ABSTRACT

Agriculture occupies an important place in the economy of India and more specially in the state of Uttar Pradesh where it contributes about half of the state's income and engages about three fourth of its population. The development of agriculture, therefore, is a prime concern of geographers, economists and planners and offers a challenge to them to find means and ways to bring out its overall reform.

The underdeveloped conditions of Indian agriculture may be proved from the fact that the per hectare yield of crops in India is comparatively low, which is barley one third or one fourth of the yield of other agriculturally advanced countries of the world. The low yield per hectare in India is mainly due to the less and improper utilization of land and modern agricultural inputs. The low yield per hectare has a direct influence upon the health, efficiency and nutritional standard of the rural inhabitants. The solution, however, lies in the increased and proper utilization of modern agricultural inputs for which a thorough study of agricultural transformation and impact of modern technology on agricultural transformation is necessary. It is, therefore, necessary to conduct a field to field survey to ascertain the impact of modern agricultural inputs and
and physical environment on agricultural transformation. The interpretation of agricultural transformation shall be helpful in determining whether the agricultural transformation is in right direction or not.

Agricultural transformation implies the rational use of land resource through applying a higher degree of modern inputs. Agricultural transformation should be such that it should provide not only the balanced and adequate diet to the entire population, but also the raw materials to the agro-based industries. It is well known fact that prior to the onset of green revolution Indian agriculture was backward and there had always been the problem of adequate supply of food in the country. But by the onset of green revolution in the mid sixties, technological and institutional advancement took place in agriculture which has given phenomenal results. This has changed the entire outlook of agriculture. Traditional agriculture is being transformed into a worthwhile enterprise.

The lower Ganga-Yamuna Doab incorporating Kanpur, Kanpur rural, Fatehpur and western portion (Sirathu, Kara, Sarsava, Manjhanpur, Kaushambi, Muratganj, Nevada, and Chail blocks) of Allahabad district, extended from 25° 16' to 27° 00' N latitudes and 79° 30' to 81° 55' E longitudes has a total area of 12,239 square kilometers and support a population of 60,12,436. It is a flat featureless plain
formed by the infilling of the Indo-Gangetic trough during the pleistocene period.

Agriculture shares more than half of the total economy of the lower Ganga-Yamuna Doab and 45 per cent of Uttar Pradesh. It is the mainstay of the people covering about 68 per cent of the region's area and engaging about three fourth of its population to earn their livelihood. Due to great pressure of population the per capita land averages are very low, which has led to fragmentation of holdings. About 60 per cent of the land holdings are below 1 hectare of area which covers about 30 per cent of the total cropped area.

The present work is an attempt to highlight the regional disparities in agricultural transformation in one of the agriculturally important regions of India, i.e., lower Ganga-Yamuna Doab. The role of technological and institutional factors in bringing about variations in the spatio-temporal transformation of agriculture in the region is brought to light and suggestions are proposed to remove the regional imbalances in agricultural transformation of the study region.

The entire work has been grouped into four parts consisting of eleven chapters. In the beginning a discussion has been made on the geographical background and the analysis of various complex problems. In the first part there are three
chapters, viz., Structure and relief including drainage, Climate and soils of the lower Ganga-Yamuna Doab.

The drainage of the lower Ganga-Yamuna Doab discharges itself into the river Ganga. The course of all the rivers and their tributaries follow the general slope of the region. A number of perennial and seasonal rivers are flowing in the area from north-west to south-east. Its monsoon climate characterised by cool winters, hot summer and seasonal rains (annual average 89 cms.) is envigorating but more susceptible to drought and famine. The region is gifted with fertile alluvial soils which belong to two river systems—the Ganga and the Yamuna, each consisting of recent alluvium, flat lands, uplands and lowlands.

Part second is having three chapters viz. Concept of agricultural transformation and planning, technological and institutional factors of agricultural transformation and changing pattern of area, production and yield of major crops of lower Ganga-Yamuna Doab. Chapter IV deals with the concept of agricultural transformation proposed by different eminent geographers, and social scientists. It reveals that negligence of agricultural sector in the country's planning, lack of irrigation facilities, obsolete methods of farming, indebtedness and illiteracy among farmers, nominal use of HYV seeds, meagre amount of chemical fertilizers and pesticides and lack
of a land tenure system based on social justice have all combined to put agriculture in low key in the lower Ganga-Yamuna Doab. It is unfortunate that major portion of agricultural land is still owned by privileged casts/classes of the society who are not only inexperienced cultivators but very often act as petty neo-Zamindars employing landless labourers for paltry wages and pocket the major share of the produce. The urbanites in many cases earn, while earning their livelihood in the cities may simultaneously own land in the villages and enjoy the benefits of neo-feudal system. It is, therefore, imperative that with the improvement in farming techniques, use of new varieties of seeds, chemical fertilizers, pesticides, the use of biofertilizers, the introduction of biotechnology should be actively encouraged. New land reform should be intacted either to restore land to the actual tiller, or manage the same through state/co-operatives to improve the conditions of agriculture in the region so that agricultural transformation in the true sense may be achieved.

Chapter fifth reveals that the components of modern technology of agriculture in the study region has been considerably increased in the decade, beginning from 1975-76. During this period the number of tube-wells and pumping sets have increased by 85.65 per 100 hectares of gross cropped area, number of improved plough by 4 per 100 hectares of
gross cropped area, the number of tractors by 0.75 per 100 hectares of gross cropped area, rate of fertilizer consumption by 50.89 kg per hectare, irrigation intensity by about 15 per cent of gross cropped area and the area under HYV seeds has increased by 18.32 per cent of the gross cropped area. Number of agricultural labourers and workers have decreased by 4 per 100 hectares of gross cropped area, but the literacy rate during this period has remained almost the same. All these increased agricultural inputs are responsible for the transformation of agriculture in the lower Ganga-Yamuna Doab. However, the distributional pattern of all the components of modern technology are not uniform throughout the study region leading to inter block disparities in agricultural transformation.

Chapter sixth deals with the changing pattern of area production and yield of major crops in the lower Ganga-Yamuna Doab. It reveals that the net sown area in 1975-76 was 1.24 million hectares which accounts for about 70 per cent of the total area of the study region. In 1985-86 there was almost no change in this area. The gross cropped area in 1975-76 was 123 per cent of the net sown area while it was 132 per cent in 1985-86, showing an increase of 10 per cent during the same period. This shows that lateral expansion of agriculture is not significant because of the limited agricultural
land. Intensive agriculture remains the only way for transforming agriculture of the study region by applying package of improved practices including all the modern inputs of agriculture at the right time and in right quantity.

The area, production and yield of major crops of the study region shows a significant change from 1974-75 to 1984-85. During this period areal extent of wheat increased by 109 thousand hectares, rice 40 thousand hectares, maize 4 thousand hectares, pulses 187 thousand hectares, oil seeds 14 thousand hectares and cash crops 3 thousand hectares, whereas the areal extent of barley decreased by 27 thousand hectares; jwar 16 thousand hectares and bajra by 2 thousand hectares. During the same period the production of wheat increased by 4,617 thousand quintals, rice 1,579 thousand quintals, maize 78 thousand quintals, bajra 217 thousand quintals, pulses 2,202 thousand quintals, oil seeds 83 thousand quintals and cash crops by 2,919 thousand quintals, while the production of barley and jwar (big millet) decreased by 228 thousand quintals and 233 thousand quintals respectively.

The yield of the crops have shown significant increase; the yield of wheat has increased by 10.64 quintals/hectare that of rice by 5.89 quintals/hectare, 4.30 quintals/hectare for maize, 1.49 quintals/hectare for barley, 4.05 quintals/hectare for bajra, 0.21 quintals/hectare for oil seeds and
103.18 quintals/hectare for cash crops. Whereas the yield of jwar decreased by 1.37 quintals/hectare and that of pulses by 0.58 quintals/hectare.

The study reveals that the continuous increase in area and production of wheat, rice and cash crops is mainly to the introduction and adoption of HYV seeds, expansion of irrigation facilities, increased use of chemical fertilizers, adoption of crop protection measures and mechanization of farming. The modern agricultural strategy is highly suitable for cultivation of wheat, rice and cash crops. The increased production of bajra and maize are attributed to the hybrid seeds of the crops. Increased production of oil seeds is the result of expansion of cultivated area under the crop as well as increase in the yield of the crop. In case of pulses the increase in production is attributed to the expansion of cultivated area under the crops. Inspite of decreased yield of pulses, its areal extent has increased considerably because of the high remunerative value of the crop. Production of barley is decreased by the reduction of its areal extent. The reduced area under barley cultivation is due to the shift of the area under wheat cultivation. The production of jwar (bulrush millet) has decreased owing to the decrease in yield as well as the area under the crop.
Chapter seventh is devoted to the study of spatio temporal transformation of agriculture in the study region. It reveals that the productivity of cereals, oil seeds and cash crops have been on the increase from 1975-76 to 1985-86. The study reveals that the areal extent of high productivity region of cereals has increased by 21 per cent and medium productivity region by 47 per cent of the area under these categories in 1975-76. While the area under low productivity region of cereals has decreased 70 per cent of the area during the same period. The reduction in area in the low productivity region of cereals has occurred as most of the area has gone to medium and high productivity region in 1985-86.

Pulses suffered heavily in areal extent under all the three categories of productivity region. The decrease in the area of pulses is a matter of concern, since pulses constitute the chief source of protein for the population of the study region, as it is overwhelming vegetarian. The low yield of pulses shows that it has not been benefited by the modern researches in the high yielding varieties as well as in techniques of cultivation in comparison to cereals. The use of indigenous seeds, lack of financial resources, non-use of chemical fertilizers and great susceptibility of the crop in adverse climatic conditions make the yield static or even lead to its decline. During the course of field work, the author could see that the adoption of improved technology
for pulses is almost absent and the farmers are growing pulses traditionally as a mixed crop.

The productivity of pulses can be raised by increasing their production per unit area and per unit of time through better management. In the study region it has been found that pulses of summer season generally do not suffer from diseases and pests. Arhar (pigeon pea) T-21 can be introduced on a large scale in the areas of assured irrigation in the study region, because this variety can yield 2,000 – 2,500 kg per hectare before the cultivation of wheat. Varieties like T-21 and T-44 need to be developed which can thrive well with less irrigation and give higher net return. It was also observed during the course of field work that the average yield of moong (Phaseolus aureus Raxb) and urd (Phaseolus radiatus) in Zaid (the short season following the harvest of wheat) is better than that of Kharif season in irrigated areas because of low susceptibility of diseases and pests.

Areal extent of high productivity region of oil seeds has declined by 57 per cent during this period. While the areal extent of medium and low productivity region has grown up by 216 per cent and 17 per cent respectively.

High productivity region of cash crops recorded an areal increase of 344.5 thousand hectares and medium productivity region 213.5 thousand hectares in 1985-86. Whereas the
areal extent of low productivity region decreased by 193 thousand hectares. The areal reduction of low productivity region of cash crops is due to the increase in the areas of medium and high productivity.

The overall high productivity region of agriculture in the lower Ganga-Yamuna Doab has increased by 3,445 thousand hectares (162 per cent) and medium productivity region by 213.5 thousand hectares (38 per cent) from 1975-76 to 1985-86. Whereas the low productivity region of agriculture has decreased by 193 thousand hectares (67 per cent) during the same period. The reduced area of low agricultural productivity region is due to its being changed into the areas of medium and high productivity regions. Thus it gives a rising trend of overall agricultural productivity of the lower Ganga-Yamuna Doab.

Chapter eighth is devoted to the study of cropping pattern of the region. It shows that most of the cultivated area is devoted to subsistence food crops, mainly for local consumption and the immediate market. Cash crops receive negligible percentage of the average farm. In the lower Ganga-Yamuna Doab, the farmers respond to changes in input cost, output price and crop yield, but this response is limited to relative change in acreage while there is little change in the overall cropping pattern of the area. Lack of
sufficient credit facilities, illiteracy and uncertain future prospects restrain the farmers from undertaking any significant change in their area allocation.

The cropping pattern of lower Ganga-Yamuna Doab has undergone a very little change. During the period of study the gross cropped area has increased by 16.14 per cent. The percentage share of wheat in gross cropped area increased by 10.2 per cent, paddy 3.7 per cent, pulses 17.6 per cent, oil seeds 1.3 per cent and cash crops by 0.3 per cent. The remaining crops i.e., maize, barley, jwar and bajra have a decreased percentage share in gross cropped area of the study region. There is need for immediate attention to increase the production of oil seeds and cash crops either through expansion of area under the crops or through intensive cultivation. Increased demand of oil seeds and cash crops are to be met through increased production only.

The study reveals that wheat and paddy are the two most important crops which made the largest percentage gain of the total harvested crop land from 1975-76 to 1985-86. During the same period maize, arhar (pigeon pea), barley, gram, bajra (big millet) and jwar (bulrush millet) suffered the largest decrease percentage of the total harvested crop land in different blocks of the lower Ganga-Yamuna Doab. Much of the agriculturally stable areas lie in the middle
and upper parts of the Doab, while areas prone to large scale changes are generally spread over the eastern and western parts of the study region.

Chapter ninth is devoted to study the impact of the components of modern technology on agricultural transformation of the region. The result of the simple linear correlation test shows that agricultural productivity as a parameter of agricultural transformation of the study region has significant degree of positive relationship (at 1 per cent level of confidence) with tube-wells and pumping sets ($X_1$), iron plough ($X_2$), blade harrow and cultivators ($X_3$), tractor power ($X_4$), fertilizer consumption ($X_5$), rural electrification ($X_6$), agricultural labourers and workers ($X_9$), irrigation intensity ($X_{11}$) and area under HYV seeds ($X_{13}$). It has negative correlation with literacy rate ($X_{10}$) and size of land holding ($X_{12}$). It therefore, follows that there is urgent need to improve the literacy situation so that adoption of new technology may become easier. Similarly the size of land holding should be more viable.

The study reveals that there exist inter-relationship among the independent variables. It is seen that each of the independent variable when considered as dependent variable have high positive correlation with about 65 per cent of the variables selected. Size of land holding ($X_{12}$)
is having negative correlation with all other variables except area under HYV seeds \( (X_{13}) \).

While studying the inter-relationship among independent variables for the year 1985-86, it is found that each independent variable when considered as dependent variable is having a high degree of positive correlation with about 69 per cent of the variables. Almost all the variables have strong and negative correlation with size of land holding \( (X_{12}) \).

Factor analysis for the year 1975-76 shows that 76.79 per cent of the total variance is explained by two groups of factors. Factor \( F_1 \) explains 62.03 per cent of the total variance is strongly loaded on \( X_1 \) tube-wells and pumping sets (0.95), \( X_2 \) iron plough (0.92), \( X_3 \) blade harrow and cultivators (0.95), \( X_4 \) tractor power (0.74), \( X_5 \) fertilizer consumption (0.93), \( X_7 \) rural electrification (0.98), \( X_{11} \) irrigation intensity (0.96) and \( X_{13} \) area under HYV seeds (0.97). Factor \( F_2 \) accounts for 14.76 per cent of the total variance explained and is heavily loaded on \( X_6 \) cooperative banks (0.74), \( X_8 \) length of metalled road (0.54), \( X_9 \) agricultural labourers and workers (0.78) and \( X_{12} \) size of land holding (-0.84).

Factor analysis for the year 1985-86 shows that in all 84.15 per cent of the total variance is explained by three
groups of factor. Factor $F_1$ explains 62.07 per cent of the variance and is highly loaded on $X_1$ tube-wells and pumping sets (0.90), $X_2$ iron plough (0.92), $X_3$ blade harrow and cultivators (0.93), $X_4$ tractor power (0.82), $X_5$ fertilizer consumption (0.93), $X_7$ rural electrification (0.92), $X_{11}$ irrigation intensity (0.88) and $X_{13}$ area under HYV seeds (0.92).

Factor $F_2$ explains 13.29 per cent of the variance and is strongly loaded on $X_6$ cooperative banks (0.70), $X_9$ agricultural labourers and workers (0.77), $X_{10}$ literacy rate (-0.81) and size of land holding (-0.74). Factor $F_3$ accounts for 8.79 per cent of the variance explained and is highly loaded on $X_8$ length of metalled road (0.95) and $X_{12}$ size of land holding (-0.46).

A trifocal approach is adopted to examine the impact of changed technological factors on the levels of agricultural transformation in respect of its three parameters, i.e. changed cultivated area, changed agricultural production and changed agricultural productivity from 1975-76 to 1985-86 in the lower Ganga-Yamuna Doab. The study reveals that changed cultivated area in three fourth of the blocks lie within the deviation of ±2,000 hectares, but half of the blocks are on the negative side of the scale. About 12 per cent of the blocks have decreased the cultivated area by
more than 2,000 hectares. It has been found that the transformation in cultivated area of the study region is not due to the result of change in the magnitude of selected variables. About half of the variables of agricultural transformation are directly proportional to the transformed cultivated area, but their rates of change are dissimilar. Size of land holding ($X_{12}$) is the only variable which has a high degree of positive relationship.

Total agricultural production in almost all the blocks of the study region has increased. In a little less than 10 per cent of the blocks the production is increased by above 450 thousand quintals, in 29 per cent blocks it is increased from 300 thousand to 450 thousand quintals, in about half of the blocks it is increased from 150 thousand to 300 thousand quintals and in a little less than 10 per cent of the blocks its increase is below 150 thousand quintals. The study reveals that there exist some relationship between the transformed agricultural production and changed independent variables. But the relationship between them is weak, because of the fact that the change in about 65 per cent of the technological correlates of different blocks are directly proportional to the transformed agricultural production, but the rates of the change are not uniform.
While studying the change in agricultural productivity as the third parameter of agricultural transformation, it is found that in about half of the blocks the changed agricultural productivity lie within the deviation of ± 10 (index number) of which 15 per cent are at the negative side of the scale. In 12 per cent of the blocks it is transformed above -10, in 27 per cent blocks it ranges between + 10 to + 20 and in about 10 per cent blocks it ranges above + 20. The study reveals that the changed agricultural productivity ($Y_3$) has strong positive correlation with $X_1$ tube-wells and pumping sets (0.49), $X_2$ iron plough (0.64), $X_3$ blade harrow and cultivators (0.41), $X_4$ tractor power (0.53), $X_7$ rural electrification (0.70), $X_{11}$ irrigation intensity (0.72) and $X_{13}$ area under HYV seeds (0.61). It has weak and negative correlation with $X_8$ length of metalled road, $X_{10}$ literacy rate and $X_{12}$ size of land holding.

Tenth chapter is devoted to study the impact of biotechnology on crop production in the region. It shows that by the application of biotechnology as a tool of crop production in various blocks of lower Ganga-Yamuna Doab, the production of major food crops can be raised upto considerable extent. The study reveals that the total production of cereals in the study region is likely to be increased by 145.3 thousand quintals which will support an additional population of about one hundred thousand.
In order to lessen dependence entirely on energy and cost intensive fertilizers, steps have been taken towards tapping biological nitrogen fixation symbiotic and non-symbiotic bacteria, blue-green algae, rhizobium and azolla. The livestock excreta if cycled through anaerobic fermentation in gobar gas plant, could provide simultaneously manure and gas energy for rural household of the lower Ganga-Yamuna Doab. The study reveals that by the application of biotechnology 42 million to 57 million tonnes of chemical fertilizer's consumption can be curtailed annually.

By the application of biofertilizers in the lower Ganga-Yamuna Doab the production of rice is estimated to increase by 713 thousand quintals, jwar (bulrush millet) 93 thousand quintals, bajra (big millet) 151 thousand quintals and pulses 284 thousand quintals. Thus through biofertilizers, rice, jwar, bajra and pulses together can raise agricultural production of the study region by the tune of 1,241 thousand quintals. The increased production of cereals will support about 7 hundred thousand additional persons and the increased production of pulses will be consumed by an additional population of about 1.1 million. Thus, it can be concluded that the increased production of cereals through biotechnology will provide food for about 8 hundred thousand of additional mouths and the increased
production of pulses will be consumed by about 1.11 million additional population of the study region.

The pace of agricultural transformation in right direction can be accelerated if the following things are taken into consideration: Irrigation facilities in the north western parts of the district of Kanpur particularly in the following blocks need to be increased. The quickest method would be digging of tube-wells. The farmers could be extended credit facilities for such wells. These blocks are Ghatampur, Patara, Bheetargaon, Amraudha, Rajapur, Malasa, Akbarpur, Derapur, Sandalpur, Chaubypur, Kalyanpur, Sarsaul, Vidhnu.

A similar facility needs to be extended in the following blocks of Fatehpur: Amauli, Khajuha, Malwan, Bahuva and Asother. There is one block in Allahabad which stands in dire need of the facility, namely Dhata. Regular supply of electric power and diesel oil at controlled rate in these blocks will further help the farmers to irrigate their fields when required. Distribution of chemical fertilizers HYV seeds and pesticides in all the blocks of the study region in general and in the blocks of Ghatampur, Rajapur, Akbarpur, Derapur, Sandalpur, Kalyanpur, Sarsaul, Vidhnu, Khajuha, Asother and Dhata in particular should be done only through the co-operative societies on credit so that needy farmers
can get it on time and the quality can also be assured. Co-operative societies should provide tractors and costly farm implements on subsidised rates in various blocks of the study region so that small and poor farmers can afford the facilities. Stress should be laid on adopting biotechnology including biofertilizers for crop production as the method increases agricultural production without causing any appreciable environmental damage. Long term and short term loan on nominal interest rate should be extended to needy farmers in the blocks of Akbarpur, Kalyanpur, Sarsaul, Vidhnu, Asother and Dhata for soil conservation and water harvesting. Consolidation of holdings is urgently required in all the blocks of the region so that the farmers can use modern agricultural tools and implements which facilitate multiple cropping and also diversification and commercialization of agriculture. For complete abolition of neo-Zamindars, new land reform should be intacted either to restore the land to the actual tiller or manage the same through state/co-operatives to improve the conditions of agriculture in the study region.

In the light of the study conducted, the author is confident enough that if the above mentioned suggestions are adopted then agriculture’s transformation in the true sense may be achieved in the lower Ganga-Yamuna Doab.