations emerged in the state, ranging from monoculture/single crop-combination, which dominates over the districts of Muzaffarnagar, Meerut, Baghat, Mathura, Bijnor, S.R.Nagar, Gorakhpur, Lucknow and Unnao to six crop-combination regions in the districts of Kanpur Dehat and Lalitpur of Awadh and Bundelkhand regions, respectively. Two crop-combinations were dominant in the districts of Purvanchal region and in some pockets of upper doab, Awadh and Rohilkhand plains with wheat-rice, rice-wheat and sugarcane-wheat emerged as common crop components. Three crop-combinations were seen in middle doab, Rohilkhand and northern districts of Awadh plains. The districts of Bundelkhand region present more complex combinations (four, five and six combinations). It can be concluded from the foregoing description that irrigation development has provided an opportunity to the farmers to adopt crops requiring much water and highly remunerative, like wheat, rice and cash crops. In addition, it is revealed from the analysis that, the districts marked with least irrigation development have more complex crop-combinations.

In general, cropping intensity is high in regions with higher percentage of net irrigated area and high intensity of irrigation. As illustrated that, the districts belonging to western parts of the state show significantly higher intensity of cropping, whereas, the districts of Bundelkhand have a contrasting picture with low irrigation development, hence low cropping intensity. The study has established a positive correlation between cropping intensity and irrigated area. The regression analysis has also confirmed that, there is a significant and positive association between tubewell irrigation and intensity of cropping. High cropping intensity was confined in the districts marked with high irrigation development, securing a large area within the category of area irrigated more than once, which depicts a strong positive relationship with net irrigated area and area irrigated more than once. Tubewell irrigation has a dominant role in raising the intensity of cropping. It is considered to be the most reliable source of irrigation and assures farmers to refrain from the risks associated with the vagaries of monsoon, and encourages them to cultivate land intensively. In contrast, canal irrigated area shows a low and negative relationship. A negative correlation was also observed in canal irrigated area, and net irrigated and area irrigated more than once. Irrigated area by other wells and tanks presented a value which bears high negative correlation.
Crop productivity regions delineated for major groups of crops: cereals, pulses, oilseeds and cash crops by applying Yang’s Crop Yield Index method show very interesting results. High productivity regions for cereal crops were mainly confined to western parts of the state and the districts belonging to the Ganga-Yamuna doab and Rohilkhand plains. Whereas, low productivity regions form the part of Bundelkhand and Purvanchal region during all the periods of study. Productivity of pulses was high in the regions of Rohilkhand, middle and lower doab, and least developed regions in pulses productivity were in the northeastern corner of the state and Bundelkhand region. Productivity of oilseeds was found high in the entire Ganga-Yamuna doab. High productivity of cash crops was noticed in few districts lying in the upper and middle doab. It is important to mention that Awadh, Purvanchal and Bundelkhand were all demarcated as low productivity regions in cash crops.

Productivity indices computed for all crops and aggregated for the cereals, pulses, oilseeds and cash crops present a composite index that show, high productivity was recorded in the districts lying in the Ganga-Yamuna doab and Rohilkhand plains of the state. Contrary to this, low productivity regions were confined to Bundelkhand region. High positive correlation was seen between irrigation and crop yield indices. Therefore, it is worth mentioning that, productivity levels are in harmony with the development of irrigation in the state.

Water saving devices in the state are very much poor due to paucity in rural infrastructure, particularly rural electrification, relative water abundance, shallow groundwater in most areas, and very small size of operational holdings. Thus, water productivity (WP) of crops is low. Sugarcane achieved highest WP, and it was lowest for rice crop. High WP of wheat (above 1 kg/m³) was seen in the districts belonging to western parts of the state because higher yields in wheat were due to low evapotranspiration losses. On the other hand WP of wheat was lowest in Bundelkhand and Purvanchal regions. WP of sugarcane is highest (above 3 kg/m³); even it requires comparatively more water than other crops. This is mainly because of higher yields of crop. For rice crop, WP was high in northeastern districts forming a part of tarai belt. WP of maize was seen high in the districts of the Ganga-Yamuna doab and Rohilkhand plains. It was confirmed with the analysis of correlation and regression that, there is a positive correlation between yield and WP of the crops, whereas, CWU and WP show a negative correlation.
From the foregoing analysis, it can be concluded that irrigation plays a significant role in overall agricultural development of the state. In terms of overall irrigation and agricultural development, the districts of upper-middle doab and Rohilkhand plains form the most developed regions. Only few districts belonging to eastern parts namely, Ambedkar Nagar, Azamgarh and Ghazipur were characterized as highly developed with respect to irrigation and agriculture development. Contrary to this, the districts of Bundelkhand region, few districts of northern Awadh plains, and the districts of Siddharthnagar, Mirzapur and Sonbhadra of Purvanchal region were characterized as backward on the basis of irrigation and agricultural development.

It was further observed that, on the basis of other selected indicators of agricultural development (land use, technology and agricultural production) the southern districts of the state were placed at the bottom of the list. Moreover, the results of correlation and regression analyses confirm that, irrigation development has a strong positive relationship with agricultural land use, technology, agricultural production, rural infrastructure and agricultural development.

The result of primary surveys in nine sampled villages revealed that, tubewell is a major source of irrigation and irrigates large areas (about 94 per cent). In villages where canal water is available, farmers prefer to irrigate the fields only during rainy season when water is abundantly available in canal. Most farmers who cultivate crops by using canal water are marginal holders who can not afford to install pumpsets or tubewells. They have to rely on water to be obtained on hire basis, which they get from large farmers owning pumpsets and tubewells. Buying of pumpset/tubewell water is preferred by the farmers who possess small and fragmented holdings. Electric operated privately owned tubewells are dominant in villages of Darbara, Ujrai and Kakethal, where tubewells are considered to be the most reliable source of tapping groundwater. Farmers in Darbara, Kakethal and Ujrai villages preferred to grow cash crops (sugarcane and potatoes), wheat and rice. The advantage to the farmers in their native villages is that forming the part of western U.P., the provisions of irrigation have been developed during the phase of green revolution. Whereas, in villages of Dostinagar, Mohammadpur Bahun and Asnahara, where a large number of farms have marginal holdings and form parts of the central and eastern U.P. Farmers have to face fluctuations in electricity supply, hence diesel operated tubewells are necessary for irrigation. Net irrigated area is high in Darbara.
and Kakethal and low in Ujrai and Asnahara villages. Irrigation intensity was high in Ujrai and Mohammadpur Bahun villages because of the cultivation of cash crops and mint, respectively, which require adequate amount of water during the cultivation period.

Primary surveys reveal that, the use of inputs (fertilizers, seeds and machinery) is constrained in canal irrigated and government tubewells irrigated areas due to the poor efficiency and higher risks associated. Probability of inputs use at right time and in adequate amount declines with the size of holding, due to the fact that, both the irrigation efficiency and access to resources is poor in case of marginal and small farmers. ‘Most productive agriculture’ is found in villages with area privately irrigated by tubewells and preponderance of large land holdings. Results of the study show that, tractors operated farms were high in Tara Gay, Darbara, Kakethal and Mohammadpur Bahun because of having high percentage of tubewell irrigated area. The villages of Asnahara, Kalauli Teer Daria have the largest number of hired tractors in use because of the preponderance of either the marginal holdings or the poor status of farmers. Agricultural operations in Kalauli Teer Daria village are carried out with the use of bullocks. Numbers of agricultural implements are high in Mohammadpur Bahun village. Seed drillers were large in numbers in Ujrai village, and mostly used in potato cultivation. Most marginal and small farmers depend on canal water for irrigation, and a large number of diesel operated tubewells also irrigate the land in canal irrigated areas. The extent of gross cropped area is low on farms with marginal and small holdings. Tractor use intensity was high on private electric tubewells operated farms. Yield of cash crops has been relatively high in areas of electric tubewells and on tractor operated farms.

Suggestions

Some suggestions for developing irrigation in least developed areas of the state for the development of agriculture can be taken into consideration as follows:

Cereal crops (wheat and rice) have created serious imbalances in cropping pattern which cause regional disparities and instability in production of other crops. To improve the situation, the components of green revolution strategy have to be re-examined. These include the evolving of HYV of seeds, pest and drought resistant varieties of all crops particularly, the coarse grains, millets, pulses and oilsseeds; exploiting the untapped potential (mostly in ill irrigated areas), realizing the full
potentials of fertilizers use, development and management of irrigation facilities, and market expansion. Government’s role in supplying the inputs on subsidized basis to farmers will be appreciable in rain-fed areas, so that the crops can be grown suited to agro-climatic conditions successfully. It is needed, that in Bundelkhand and Purvanchal regions, the state government should provide credit to poor farmers on easy rate of interest, so that they can get the opportunity to purchase the agricultural inputs: HYV of seeds, fertilizers and farm machinery, needed on farms.

The government has taken initiatives to step up the production of pulses. Setting of the Indian Institute of Pulses Research at Kanpur is a step in the right direction and that acts as a national centre for basic and applied research on pulse crops. To promote pulses cultivation, enhance productivity and reduce production cost, post-harvest losses and handling charges of pulse crop production, attention is urgently required. HYVs and short-duration crops suitable to local conditions are being developed in different parts of the state and popularised. Pulses require being stored under optimal humidity conditions to prevent them from post-harvest losses. For improvements in pulse production, innovative techniques, particularly the mutation breeding techniques, are needed. There is a need to develop early maturing varieties for multiple cropping. Priority should be given to develop integrated pest and disease management schedules. Pulses cultivation is generally perceived by farmers as a risk hence crop insurance schemes should be extended to farmers who intend to bring their land under pulse crops.

Purchasing of improved varieties of pulses is difficult to many farmers due to the lack of concerned seed stores. Infestation of pest and diseases and lack of plant protection measures are other important constraints. One of the most important constraints to pulses production is lack of proper markets. It has been observed that, government’s procurement policy for pulses has not been as effective as in case of cereals and other crops. To encourage pulses production, similar mechanisms as for rice and wheat procurement needed to be evolved. Price and yield risks for pulses have been much higher than those of rice and wheat, because pulses are more prone to risk due to crop failure in comparison to rice and wheat.

Importance of pulses in maintaining food security as well as nutritional security has been felt since very long. Production of pulses definitely needs to be increased manifold to meet the demand in coming years. Farmers grow pulses on the marginal lands with minimum inputs. There is enormous potential for pulse
cultivation in irrigated areas. Adoption of improved varieties of pulses should be emphasized, and transfer of technology pertaining to pulses should be strengthened in farmers' participatory mode with active involvement of multidisciplinary team of scientists. Creation of Informal Seed Village System is required, wherein farmer to farmer seed production and distribution chain will ensure easy availability of quality seeds. Farmers need training to incorporate improved harvesting methods, standardization and grading, improved packaging and handling of grains for proper storage, etc. for profitable marketing.

Moisture conservation or rain-water management should receive due attention as there is a strong contemporaneous relationship between moisture conservation and crop-centred technologies. Developing drought resistant varieties of seeds to sustain with low rainfall and to protect themselves from foliar diseases should be emphasized. In most dryland areas, output surpluses for marketing remain very low. This in turn results in localisation of demand for a number of commodities and poor market infrastructure facilities. Weak market infrastructure sometimes leads to decline in market prices for commodities in post-harvest period for three to four weeks. Further, the crops grown on dry lands generally spread thinly over large areas and thus could make intervention of public agencies due to which overhead costs become very high. For this, the Commission on Agricultural Costs and Prices has recommended that, state governments should make adequate arrangements for timely purchasing of crop commodities.

Technological changes to improve water productivity of crops by raising the yields hold a better promise in the state. In canal command areas, farmers should be given subsidies to install small pumpsets and the construction of warehouses should be regulated for crop storage. This would result in a greater control over “water delivery” and better quality of irrigation to achieve higher water efficiency and WP. Through “water control” interventions either through micro-irrigation technologies; water delivery control devices such as the storage, particularly in case of surface irrigation can help to achieve control over water, and reduce non-beneficial depletions of applied water and maximizing the consumptive use fractions of applied water. Improvement in quality of irrigation (adequacy and reliability of applied water) would significantly impact on crop yield and WP.

Improvements in crop productivity by genetically methods can further contribute much in the realm of possibility. These methods, at the same time, can
significantly raise WP of crops, if such improvements are adopted with the aim to save water. Better water management is needed for the supply of water in canal irrigated areas in the concerned districts so that the farmers can get water in accordance with their actual needs. The pricing of water must be regulated according to the needs and capability of the farmers, and controlling the wasteful use of water.

In dry areas of Bundelkhand region of the state, farmers depend on rainfall for cereal production. Yield of these crops can be increased by using supplemental irrigation, which entails harvesting run-off water, storing it in ponds, tanks or small dams, and applying it during critical crop growth stages. It will allow earlier planting of crops, while the planting date in rain-fed areas is determined with the onset of monsoon. Supplemental irrigation allows the farmers to select the date of sowing precisely, which will help in improving crop productivity.

Irrigated farming, in general is very wasteful as it uses more water, partly due to farmers' lack of knowledge of water requirement of crops. Recent researches have led to a drastic revision of these ideas, and it is now generally accepted that irrigation in an area, at a given time requires the same amount of water almost irrespective of the crop being grown. Therefore, the farmers should grow crops which give highest economic returns per unit of area and per unit of time. The most critical stages of a crop are seedling and flowering. Irrigation should be applied at these critical stages of growth under limited water supply conditions. As irrigation facilities are extended to new areas, farmers in those areas have a choice to grow rice in _kharif_ and wheat in _rabi_ season. Farmers need advice on spot and demonstrations pertaining to water management practices for increasing crop production under limited water supply conditions. There should also be sincere efforts to provide knowledge for transferring water management methods and practices to the farmers. When water supply is limited, the proper water conveyance and land development (levelling, grading etc.) are important steps to minimize water losses.

Installation of deep tubewells should be financed with subsidy and supply of chemical fertilizers be regulated by the government at subsidized rates to farmers in rain-fed districts in Bundelkhand region. In areas where irrigation is provided through tubewells, there should be least fluctuations in electricity supply to achieve greater efficiency in irrigation water use. Water Use Efficiency (WUE) is as low as 30-35 per cent in rice crop whereas, average WUE in other crops ranged from 45 to 50 per cent. Hence, it is necessary that, attention should be focused on efficient water
management practices for rice cultivation without compromising it yield levels. For conserving water, the entire areas under sugarcane by tubewell need to be covered under drip irrigation. Drip irrigation can bring improvements in output and optimize the use of fertilizers and other nutrients.

Achievements in rain-fed agriculture are associated with new crops, supplemental irrigation, deficit irrigation, rainwater harvesting, and precision irrigation. Dry farming techniques in low rainfall and water scarcity areas can avert the ill effects of droughts. Deficit irrigation has been widely investigated as a valuable strategy for dry regions where water is the limiting factor. Genetically modified varieties of seeds, if adopted and introduced can sustain on minimum moisture in water scarcity districts. Subsidy on farm inputs or special package of farm incentives should be given to poor farmers, for improving irrigation facilities for the betterment of agriculture.

According to Famine Enquiry Commission (1945), different sources of irrigation are complimentary and supplementary rather than competitive. The problem of water supply can not be solved by mere extending application of any particular method of irrigation but by using all the methods combined. Moreover, for getting the maximum benefit from irrigation, a region requires firstly, an increase in number of canals, tubewells and tanks etc. Secondly, the loss of irrigation water through evaporation and seepage must be reduced based on the techniques suggested. Thirdly, those techniques should be adopted which involve less investment and can lift water to a higher level, if required. Lifting of water to a higher level is regulated either by man power, bullocks or mechanical power, such as oil engine with pump or electric motor attached with pump. And fourthly, in parts of the country, the methods of irrigation being used are not much efficient. The selection of a most suitable irrigation method for each field, carefully applied, can definitely bring transformation of agriculture by increasing crop yield.

Expansion of area under irrigation can greatly increase agricultural productivity; much can also be achieved by increasing yields on land already irrigated. Bringing new land under irrigation is usually both time-consuming and costly. Increasing yields on land already irrigated contribute to maximize the returns from costs that have already incurred. Improvements in irrigation efficiency or supplemental irrigation can double or triple production in many existing irrigated areas. Better irrigation practices could result in enormous savings.
It was found during surveys in the villages that, electric supply has not been regular. Assured electric supplies in rural areas with affordable cost will not only help the farmers in reducing the cost of crop production but also the judicious use of groundwater for irrigation.

The government has incorporated some policies and programmes for the better management and conservation of water resources in different states and also in the state of Uttar Pradesh. Some of them are as discussed below:

Methods for enhancing groundwater recharge through rainwater harvesting or through different soil conservation measures along with training of farmers pertaining to judicious use and management of available groundwater would help in sustaining this vital natural resource. Artificial Groundwater Recharge (AGWR) has the capacity to alleviate the stress in groundwater overexploited areas. A total of 83 projects for the construction of 1488 artificial recharge structures (amounting to ₹ 839.24 million) have been approved in the 11th Five Year Plan (2007-2012) and a sum of ₹ 646.98 million was released to 20 states by 31st December 2011. At least 568 recharge structures were completed till December, 2011.

Formation of a group of water users/farmers known as Participatory Irrigation Management (PIM) is a formal body made for the purpose of managing parts or whole of an irrigation system. This body is often called Water User’s Association (WUA). PIM implies the involvement of water users in levelling the management of water including planning design, construction, maintenance and distribution as well as financing. The primary objective of PIM is typically to achieve better availability and utilization of water through a participatory process that gives farmers a significant role in the management decisions of water in their hydraulic units.

As irrigation is one of the six components for development of rural infrastructure under ‘Bharat Nirman’, the Ministry of Water Resources in collaboration with State Governments is responsible for creation of additional 10 million hectares of irrigation capacity during four years from 2005-06 to 2008-09. The target for creation of irrigation potential under Bharat Nirman was proposed to be met through completion of on-going major and medium irrigation projects, Extension, Renovation and Modernization (ERM) of major and medium irrigation projects, surface water minor irrigation projects and ground water minor irrigation projects. Emphasis has also been laid on repair, renovation and restoration (RRR) of
water bodies. The ‘National Water Mission'\textsuperscript{12} has been formulated by the Ministry of Water Resources with the main objective of “conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within states through integrated water resources development and management”. Five identified goals of the Mission are: (i) a comprehensive water data base in public domain and assessment of impact of climate change on water resource; (ii) promotion of citizen and state action for water conservation, augmentation and preservation; (iii) to focus attention on vulnerable areas including over-exploited areas; (iv) increasing water use efficiency by 20 per cent, and (v) promotion of basin level integrated water resources management in the state of Uttar Pradesh.

To sum up, agricultural development relies on a perfect combination of irrigation and other farming inputs together with physical characteristics of the component areal unit. There are inter-regional variations in sources of irrigation water and development that have led to uneven development in agriculture in the state. Thus, for an overall development of agriculture, efforts should be made in a sustainable manner. The scope of this research work presented in the form of thesis, so far exists to locate the backward districts in the state of Uttar Pradesh with reference to irrigation and agricultural development, and to suggest some remedial measures for irrigation and agriculture development in these districts.

\textsuperscript{12} National Water Mission was approved by Honourable Prime Minister's Council on August 30, 2010 and by the Union Cabinet on April 6, 2011.