Chapter 3

Agricultural Productivity and Productivity Regions in Rohilkhand Region
A. THE CONCEPT OF AGRICULTURAL PRODUCTIVITY

Term productivity has been used with different meanings and has aroused many conflicting interpretations. Sometimes it is considered as the overall efficiency with which a production system works, while others it is defined as a ratio of output to resource expanded separately or collectively. This term has also incorrectly and interchangeably been used with production. In reality, production refers to the volume of output, while productivity signifies the output in relation to resources expanded. The quantum of production can be increased by employing more resources without increasing productivity and productivity per unit terms can be increased without increasing production by employing less inputs for the same production level. It is commonly agreed that productivity is the ability of a production system to produce more economically and efficiently. Therefore, agricultural productivity can be defined as a measure of efficiency in an agricultural production system which employs land, labour, capital and other related resources.

In recent years many attempts have been made to define the connotation of agricultural productivity. Dewett (1966) explains it as, "productivity expresses the varying relationship between agricultural output and one of the major inputs, like, land or labour or capital, other complementary factors remaining the same....". It may be borne in mind, that productivity is physical rather than a value concept.1 The connotation of agricultural productivity engaged the attention of many an economist at the

Some economist suggested, that the yield per acre should be considered to express agricultural productivity. A number of objections were raised against this because it considers only land which is just one factor of production while other factors are also responsible, and therefore, it will be arbitrary to attribute productivity entirely to land and express it per hectare of land. It was suggested, for instance, that productivity should also be measured in terms of per unit of labour and different regions be compared on that basis. After a through discussion, it was generally agreed that the yield per hectare may be considered to represent the agricultural productivity in a particular region, and that other factors of production be considered as the possible cause for the variations while comparing it with the other regions.\textsuperscript{3} Pandit (1965) has expressed the connotation of productivity in these words, "productivity is defined in economics as the output per unit of input.... the art of securing an increase in output from the same input or of getting the same output from a smaller inputs".\textsuperscript{4} He further suggests, that increases in productivity, whether in industry or agriculture, is generally the result of a more efficient use of some or all the factors of production, viz., land, labour and capital. Saxon (1965) consider productivity as a physical relationship between output and input, which gives rise to that output.\textsuperscript{5} Horring (1964) considers productivity in broad


\textsuperscript{3} Summary of Group discussions, Regional Variation in Agricultural Development and Productivity, \textit{ibid.}, pp. 263-66.


\textsuperscript{5} Saxon, I.A., Special Concepts of Productivity, \textit{ibid.}, p. 226.
terms, to denote the ratio of output to any or all associated inputs, in real
term. There are many different concepts of productivity, and still diverse
ways for computing it. The chairman of the International Commission on
Agricultural Typology, Prof. Kostrowicki, invited different views on this
problem by sending a questionnaire to over 100 scholars throughout the
World, which embodied the following two questions⁶:

1. What methods, of measuring intensity of agriculture should be
   applied in typological studies of various orders?

2. What methods, measures and indices should be used to define land,
   labour and capital productivity of agriculture in typological studies of
   various orders?

About fifty geographers from all over the world responded and suggested
various approaches to the measurement of agricultural intensity and
productivity. The Chairman of the Commission while evaluating different
views pointed out, that a special study for testing various methods and
techniques to be used in studies of various scales were needed.⁷ Land, labour
and capital are the partial measures to examine agricultural productivity.
‘Land’ is viewed as area with different natural attributes. It realizes different
rents and its cost varies in accordance with the need and location. ‘Labour’
represents all the human rendered services, other than decision making, and
‘capital’ the non-labour resources employed in cultivation by the farmers.

⁶ Horring, J., Concept of Productivity Measurement on a National Scale, OECD,
Documentation in Food and Agriculture, No. 27, Paris 1964, p. 10.

⁷ Proceedings of the International Commission on Agricultural Typology
It is only due to pressure of population that a special attention is being given to productivity of land. Maximum production from land can be achieved with the application of available inputs. Inevitably the inherent chemical and physical properties of the land vary spatially and impose varying limits on agricultural use, although actual use dependents upon technology, profit and cultural constraints.8

Land productivity is obviously of primary importance in countries where there is a high density of population. Where land resources are scarce, the principal means of raising production to keep pace with the growth of population is by raising yield per hectare. However, raising the productivity of land does not mean only raising the yield of individual crops. It encompasses the whole output of a farm or country in relation to the total area of farm land, and which may also be raised by changing the pattern of crop production and toward more intensive system of cultivation or toward higher value crops.

A distinction must be made between the measurements of agricultural output in terms of calories (or some other measurement of food values), and in terms of money values. For example, if in temperate countries the cultivation on land is shifted from cereals to potatoes, the output per hectare in terms of calories of human food is likely to be increased, but its productivity in terms of money value may be changed upward or downward in accordance with the relative prices of cereals and potatoes. Again, shifting the land for cultivation of main crop potatoes to

early season potatoes or to luxury vegetables may well increase its productivity in money terms, but will almost certainly reduce its output in terms of calories.

The productivity of labour is a somewhat more complex aspect than land productivity. Labour productivity means the income of the population engaged in agriculture, and can be measured in terms of output per worker. It takes into account all the labour which contributes to agriculture production, the labour that is used directly on the farm as well as that used indirectly off the farming producing the materials and services used on agricultural production. The labour input may be expressed as the total numbers in the labour force or in order to take into account the intensity of labour, as the number of man-hours worked in agriculture. Similarly, the total agricultural output may be taken as the gross farm output or it may be taken as the value added by labour and other factors in the agricultural sector; i.e., the value of fertilizer, pesticides, fuels and other inputs from outside the agricultural sector, is subtracted from the value of the output in order to determine the net contribution of the agricultural sector.

Labour productivity is in fact the most common form of income measurements, and is usually implied in economic discussions. For ascertaining the output per man it is one of the major determinants of the general level of economic welfare, labour productivity is a significant yardstick of economic progress. Various measurements of labour


productivity may have specific use in policy implications e.g., with regard to income distribution, occupational distribution of labour force etc.\textsuperscript{11}

Increases in productivity of land and of labour often go hand in hand. When crop yield are increased or the pattern of cropping intensified there is usually – although not always – an increase in output per man. Similarly, when improved methods are adopted to increase efficiency and raise labour productivity and farm incomes, there is often, as a secondary result, an increase in land productivity and total output. In countries with agricultural surplus problems this may be embarrassing, and increased labour productivity may then have to go hand in hand with measure to limit the area under cultivation.

Capital productivity of agriculture is particularly complicated to compute and difficult to interpret. This is largely because of diversity of capital being utilized in agriculture production: for land purchase and for improvements, land reclamation, drainage, irrigation, farm building, mechanical power, machinery and implements, livestock, feeds, seeds, fertilizers, crop protection chemicals etc. The presence or absence of amount, quality and price of each factor of production varies spatially, affecting the relationship between them and their deployment on individual farms. These spatial patterns are not static, labour and capital being geographically mobile. The use of each production factor will not depend solely upon its availability. It will be influenced by technological, economic and social circumstances which permit the substitution of one for another and in turn will be affected by their degree of divisibility.

\textsuperscript{11} Ibid., p. 98.
Estimates of capital productivity give relatively little guidance in ensuring the most efficient use of the limited capital resources. In part this is because that the statistics on capital in agriculture are less informative than those on land and labour, not because much of this investment, especially developing countries, consist of non-monetized investment stemming from the unpaid labour of the farmers themselves. The terracing of slopes, the bunding of paddy fields, the construction of irrigation ditches are examples of this type of non-monetized investment which is of crucial importance – for raising both output and productivity. This does not mean, of course, that capital is not the vital importance to agriculture. The requirements of fixed capital stock in agriculture – even excluding land – often appear to be greater in relation to the output than those of manufacturing industries and mining, though there are considerable differences between countries in method of estimation.

The productivity of livestock is again more difficult to measure than the productivity of land. The difficulty arises both in the measurement of the input and output. Much of the livestock production results in more than one end product: Cattle may produce milk, beef and hides, sheep may produce wool and meat etc. A comparison to say, the milk output of specialized dairy cows with that of dual purpose animals kept for both milk and beef may be misleading. To aggregate the output of all livestock products, with suitable price weights, solves part of the problem but not all of it because of the widespread use of livestock, particularly in the developing regions, for draft power. A complete accounting of the output would, therefore, also require the inclusion of the draft power produced by livestock. The principal input is
the Capital represented by the livestock itself. Other input include the feeding stuffs which they consume, whether from grazing or in the form of preserved or concentrated feeds, and the land which is pasture or cropland is devoted to livestock production.

The above measurement when combined shell not give a very satisfactory indication of productivity. The simplest and the most frequently used comparison is the output of milk or meat per animal, which would be significant when cattle are of about the same size or weight. But if in one country, the common breeds of livestock are large and in another small, differences between the average output per animal in the two countries will in part reflect these differences in size rather than their relative efficiency. And since small cattle eat less and since more cattle can be kept on a given area, the total output of meat or milk per unit of feed or per hectare of land may be as high in one country as in the other. It could not then be said, that the average productivity of the larger breeds was greater than that of the smaller breeds.\(^{12}\) The whole output from each hectare of land used for agriculture is known as the overall productivity of land. It is more significant than crop yields per hectare or livestock yields. The individual yield reflects only the efficiency of crop husbandry or livestock husbandry, the overall productivity also takes into account the managerial skill with which the various farm enterprises are integrated to increase the total farm output. The overall productivity reflects also the opportunities to produce high value crops, e.g., tobacco, or in suitable climates or under irrigation to raise more than one crop per year from the same land. Thus, the countries

with the highest total output per hectare appear to have an overall productivity some 40 times greater (exceptionally even more) than those with the least intensive agriculture.\textsuperscript{13}

**B. THE MEASUREMENT OF AGRICULTURAL PRODUCTIVITY**

The measurement of agricultural productivity is not a simple task as it deals with to establish a relationship between output and input in agricultural production. Inputs committed to agriculture have a complex phenomenon which governs farming efficiency. Stamp (1960), while attempting to measure crop productivity per unit area emphasized that the areal differences in crop productivity are the result partly of the natural advantages of soil and climate and partly of the farming efficiency.\textsuperscript{14} Farming efficiency refers to the properties and qualities of various inputs, the manner in which they are combined and utilized for production and effective market demand for crop output. The assessment of agricultural productivity has engaged the attention of scholars working in different disciplines like, geography, economies, agricultural economics and agricultural sciences, for a long time. Many attempts have been made to measure and quantify agricultural productivity in India as well as other countries of the world.

Thompson\textsuperscript{15} (1926) while measuring the relative productivity of Birtish and Danish farming emphasized and expressed it in terms of gross output of crops and livestock. He considered the following seven

\begin{itemize}
  \item \textsuperscript{13} Ibid., p. 110.
  \item \textsuperscript{15} Thompson, R.J., The Productivity of British and Danish Farming, *Journal of the Royal Statistical Society*, Vol. 89, Part II, 1926, p. 128.
\end{itemize}
parameters: (i) the yield per acre of crops, (ii) the livestock per 100 acres (iii) the gross production or output per 100 acres, (iv) the proportion of arable land, (v) the number of persons employed, (vi) the cost of production expressed in terms of wages and labour costs, rent or interest, and (vii) prices relative profitability and general economic conditions. Ganguli\textsuperscript{16} (1938) presented a theoretical discussion for computing productivity in agriculture. Firstly, he took into account the area under any crop ‘A’ in a particular unit which belongs to a certain region. This area is expressed as a proportion of the total cropped area under all the selected crops. Secondly, Ganguli, tried to obtain the index numbers of yield. This is found by dividing the yield per hectare for the entire region as the standard. This yield may be expressed as a percentage, the percentage may be regarded as the index number of yield. Thirdly, the proportion of the area under ‘A’ and the corresponding index number of yield were multiplied. There are two advantages which are apparent by using this method, i.e., (a) the relative importance of the crop ‘A’ in that unit of study is assessed (as indicated by the proportion of the cropped area which is under ‘A’ and (b) the yield of the crop ‘A’ in comparison to the regional standard. The product thus obtained indicates actually an index of the contribution of the crop ‘A’ to the productivity of the unit considered.

Kendall\textsuperscript{17} (1939) treated it as a mathematical problem and initiated a system of four coefficients: (a) productivity coefficient, (b) ranking coefficient, (c) money value coefficient, and (d) starch equivalent or energy


coefficiency. Kendall pointed out, that the productivity coefficient and the ranking coefficient are concerned only with the yield per acre, but are not in any way weighted according to the volume of production. He, therefore, evolved a measure of crop productivity by using index number technique. In this technique the yield of different crops are expressed in terms of some common units of measurement. Kendall pointed out, that there are two common units which can be taken into consideration: first money value 'as expressed in price' and second energy 'as expressed in starch equivalent'. In case of money value index, there is one major difficulty, that price data for certain crops are not available, for example, there are many vegetables and bears which are grown mostly for the consumption on the farms and their price data are not maintained in contrast to cereal crops whose data are adequate. While determining the money value coefficient, another difficulty arises with regard to the price for example, the prices prevailing in the area should be adopted, or those prevailing in the region or in the country as a whole, in addition to the local variations in prices which depend on circumstances like, the proximity to the market or the relative nutritive character of the product. Significant differences in price, and then add the results for the selected number of crops together. The total is divided by the total acreage in the unit area under the total selected crops. The result gives for each unit area a figure of money value per acre/hectare under the crops considered. So far as the energy coefficient is concerned, an index based on nutritional factor ignores local variations because of the absence of data. Kendall, therefore, suggested starch equivalent as the most suitable unit. While calculating a coefficient based on starch equivalent it should be decided: (a) whether a gross or net digestible energy figure is to be taken,
(b) whether any allowance is to be made for byproducts, such as wheat and barley straws or the green stalks of maize, jowar, and bajra, and (c) whether any account should be taken of the fact that the energy in certain foods has first to be fed to livestock and then wheat and milk is used for human consumption. The basic question that arises in this technique is whether the gross starch equivalent of the various crops should be considered or the net equivalent. Net energy refers to the amount of energy for work and body building, whereas a gross figure includes the energy employed in the digestive process of the consuming animal and similar non-realisable forms. Kendall suggested that production of energy be preferred as the gross figures.

It should be mentioned here, that the money value coefficient does not take into consideration the value of the by-products of the crops but a similar omission of any allowance or the energy of the by-products in the energy coefficient would have a serious affect. It is surmised that there is nearly as much starch equivalent in the straw produced on a hectare of land as the grain itself. Therefore, it becomes necessary to estimate the production by weight of by-product to the main products of wheat, barley, oats, beans, peas, etc.

The determination of productivity by the productivity coefficient method involves the use of higher mathematics and the money value coefficient and starch equivalent or energy coefficient pose a practical difficulty. Therefore, Kendall looked for a coefficient which might lead to similar results in productivity and save a good deal of calculations. The method attempts to arrange in sequence any given number of units growing
the same range of corps and then assess their agricultural efficiency. Kendall, took the acre yield of ten leading crops in each of the forty-eight administrative counties of England for four selected years. The places occupied by each county in respect to the selected crops were then averaged, and thus ranking coefficient of agricultural efficiency of each county was obtained. If a county was at the top of every list, it would have a ranking coefficient of one and if it were at the bottom of every list, it would have a ranking coefficient equal to the number of countries concerned.

Hirsch\textsuperscript{18} (1943) has suggested, ‘Crop Yield Index’ as the basis of productivity measurement. It expresses the average of the yield of various crops on a farm or in a locality relative to the yield of the same crops on another farm in a second locality. Zobel\textsuperscript{19} (1950) has attempted to determine the labour productivity. He considered productivity of labour as the ratio of total output to the total man-hours consumed in the production of that output resulting in output per man-hour. This has been designed with the equation:

\[ \pi = f(P, L) \]

where,

\[ \pi \] = productivity of labour;
\[ P \] = production; and
\[ L \] = Labour utilized


Stamp\textsuperscript{20} (1952) applied Kendall's ranking coefficient technique on an international level in order to determine agricultural efficiency of a number of countries as well as some major crops. Huntington and Valkenburg\textsuperscript{21} (1952) considered land productivity on the basis of acre yield of eight crops raised very widely in Europe. They selected average yield per acre of each crops for Europe as a whole, and assumed as an index of 100 for it, and thus calculated this specific yield index of each country. Stamp\textsuperscript{22} (1958) suggested another method for measuring the agricultural productivity, i.e., to convert the total agricultural production in calories. The calories intake is a measure of the general health of a person because it determines the amount of heat and energy needed by the human body. The British Medical Association on the basis of exhaustive enquiry, published a table showing a range of desirable calorie intake among adults from 2,100 calories a day for woman in sedentary occupation to 4,250 calories for a man engaged in active manual work. For children, the desirable intake is calculated as 800 calories a day, for infants under one year to 3,400 calories for teenage boys.\textsuperscript{23} Taking into consideration the age structure of the population, the range of occupation, the weight and height of the people living under climatic conditions of northwestern Europe, the average is 2,460 calories a day or about 9,00,000 calories per year. Stamp, called it as a

\textsuperscript{20.} Stamp, L.D., The Measurement of Agricultural Efficiency With Special Reference to India, Silver Jubilee Souvenir Volume, Indian Geographical Society, 1952, pp. 177-78.


'Standard Nutrition Unit'. Shafi\(^2\)\(^4\) (1960) applied the technique of 'ranking coefficient' of Kendall for measuring agricultural efficiency in Uttar Pradesh taking into account eight food crops grown in each of the forty-eight districts of the state. He applied this method to acre yield figures for the two quinquennial years ending 1952 and 1957.

Loomis and Barton\(^2\)\(^5\) (1961) have measured United States agricultural inputs and productivity in aggregate. To them, aggregate productivity depends upon conceptually consistent measures of agricultural output and input. The measures of inputs includes all the production factors and depend directly on the decisions of farmers. Meiburg and Brandt\(^2\)\(^6\) (1962) have surveyed the earlier indices relating to the United States agricultural output, e.g., output estimates of total productivity. They considered eight indices of agricultural production which cover various phase of the period extending between the year 1866 and 1960. Mackenzie\(^2\)\(^7\) (1962) has measured the efficiency of production in Canadian agriculture by using the coefficient of output relative to input. He mentions, that the concept of productivity measurement is difficult to quantify. Common\(^2\)\(^8\) (1962) while working out the trends of productivity in agriculture of the


state of Kerala (India) has measured productivity on the basis of yield per acre.

Enyedi\(^2^9\) (1964) while describing geographical types of agriculture in Hungary refers to a formula for determining agricultural productivity. This formula for assessing productivity coefficient would be read thus:

\[
\frac{Y}{Y_n} : \frac{T}{T_n}
\]

Where,

- \(Y\) = total yield of the respective crop in the unit area;
- \(Y_n\) = total yield of the crop at the national level;
- \(T\) = total cropped area of the unit; and
- \(T_n\) = total cropped area at the national level.

Horring\(^3^0\) (1964) has suggested, that the concept of productivity is based not only on the single relationship between output and input, but rather on the differences between two or more relationships i.e., differences in the same agricultural region or sub-region as between successive periods (in time), and between similar agricultural regions in different countries or regions during the same period (in space). It may also be possible to make comparisons between the trends of productivity for different products, between different regions of the national economy or between the agricultural regions and the national economy as a whole. The Indian society of agricultural economics, considered the problem and published a series of

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articles under the broad head ‘regional variation in agricultural development and productivity’. Among the contributors Chatterji and Maitreya (1964) have determined the levels of agricultural development and productivity during 1950-51 to 1957-58 in the state of West Bengal, considering only two principle crops viz., rice (among the food crops) and jute (from the cash crops). They utilized the acre yield figures for this purpose. Dhondyal (1964) has measured variations in agricultural development and productivity by selecting three representative districts from the three regions of the Uttar Pradesh, while assessing the role of credit, intensive crop enterprises, and the influence of irrigation water during 1962-63.

Garg (1964) worked out the trends in agricultural development with respect to total cropped area, gross irrigated area and foodgrains production in the two districts of Uttar Pradesh viz., Gorakhpur representing the eastern region, and Meerut from the western region and productivity by assessing acreage, production and average yield per acre of three important crops viz., rice, wheat and sugarcane. This study extends from 1951-52 to 1960-61 covering the period between the first and second Five Year Plans. Gopalkrishnan and Ramakrishna (1964) have taken Andhra Pradesh to

measure the degree of variation with respect to (a) agricultural output per acre (Rs.), and (b) output per head of agricultural population (Rs), and to account the causes of variation in each of twenty districts of the state during 1959-60. The variables relating to the level of output per acre are selected as follows: (i) normal level of rainfall; (ii) percentage of current and old fallows; (iii) percentage of area under irrigation; (iv) percentage of literacy; (v) percentage of population engaged in agriculture; (vi) intensity of cropping; (vii) percentage of gross value other than foodgrains and fodder; (viii) the percentage of area under all crops excluding fodder and foodgrains; (ix) density of agricultural population per acre; and (x) percentage of total area under commercial crops including rice.

Sapre and Deshpande\textsuperscript{36} (1964) have attempted to modify Kendall’s ranking coefficient by giving weightage to that of the area of different crops. The weights for ranks of various crops are proportional to the percentage of cropland under each crop. For example, an enumeration unit ‘A’ which has rank 2 on the basis of wheat acre-yield and occupied 30 per cent of the total cropped area, rank 3 on the basis of rice acre-yield and occupies 25 per cent of the total cropped area, rank 8 on the basis of gram acre-yield and occupies 10 per cent of the total cropped area. Thus the weighted average of the rank would be: (2x30) + (3x25) + (8x10) = 215 divided by the sum of the weights as 215/65 = 3.3 According to Kendall’s method it would have been 2+3+8 = 13 divided by the number of crops as 13/3 = 4.3.

\textsuperscript{36} Sapre, S.G. and Deshpande, V.D., Inter-District Variations in Agriculture Efficiency in Maharashtra State, \textit{ibid}, p. 243.
The Indian Society of Agricultural Statistics, organized a symposium on the topic, 'Measurement of Agricultural Productivity' at the 17th annual conference of the society held at Jaipur in 1964. The research papers contributed by different scholars appeared in the society's journal viz., *Journal of the Indian Society of Agricultural Statistics*, in the succeeding issue of 1965. Sarma" (1965) while elaborating the concept of agricultural productivity suggested various parameters on which it can be measured. According to him, productivity can be considered in relation to land, labour, and capital. It can also be considered in terms of overall resources employed in agriculture. In case of commodities like foodgrains, fruits, and vegetables, sugarcane and edible seeds, he suggests, that the output of these commodities be converted into calories. While considering the other non-food crops such as cotton and other fibres the only common measure being the value which involves the pricing of different products. For evaluating value of production, farm harvest or wholesale price have the definite significance. He also emphasized agriculture workforce as the basis of productivity measurement. For that he suggests the total number of labourers employed (in order to account the intensity of labour) or the number of man-hours worked in agriculture per unit area.38

Khusro39 (1965) has linked assessment of productivity with the output per unit of a single input and output per unit of cost of all input in the


38. Ibid., p. 254.

agricultural production. Saran\textsuperscript{40} (1965) has applied Cobb-Douglas Production Function approach for the measurement of productivity. The common purpose of this function is to express input output relationship between several inputs and one output in the agricultural system. The function takes the following forms:

\[ Y = A x_1^b x_2^c x_3^d x_4^e \cdots x_n^y \]

where, \( x_1, x_2, x_3, x_4 \ldots n \) denote various inputs like land, labour, capital assets and other working expenses. The values of \( b, c, d \ldots y \) represent elasticities of the respective inputs.

Shafi\textsuperscript{41} (1965) examined the labour productivity on the basis of labour population engaged in agriculture. According to him, it can be computed by dividing the gross production in an unit area by the number of man-hours or less precisely by the number of persons employed in agriculture. In order to assess the productivity on the basis of population engaged in agriculture it can either be obtained by dividing the total production with that of the number of workers, or a reverse index be applied where the total number of workers per unit of production is assessed.

Agarwal\textsuperscript{42} (1965) has adopted, ‘Factorial Approach’ while measuring agricultural efficiency in Baster district of Madhya Pradesh. In this approach a number of human controlled factors relating to agricultural

\begin{itemize}
  \item \textsuperscript{40} Saran, R., Production Function Approach to the Measurement of Productivity in Agriculture, \textit{ibid.}, p. 268.
  \item \textsuperscript{41} Shafi, M., Approaches to the Measurement of the Agricultural Efficiency, \textit{Proceeding of the Summer School in Geography held at Nainital} (unpublished), Department of Geography, Aligarh Muslim University, Aligarh, 1965, p. 4.
  \item \textsuperscript{42} Agarwal, P.C., Measurement of Agricultural Efficiency in Bastar District : A Factorial Approach, \textit{ibid.}
\end{itemize}
production as: crop superiority, crop commercialization, crop security, landuse intensity and power input have been selected, excluding the environmental factors.

Buck\textsuperscript{43} (1937) assessed the agricultural progress in China by adopting the approach of 'Grain Equivalent'. For this purpose, he converted all the agricultural products into kilogram of grain equivalent in order to select as a unit of measure a kilogram, with whatever kind of grain was predominant in the region. A modification in this method was attempted by Clark and Haswell\textsuperscript{44} (1967) by expressing the output in terms of kilogram of 'wheat equivalent' for head of population. Dovring\textsuperscript{45} (1967) has measured the productivity of labour in the United States agriculture in aggregate from 1919 to 1954 as a whole, as well as commoditywise. Bhatia\textsuperscript{46} (1967), while assessing the changes and trends in agriculture efficiency in Uttar Pradesh during 1953-1963 adopted Ganguli's method of productivity measurement and has devised an equation which would be read thus:

\begin{equation}
I_{ya} = \frac{y_c}{y_t} . 100
\end{equation}

where,

\begin{itemize}
\item $I_{ya}$ = the yield index of crop a;
\end{itemize}

\textsuperscript{43} Buck, J.L., \textit{Land Utilization in China}, I, Nanking, 1937.
\textsuperscript{44} Clark, C. and Haswell, M., \textit{The Economics of Subsistence Agriculture}, London, 1967, pp. 51-52.
\textsuperscript{45} Dovring, F., Productivity of Labour in Agricultural Production, \textit{Agriculture Experiment Station Bulletin}, No. 726, College of Agriculture, Urbana, Illinois, 1967.
\[ y_c = \text{the average acre yield of crop 'a' in the component unit}; \text{ and} \]
\[ y_r = \text{the average acre yield of crop 'a' in the entire region, and} \]

\[(ii) \quad E_i = \frac{I_{ya}C_a + I_{yb}C_b + \ldots + I_{yn}C_n}{C_a + C_b + \ldots + C_n} \]

where,
\[ E_i = \text{is the agricultural efficiency index}; \]
\[ I_{ya}, I_{yb} \text{ etc.} = \text{the indices of various crops}; \text{ and} \]
\[ C_a, C_b, \text{ etc.} = \text{represent the proportion of cropland devoted to different crops.} \]

Shafi\(^47\) (1967) applied Stamp’s ‘Standard Nutrition Unit’ technique for measuring the efficiency of agriculture in India. He considered the district as the areal unit, and selected all the food crops grown in India. Noort\(^48\) (1967) considered ‘net total productivity’ (being the relationship between the net product and factor input) as a method for the measurement of productivity and also to compare it ‘in time’ or ‘in space’. The purpose of which is to account change in labour and capital inputs in agriculture.

Sinha\(^49\) (1968) adopted a standard deviation formula to determine agricultural efficiency in India. In his study he selected all the twenty five major crops grown in the country which were grouped into cereals, pulses and oilseeds. In case of cash crops, their monetary values were calculated in


Rs. per hectare by incorporating wholesale market prices. Finally, the standard scores were computed and to give them weightage, these values were multiplied by the acreage figures.

Shafi\(^{50}\) (1972) while measuring the agricultural productivity of the Great Indian Plains attempted to modify the Enyedi’s formula. In the modified formula the summation of the total yield of all the crops in the district is divided by the total area under the crop considered in the district and the position thus obtained is examined in relation to the total yield of all the crops considered at the national level divided by the total area under those crops. The modified formula would be read thus:

\[
\frac{\left(\sum y/w + \sum y/r + \sum y/m + \ldots \right)}{\left(\sum Y/W + \sum Y/R + \sum Y/M + \ldots \right)}
\]

or

\[
\frac{\Sigma y}{t} : \frac{\Sigma Y}{T}
\]

where,

- \(y_w, y_r, y_m, \ldots\) = total yield of various crops in the district;
- \(Y_w, Y_r, Y_m, \ldots\) = total yield of various crops at the national level;
- \(t\) = total area under different crops in the district; and
- \(T\) = total area under different crops at the national level.

Singh\(^{51}\) (1972) attempted to measure the agricultural efficiency of Haryana in terms of nutrition units per unit area. He tried to measure the

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carrying capacity per square mile in the areal unit by initiating a formula which can be expressed as:

\[
\frac{Co}{Cp} = \frac{Cp}{Sn}
\]

where,

- \( Cp \) = carrying capacity;
- \( Co \) = calorie output per square mile;
- \( Sn \) = Standard nutrition for ingestion in calories per person/annum

Singh, expressed it as a percentage of the carrying capacity in the entire region to obtain index numbers, which gives a measure of the agricultural efficiency of the areal unit relative to the entire region. The above may be expressed as:

\[
\frac{Cpe}{Iae} = \frac{Cpe}{Cpr} \times 100
\]

where,

- \( Iae \) = the index number of agricultural efficiency of an enumeration unit;
- \( Cpe \) = the carrying capacity in terms of population in the component enumeration unit;
- \( Cpr \) = the carrying capacity in the entire region.

The Indian Society of Agricultural Statistics in its 30th Annual Conference held at Bhubaneswar (Orissa) India, discussed some aspects on agricultural productivity in the Indian context.\(^{52}\) Raheja\(^{53}\) et al. (1977) have

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measured the impact of high-yielding varieties based on data collected under the scheme 'Sample Surveys for Assessment of High-yielding Varieties Programme' during 1973-74 and regional variations in productivity on the basis of yield per hectare in India. Singh\textsuperscript{54} et al. (1977) have accounted the level of increase in the yield of different crops during three decennial years i.e., 1950-51, 1960-61 and 1970-71 in each state of India, considering the relationship between the output of foodgrains and related inputs like, the application of fertilizers, proportion of area sown more than once and gross irrigated area. Nagia\textsuperscript{55} et al. (1977) conducted a field survey in the village of Khandewala, of Haryana state. The study takes into account the productivity level at different field of the village in terms of money value during 1974-75 and a number of factors enumerated in three broad categories, viz. environmental, technological and institutional which hold responsibilities for the productivity variation. Bhalla\textsuperscript{56} (1978) has considered output per person on the basis of constant average prices for measuring productivity of labour in agriculture for each district of India. Singh\textsuperscript{57} (1979) devised a method of presenting a two-dimensional picture of agricultural productivity, comprising two components viz., intensity and spread, considering three variables (i) yield; (ii) grain equivalent; and (iii) cropping system in the


\textsuperscript{55} Nagia, S. \textit{et al.}, Variations in Field Productivity – A Case Study of Khandelwala Haryana, \textit{Occasional Paper} No. 7 (Mimeo.), Centre for the Study of Regional Development, Jawaharlal Nehru University, New Delhi, 1977.


\textsuperscript{57} Singh, V.R., A Method for Analysing Agricultural Productivity, \textit{Agriculture and Food Supply in Developing Countries} (ed. J.T. Coppock), Published for the Commission on World Food Problems and Agricultural Productivity of the IGU, Department of Geography, University of Edinburgh, 1979, pp. 43-51.
districts of the state of Andhra Pradesh. Accordingly, a relative share of intensity and spread for each micro-unit (district) has been computed to the macro-unit (state) separately for the above three variables with the help of equations that have been derived.

C. CROP PRODUCTIVITY REGIONS IN ROHILKHAND

Crop productivity is a multi-dimensional concept, which includes technological advancement, effective management of available resources, and organizational setup for crop production. These factors in turn affect the relative crop production in the region. It may be pointed out, that the development of agriculture should be assessed by evaluating the use of various inputs i.e., the extent of cultivated area, provision of irrigation, fertilizers, improved varieties of seeds and labour availability. It provides food for growing population and help to expand the secondary and tertiary sectors, increases the income and provide a welfare to the population living in rural areas.

In order to assess crop productivity in each of the 90 development blocks belonging to 7 districts of Rohilkhand region of the state of Uttar Pradesh for the period of 1994-95 to 1998-99, on an average basis. Some 18 major crops* grown in the region were considered for the productivity analysis. Yang (1965)\textsuperscript{58} ‘Crop Yield Index’ method was applied for the computation of productivity.

*Crop considered can be grouped in different categories as follows :

(i) Cereal crops - rice, wheat, barley, jowar, bajra and maize;
(ii) Pulse crops - blackgram (urd), greengram (moong), lentil (masoor), gram, peas and pigeon-pea (arhar/tur);
(iii) Oilseeds - mustard, sesameum (til), groundnut and sunflower;
(iv) Cash crops - sugarcane and potatoes.

Table 3.1

Method of Calculating Crop Yield Index for Najibabad block, District Bijnore of Rohilkhand Region

| Crops | Yield in quintals per hectare | Area under crop in the block (in hectare) | Crop yield in block as a percentage of the entire region \( \times 100 \) | Percentage multiplied by area under crops (Col.4xCol.5) |
|-------|-----------------------------|------------------------------------------|------------------------------------------------|-------------------------------------------------
|       | Average yield in the entire region | Average yield in the block | Col. 3 | Col. 2 | 5 | 6 |
| Rice  | 24.35 | 29.23 | 6455 | 120.04 | 774858.2 |
| Wheat | 30.67 | 25.76 | 11651 | 83.99 | 978567.49 |
| Barley| 20.92 | 21.78 | 30 | 104.11 | 3123.30 |
| Jowar | 8.57  | 9.45  | 86 | 110.26 | 3969.36 |
| Bajra | 10.48 | 11.70 | 1 | 111.64 | 111.64 |
| Maize | 10.71 | 12.25 | 22 | 114.37 | 2553.88 |
| Total | 18195 | | | 1763183.6 |

Crop Yield Index for Najibabad block \[ = \frac{1763183.6}{18195} \]

\[ = 96.90 \text{ per cent} \]

The procedure for calculating 'Crop Yield Index' for a block of Najibabad belonging to Bijnore district may be taken as an example. Firstly, the average yield of each crop grown in the entire region is determined. Secondly, the yield value of each crop is divided by the yield of the entire region and multiplied by 100, to get the value in per cent or the index number (as shown in col. 5, Table 3.1). By considering the area devoted to
each crop as a weight and multiplying it with the index number, a product is obtained (as shown in col. 6, Table 3.1). By adding the products and dividing the sum of the products by the total crop area (in hectares) of the farm and using the crop area as the weight, the resultant average index is the desired index for the particular farm in the block. The computed values of productivity indices for each block of the region are given in Appendix B.

I. Productivity Regions – Based on Cereal Crops Yield Index

Cereal crops acquire an important position in the agriculture of Rohilkhand region. Of these rice, wheat, barley, jowar, bajra and maize occupy an important position in cultivation.

i. Very high productivity region

Very high productivity for cereals is confined to 7 blocks. It may be seen from Fig. 8 that six blocks lie in Rampur district of Rohilkhand region. The blocks of Rampur district possessing very high productivity in cereals are namely, Shahabad (109.59), Saidnagar (107.16), Milak (107.04), Bilaspur (106.79), Suar (106.87) and Chamraon (106.76) cover the northeastern part of the region.

A single block namely, Lalaurikhera (107.90) of Pilibhit district is also characterized with very high productivity (with 77.63 per cent of area under cereal crops) and lies in eastern part of the region.

As seen from Table 3.2, that very high productivity region for cereal crops occupy 11.11 per cent of the total cereal cropped area in Rohilkhand region. Very high productivity is designated with the index value above 104.92.
Table 3.2
Productivity Regions – Based on Cereal Crops Yield Index in Rohilkhand Region - 1994-95 to 1998-99

<table>
<thead>
<tr>
<th>Productivity Category</th>
<th>Crop Index</th>
<th>Area (in ha.)</th>
<th>Percent of Area</th>
<th>Number of Blocks</th>
<th>Name of Development Blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>Above 104.92</td>
<td>262307</td>
<td>11.11</td>
<td>7</td>
<td>Shahabad, Saidnagar, Milek, Bilaspur, Suar, Chamaon, Lalaurikhera</td>
</tr>
<tr>
<td>High</td>
<td>97.61-104.92</td>
<td>764858</td>
<td>32.39</td>
<td>25</td>
<td>Afzalgarh, Kotwali, Nahtaur, Dhampur, Morari, Bilsanda, Amaryia, Puranpur, Barkhera, Bisalpur, Jaitipur, Banda, Powayan, Dadrol, Tilhar, Bhawalkhera, Khutar, Sindhauli, Jalalabad, Kalan, Katra, Kanth, Nighoi, Mirzapur, Bhagatpur- Tanda</td>
</tr>
<tr>
<td>Medium</td>
<td>90.30-97.61</td>
<td>543284</td>
<td>23.01</td>
<td>25</td>
<td>Seohara, Najibabad, Kiratpur, Noorpur, Mdpur Deomal, Jalipur, Haldor, Asmoli, Gangeshwari, Thakurdwara, Dilari, Mundapandey, Chajlat, Gajraula, Dhanaura, Bilari, Dirgarpur, Joya, Baniyakhera, Hasanpur, Panwasa, Bahjoi, Sambhal, Dhagavan, Ramnagar</td>
</tr>
<tr>
<td>Low</td>
<td>82.99-90.30</td>
<td>689319</td>
<td>29.19</td>
<td>29</td>
<td>Rajpura, Junabai, Gunnaur, Sahaswan, Ambiapur, Ujhani, Bisauli, Asafpur, Islamnagar, usawa, Wazirgan, Jagat, Salarpur, Alampur- Jafarabad, Kyara, Qadarchowk, Mirganj, Fatehganj, Shergarh, Faridpur, Dumkhoda, Bhojipur, Bithri-Chainpur, Bhadpura, Majhgawa, Bhuta, Nawabganj, Amroha, Moradabad</td>
</tr>
<tr>
<td>Very low</td>
<td>Below 82.99</td>
<td>100991</td>
<td>4.27</td>
<td>4</td>
<td>Samrer, Dataganj, Mion, Baheri</td>
</tr>
</tbody>
</table>
ii. **High productivity region**

High productivity region are designated with the index values ranging between 97.61 and 104.92. At least 25 blocks are characterized with high productivity in the region. In Bijnore district, there are 4 blocks of high productivity are namely, Afzalgarh (101.76), Kotwali (99.42), Nahtaur (98.35) and Dhampur (97.89). A total of 6 blocks in Pilibhit district possesses high productivity are namely, Marori (101.51), Bilsanda (101.17), Amaryia (100.91), Barkhera (100.83), Bisalpur (100.80) and Puranpur (100.87) lies in eastern part of Rohilkhand region. Another important district which has high productivity is Shahajahanpur, and the development blocks as shown in Fig. 8 lying in southeastern part of the region are namely, Jaitipur (100.59), Banda (100.57), Powayan (100.56), Dadrol (100.53), Tilhar (100.49), Bhawalkhera (100.47), Khutar (100.44), Sindhauilli (100.44), Jalalabad (100.37), Kalan (100.29), Katra (100.24), Kanth (100.95), Nighoi (100.07) and Mirzapur (99.63).

The BhagatpurTanda a single block belongs to Moradabad district also possesses high productivity with an index value of 97.68 per cent. The productivity amongst these block varies due to the variations in soil fertility, irrigation, relatively a high rate of fertilizer consumption and socio-economic conditions.

iii. **Medium productivity region**

There are different pockets of medium productivity in cereal crops (as shown in Fig. 8) lies in northern and northwestern parts of the region with the index values ranging between 90.30 and 97.61 per cent. In Bijnore district, blocks having the medium productivity are namely, Seohara
ROHILKHAND REGION
Productivity Regions - Based on Cereal Crops Yield Index
1994-95 to 1998-99

INDEX

Very High
Above 104.92
High
97.61 - 104.92
Medium
90.30 - 97.61
Low
82.99 - 90.30
Very Low
Below 82.99

Fig. 8
(97.44), Najibabad (96.90), Kiratpur (96.37), Noorpur (94.49), Mdpur-Deomal (93.47), Jalilpur (90.58) and Haldor (90.57). Another district lying in northern part of the region is the district of Moradabad. In this district at least 16 development blocks are characterized with medium productivity are namely, Asmoli (96.96), Gangeshwari (96.79), Thakurdwara (96.35), Dilari (96.34), Mundapandey (96.21), Chajlat (95.83), Gajraula (95.75), Dhanaura (95.66), Bilari (95.07), Dingarpur (94.91), Joya (94.71), Baniyakhera (94.42), Hasanpur (94.42), Panwasa (94.12), Bahjoi (93.73) and Sambhal (93.67).

A single block of Dhagavan in Budaun district with an index value of 90.44, and Ramnagar block (90.32) of Bareilly district have medium productivity in cereal crops.

iv. Low Productivity Region

Low productivity in cereals is confined to 29 development blocks forming parts in different districts of the region to cover 29.19 per cent area to the total cereals cropped area with an index value of 82.99 and 90.30.

In Budaun district at least 14 development blocks lying in southwestern parts characterized with low productivity are namely, Rajpura (90.07), Junabai (90.05), Gunnaur (89.77), Sahaswan (88.95), Ambiapur (88.10), Ujhani (87.62), Bisauli (87.54), Asafpur (87.15), Islamnagar (87.07), Usawa (86.61), Wazirganj (85.34), Jagat (84.08), Salarpur (83.32) and Qadarchowk (87.24).

In Bareilly district there are 13 blocks which lies in central part of the region are marked with low productivity. They are namely, Alampur-
Jafarabad (90.13), Kyara (87.72), Mirganj (86.70), Fatehganj (85.77), Shergarh (84.98), Faridpur (84.95), Dumkhoda (84.70), Bhojipur (84.64), BithriChainpur (84.35), Bhadpura (84.30), Majhgawa (84.17), Bhuta (83.96) and Nawabganj (83.12). In Moradabad district a very small area spreading over on two blocks of Amroha (88.78) and Moradabad (84.64) is characterized with low productivity.

v. Very Low Productivity Region

Very low productivity in cereal crops is confined to 4 development blocks and cover 4.27 per cent of the total cereals cropped area with an index value of below 82.99. In Budaun district of Rohilkhand region, 3 blocks which possesses very low productivity are namely, Samrer (81.70), Dataganj (81.65) and Mion (81.23). The Baheri is a single block in Bareilly district which is marked with very low productivity with an index value of 82.55.

II. Productivity Regions – Based on Pulse Crops Yield Index

The cultivation of pulses is very significant in Rohilkhand region. The pulses productivity varies in different parts of the region. Areas of very high, high, medium and low productivity are shown in Table 3.3 and Fig. 9 shows five different categories of pulse crop productivity regions. Very high region with the index values ranging above 120.79, high productivity region with the index values of 109.47 and 120.79, the medium productivity ranged between 98.17 and 109.47, low productivity characterized with the index values in between 86.85 and 98.17, and very low productivity is having the values below 86.85.
## Table 3.3

Productivity Regions – Based on Pulse Crops Yield Index in Rohilkhand Region - 1994-95 to 1998-99

<table>
<thead>
<tr>
<th>Productivity Category</th>
<th>Crop Index</th>
<th>Area (in ha.)</th>
<th>Percent of Area</th>
<th>Number of Blocks</th>
<th>Name of Development Blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>Above 120.79</td>
<td>9130</td>
<td>7.36</td>
<td>10</td>
<td>Saidnagar, Shahabad, Milak, Chamaron, Jalilpur, Nahta, Haldor, Noorpur, Sheohara, Kotwali</td>
</tr>
<tr>
<td>High</td>
<td>109.47-120.79</td>
<td>12763</td>
<td>10.30</td>
<td>20</td>
<td>Joya, Sambhal, Hasanpur, Bilari, Baniyakhera, Panwasa, Moradabad, Gangeshwari, Bahjol, Dingarpur, Gajrula, Dhanaura, Asmoli, Bhagatpur Tanda, Dhampur, Najibabad, Kiratpur, Mdpur- Deomal, Afzalgarh, Suar</td>
</tr>
<tr>
<td>Medium</td>
<td>98.17-109.47</td>
<td>30689</td>
<td>24.76</td>
<td>22</td>
<td>Bilaspur, Dhaagavan, Baheri, Dumkhoda, Nawabganj, Bhojipura, Bhdpura, Faridpur, Shergarh, Bithri- Chainpur, Kyara, Bhuta, Mirganj, Majhgawa, Fatehganj, Alampur-Jafarabad, Ramnagar, Dilari, Mundapanday, Thukurdwara, Amroha, Chajlat</td>
</tr>
<tr>
<td>Low</td>
<td>86.85-98.17</td>
<td>69759</td>
<td>56.30</td>
<td>37</td>
<td>Bisauli, Sahaswan, Ambiapur, Salarpur, Islamnagar, Jagat, Dataganj, Asafpur, Usawa, Wazirganj, Mion, Samrer, Ujhani, Junabai, Qadarchowk, Rajpura, Gunnaur, Bisalpur, Puranpur, Marori, Lalaurikhera, Amaryia, Barkhera, Bilsanda, Mirzapur, Dadrol, Tilhar, Kanth, Jatipur, Kalan, Katra, Jalalabad, Sindhauli, Nighoi, Powayan, Khutar, Bhawalkhera</td>
</tr>
<tr>
<td>Very low</td>
<td>Below 86.85</td>
<td>1556</td>
<td>1.25</td>
<td>1</td>
<td>Banda</td>
</tr>
</tbody>
</table>
i. Very High Productivity Region

Very high productivity region in pulses as it is confined to 10 blocks, 6 of them form parts of the Bijnore district are namely, Jalilpur (129.27), Nahtaur (123.79), Haldor (123.74), Noorpur (121.88), Seohara (121.85) and Kotwali (121.04). The other blocks with very high productivity are namely, Saidnagar (132.61), Shahabad (130.11), Milak (129.46) and Chamraon (128.53) which form the parts of the district of Rampur.

ii. High Productivity Region

High productivity is designated with the index value ranging from 109.47 to 120.79 and these regions occupy 10.30 per cent of the total pulses cropped area (Table 3.3). This category covers 20 development blocks lying mainly in the northern parts of the region to form parts in the districts of Bijnore, Moradabad and Rampur.

In Bijnore district there are 5 development blocks with high productivity in pulses which are namely, Dhampur (119.14), Najibabad (117.92), Kiratpur (117.31), MdpurDeomal (114.35) and Afzalgarh blocks where the index value ranges above 113. 47.

In Moradabad district 14 development blocks are characterized with high productivity which are namely, Joya (113.60), Sambhal (112.85), Hasanpur (112.59), Bilari (112.57), BaniyaKhera (111.64), Panwasa (111.32), Moradabad (110.77), Gangeshwari (110.69), Bahjoi (110.59), Dingarpur (110.19), Gajraula (110.11), Dhanaura (109.95), Asmoli (109.83) and BhagatpurTanda (109.48).
ROHILKHAND REGION
Productivity Regions - Based on Pulse Crops Yield Index
1994-95 to 1998-99

INDEX

- Very High: Above - 120.79
- High: 109.47 - 120.79
- Medium: 98.17 - 109.47
- Low: 86.85 - 98.17
- Very Low: Below - 86.85

Fig. 9
In Rampur district, there is a single block of Suar is characterized with high productivity with the index value of 120.03 (Fig. 9).

iii.Medium Productivity Region

The blocks with the index value between 98.17 and 109.47 are classed as having medium productivity. Medium productivity is confined to the districts of Bareilly, Moradabad. A single block in the Rampur district namely, Bilaspur (107.73), and Dhagavan in Budaun district is also characterized with the index value of 99.13. Out of the total of 22 blocks characterized with medium productivity, 15 blocks lies the Bareilly district which are namely, Baheri (102.03), Dumkhoda (101.76), Nawabganj (101.74), Bhojipura (101.57), Bhadpura (101.53), Faridpur (101.46), Shergarh (101.33), BithriChainpur (101.21), Kyara (100.94), Bhuta (100.77), Mirganj (100.53), Majhgawa (100.38), Fatehganj (100.21), Alampur Jafarabad (99.96) and Ramnagar (99.95).

In Moradabad district of the region there are 5 blocks which possess the productivity of medium order are namely, Dilari (109.41), MundaPandey (109.13), Thakurdwara (108.78) and Amroha (108.45) and Chajlat (104.98).

iv. Low Productivity Region

The low productivity forms a contiguous belt in southeastern and southwestern parts of the region. The development blocks those are having the index value between 86.85 and 98.17 are classed as the region of low productivity. These tracts marked with low productivity cover 56.30 per cent of pulse cropped area (Table 3.3). A total of 69,759 hectares of land is under pulses cultivation characterizing with low productivity and which spreads over 37 blocks of the districts of Shahjahanpur, Pilibhit and Budaun.
In Budaun district, all the development blocks except the block of Dhagavan are characterized with low productivity. The blocks forming the part of Pilibhit district having low productivity are namely, Bisalpur (97.72), Puranpur (91.78), Marori (91.33), Lalaurikhera (91.01), Amaryia (89.98), Barkhera (89.90) and Bilsanda (95.15). In Shahjahanpur district there are 13 blocks marked with low productivity are namely, Mirzapur (97.46), Dadrol (94.50), Tilhar (91.99), Kanth (91.61), Jaitipur (91.32), Kalan (91.29), Katra (91.00), Jalalabad (90.72), Sindhaul (90.49), Nighoi (90.40), Powayan (90.22), Khutar (89.67), and Bhawalkhera (89.87).

Only one block namely, Banda of Shahjahanpur district falls in the category of very low productivity with a yield index value of 86.45.

III. Productivity Regions – Based on Oilseed Crops Yield Index

Oilseeds constitute a great significance in Rohilkhand agriculture. Very recently, they have acquired attention with the static production, and subsequent decrease in area, that has resulted a fall in per capita availability. The oilseeds have a consumption significance and are grown in both kharif and rabi seasons. The important oilseeds grown in different parts of the region are: mustard, groundnut, sesamum (til) and sunflower. Their specific significance can be examined with reference to the actual area and respective share which these crops constitute in the total cropped area of the region.

i. Very High Productivity Region

In very high productivity region oilseeds occupy 4.60 per cent share in 4 development blocks of Rohilkhand region. The regional pattern of
Table 3.4
Productivity Regions – Based on Oilseed Crops Yield Index in Rohilkhand Region - 1994-95 to 1998-99

<table>
<thead>
<tr>
<th>Productivity Category</th>
<th>Crop Index</th>
<th>Area (in ha.)</th>
<th>Percent of Area</th>
<th>Number of Blocks</th>
<th>Name of Development Blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>Above 120.55</td>
<td>6248</td>
<td>4.60</td>
<td>4</td>
<td>Dhanaura, Bithri Chainpur, Jalilpur, Bilaspur</td>
</tr>
<tr>
<td>High</td>
<td>108.0-120.55</td>
<td>27069</td>
<td>19.94</td>
<td>24</td>
<td>Noorpur, Nahtaur, Seohara, Dhampur, Kiratpur, Milak, Saidnagar, Suar, Shahabad, Chamraon, Bhadpura, Nawabganj, Bhuta, Alampur-Jafarabad, Ramnagar, Kyara, Majhgawa, Fatehganj, Faridpur, Baheri, Shergarh, Dumkhoda, Mirganj, Bhojipura</td>
</tr>
<tr>
<td>Medium</td>
<td>95.46-108.0</td>
<td>66140</td>
<td>48.72</td>
<td>43</td>
<td>Najibabad, Mdpur-Deomal, Haldor, Kotwalli, Azalsoar, Chajlat, Bahjoi, Gajraula, Moradabad, Banya Khera, Joya, Mundapandey, Dingarpur, Bhagatpur-Tanda, Bilari, Amroha, Hasanpur, Asmoli, Sambhal, Panwasa, Gangeswari, Thakurdwara, Dhagavan, Rajpura, Bisauli, Salarpur, Islamnagar, Wazirganj, Mion, Jagat, Samrer, Junabai Asafpur, Sahaswan, Qadarchowk, Usawa, Dataganj, Ujhani, Ambiapur, Jaitipur, Sindhauli, Jalalabad, Puranpur</td>
</tr>
<tr>
<td>Low</td>
<td>82.91-95.46</td>
<td>26539</td>
<td>19.55</td>
<td>11</td>
<td>Mirzapur, Powayan, Kalan, Dadrol, Khuta, Nighoi, Kanth, Banda, Dilari, Bilsanda, Gunnaur</td>
</tr>
<tr>
<td>Very low</td>
<td>Below 82.91</td>
<td>9737</td>
<td>7.17</td>
<td>8</td>
<td>Barkhera, Bisaipur, LalauriKhera, Marori, Amaryia, Tilhar, Katra, Bhawalkhera</td>
</tr>
</tbody>
</table>
area under very high productivity is shown in Fig.10. Two blocks lies in the northern part of the Rohilkhand region are namely, Jalilpur (121.56) and Dhanaura (131.20). There are other small areas of very high productivity, one block lies in the northeastern part namely in the block of Bilaspur (121.29) in the Rampur district.

In Bareilly district only a single block namely, BithriChainpur (128.58) possesses very high productivity which lies in central part of the region.

ii. High Productivity Region

High productivity with the ranges with the index value between 108 and 120.55. As shown in Table 3.4 blocks having high productivity occupy 19.94 per cent share in cropped land occur in 24 blocks of the region. Out of total 24 blocks, 5 of them are in Bijnore district, lying in northern part are namely, Noorpur (119.37), Nahtaur (113.70), Seohara (112.72), Dhampur (109.97) and Kiratpur (108.31). Other areas of high productivity region lies in the northeastern part of the districts of Rampur and Bareilly, are namely, Milak (115.75), Saidnagar (114.68), Suar (113.33), Shahabad (113.15), Chamraon (109.99), Bhadpura (119.27), Nawabganj (119.18), Bhuta (118.30), AlampurJafarabad (117.57), Ramnagar (117.28), Kyara (117.01), Majhgawa (116.90), Fatehganj (114.93), Faridpur (114.64), Baheri (114.62), Shergarh (114.57), Dumkhoda (114.55), Mirganj (113.07) and Bhojipura (109.43).
ROHILKHAND REGION
Productivity Regions - Based on Oilseed Crops Yield Index
1994-95 to 1998-99

Fig. 10
iii. Medium Productivity Region

The region having medium productivity with an index value between 95.46 and 108.0 occupy large areas and cover 48.72 per cent of the total oilseed cultivated area (Table 3.4).

Accounting a regional pattern, there are large areas are found in medium productivity under oilseeds (Fig. 10). Most of them occur in southwestern part including the blocks of Budaun district, and other areas in northern part of the region including the blocks of Bijnore and Moradabad districts are namely, Najibabad (104.36), MdpurDeomal (96.11), Haldor (99.38), Kotwali (97.72), Afzalgarh (97.36), Chajlat (105.28), Bahjoi (104.83), Gajraula (103.77), Moradabad (103.50), BaniyaKhera (102.54), Joya (102.41), Mundapandey (102.33), Dingarpur (102.31), Bhagatpur-Tanda (102.28), Bilari (101.99), Amroha (101.99), Hasanpur (101.56), Asmoli (101.52), Sambhal (101.37), Panwasa (101.45), Gangeshwari (101.27) and Thakurwdara (101.16).

iv. Low Productivity Region.

The areas of low agricultural productivity form a contiguous belt in the southeastern parts of the region. These include the blocks of Shahjahanpur district are namely, Mirzapur (94.91), Powayan (91.65), Kalan (91.29), Dadrol (87.80), Khutar (86.84), Nighoi (84.46), Kanth (83.59) and Banda (83.01). The Dilari block (87.05) of Moradabad district which lies in northern part and Bilsanda block (93.61) in Pilibhit district also possess low productivity. Only one block of Gunnaur in Budaun district falls in low productivity with a index value of 94.83.
V. Very Low Productivity Region

Very low oilseeds productivity region (with an index value of below 82.91) covers 9737 hectares (7.17 per cent) of total oil seeds cropped area. The region of very low productivity lies in southeastern part and includes the blocks of Pilibhit and Shahjahanpur district are namely, Barkhera (76.55), Bisalpur (76.37), Lalaurikhera (74.24), Marori (73.05), Amaryia (72.57), Tilhar (80.16), Katra (78.11) and Bhawalkhera (77.12).

IV. Productivity Regions – Based on Cash Crops Yield Index

Among the cash crops, sugarcane and potatoes constitute a significant position on account of area devoted to them and the quantum of production of the farmers obtain. The productivity indices computed for these two crops are shown in Table 3.5.

i. Very High Productivity Region

Regional pattern of productivity in cash crops shows that blocks of very high productivity region identified are depicted in Fig. 11. Most of them lie in southwestern part of the region and forming the parts of the district of Budaun are namely, Salarpur (109.18), Rajpura (108.93), Junabai (108.53), Asafpur (108.53), Islamnagar (107.89), Qadarchowk (106.81), Bisauli (106.72), Sahaswan (106.72), Usawa (106.59) and Gunnaur (109.64).

ii. High Productivity Region

High productivity in cash crops occur in 20 blocks in the region. They form a big contiguous belt in northern part of the region as shown in Fig. 11. This belt includes the blocks of the district of Bijnore namely,
Table 3.5

Productivity Regions – Based on Cash Crops Yield Index in Rohilkhand Region - 1994-95 to 1998-99

<table>
<thead>
<tr>
<th>Productivity Category</th>
<th>Crop Index</th>
<th>Area (in ha.)</th>
<th>Percent of Area</th>
<th>Number of Blocks</th>
<th>Name of Development Blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>Above 105.83</td>
<td>21593</td>
<td>3.51</td>
<td>10</td>
<td>Salarpur, Rajpura, Junabai, Asafpur, Islamnagar, Qadarchowk, Bisauli, Sahaswan, Usawa, Gunnaur</td>
</tr>
<tr>
<td>High</td>
<td>101.92-105.85</td>
<td>225206</td>
<td>36.71</td>
<td>20</td>
<td>Wazirganj, Jagat, Mion, Ujhani, Samrer, Dataganj, Dhagavan, Noorpur, Afzalgarh, Seohara, Kotwali, Dhampur, Haldor, Najibabad, MdpurDeomal, Nahtaur, Kiratpur, Jalilpur, Sambhal, Panwasa</td>
</tr>
<tr>
<td>Medium</td>
<td>98.02-101.92</td>
<td>186934</td>
<td>30.47</td>
<td>25</td>
<td>Moradabad, Baniyakhera, Bilari, Hasanpur, Joya, Mundapanday, Asmoli, BhagatpurTanda, Bahjoi, Dhanaura, Dingarpur, Gajraula, Bilari, Thakurdwara, Amroha, Chajlat, Marori, Barkhera, Puranpur, Bilsanda, Bisalpur, Amaria, Lalauri-Khera, Ambiapur, Kalan</td>
</tr>
<tr>
<td>Low</td>
<td>94.11-98.02</td>
<td>161385</td>
<td>26.31</td>
<td>32</td>
<td>Jalalabad, Mirzapur, Jaitipur, BhawalKhera, Dadrol, Sindhauli, Powayan, Khutar, Kanth, Nighoi, Katra, Tilhar, Banda, Baheri, Dumphoda, Bhadpura, Shergarh, Nawabganj, Bhuta, Bhojipura, Fatehganj, Mirganj, Kyara, Bithrichainpur, Ramnagar, Faridpur, Majhgawa, Alampur- Jafarabad, Saidnagar, Chamraon, Suar, Gangeshwari</td>
</tr>
<tr>
<td>Very low</td>
<td>Below 94.11</td>
<td>18229</td>
<td>2.97</td>
<td>3</td>
<td>Milak, Shahabad, Bilaspur</td>
</tr>
</tbody>
</table>
ROHILKHAND REGION
Productivity Regions - Based on Cash Crops Yield Index
1994-95 to 1998-99

Fig. 11
Noorpur (102.79), Afzalgarh (102.78), Seohara (102.79), Kotwali (102.75), Dhampur (102.76), Haldor (102.76), Najibabad (102.74), Mdpur-Deomal (102.73), Nahtaur (102.71), Kiratpur (102.70) and Jalilpur (102.67). The other high productivity regions which comprise blocks of Budaun district are namely, Wazirganj (105.29), Jagat (105.20), Mion (104.73), Ujhani (103.93), Samrer (103.68), Dataganj (103.06) and Dhagavan (102.05). Two blocks of Moradabad district fall under the category of high productivity are namely, Sambhal (102.16) and Panwasa (102.05).

iii. Medium Productivity Region

Blocks of medium productivity in cash crops cover 30.47 per cent of the total cropped area. Two areas of medium productivity in cash crops are found in the region as shown in Fig. 11. One of the area lying in the northern part of the region and includes the blocks of Moradabad district are namely, Moradabad (100.23), BaniyaKhera (99.82), Bilari (98.62), Hasanpur (99.60), Joya (99.25), Mundapandey (99.25), Asmoli (99.24), Bhagatpur Tanda (99.21), Bahjoi (99.14), Dhanaura (98.91), Dingarpur (98.91), Gajraula (98.80), Bilari (98.62), Thakurdwara (98.54), Amroha (98.52) and Chajlat (98.51). The other medium productivity region occurs in the eastern part comprises the blocks of Pilibhit district namely, Marori (99.57), Barkhera (99.48), Puranpur (99.47), Bilsanda (99.47), Bisalpur (99.45) and Amaryia (99.42). Apart from this, there are other two blocks which falls under the category of medium productivity are namely, Ambiapur (100.50) and Kalan (98.45) of Budaun and Shahjahanpur districts respectively.
iv. Low Productivity Region

Regional pattern of low productivity shows two distinct areas. One forms a contiguous belt in the southeastern part of Rohilkhand region which includes the blocks of Shahjahanpur district are namely, Jalalabad (97.72), Mirzapur (97.36), Jaitipur (96.51), Bhawalkhera (96.00), Dadrol (95.95), Sindhauli (95.86), Powayan (95.83), Khutar (95.73), Kanth (95.69), Nighoi (95.65), Katra (95.48), Tilhar (95.21) and Banda (95.77).

Other area lies in the southcentral part of the region and includes the blocks of Bareilly district are namely, Baheri (97.92), Dumkhoda (97.91), Bhadpura (97.88), Shergarh (97.87), Nawabganj (97.84), Bhuta (97.78), Bhojipura (97.70), Fatehganj (97.65), Mirganj (97.46), Kyara (97.45), Bithri chainpur (97.38), Ramnagar (97.09), Faridpur (97.06), Majhgawa (95.99) and Alampur Jafarabad (95.19).

A small area of low cash crops productivity lying in the northeastern part of the region includes the blocks of Rampur district namely, Saidnagar (96.74), Chamraon (96.09) and Suar (94.88).

v. Very Low Productivity Region

The very low productivity region in cash crops covers a net area of 18,229 hectares (2.97 per cent) of total cash cropped area.

The very low productivity areas are confined to northeastern part of the Rohilkhand, and includes the blocks of Rampur district namely, Milak (94.01), Shahabad (93.83), and Bilaspur (93.59).
V. Productivity Regions – Based on Composite Yield Index

In order to wave off variations in the values of Crop Yield Index computed for different categories of crops i.e., cereals, pulses, oilseeds and cash crops, the individual values of productivity indices were summed up to get a composite index of productivity for all the crops considered in the analysis.

i. Very High Productivity Region

Regional patterns of very high productivity as identified shown in Fig. 12. One area lies in the northeastern part of the region and includes the blocks of Rampur district namely, Shahabad (108.56), Saidnagar (107.01), Milak (106.46), Bilaspur (106.18), Chamraon (106.12) and Suar (105.89).

A single block of Nahtaur of Bijnore district lies in the northern part of the region with a yield index value of 109.20 and LalauriKhera block (105.23) lies in the eastern part also possesses very high agricultural productivity in the region.

ii. High Productivity Region

As far as high agricultural productivity areas are concerned they cover 28.81 per cent of the total cropped area of the Rohilkhand. There are 22 blocks in total which come under this category. They form two big contiguous belts as shown in Fig. 12. One belt lies in the northern part of the region and includes the blocks of Bijnore district are namely, Afzalgarh (102.33), Kotwali (101.60), Dampur (101.51), Seohara (100.85), Najibabad (100.59), Kiratpur (100.49), Noorpur (100.24) and MdpurDeomal (99.09). The other region lies in the southeastern part and includes the blocks of
<table>
<thead>
<tr>
<th>Productivity Category</th>
<th>Crop Index</th>
<th>Area (in ha.)</th>
<th>Percent of Area</th>
<th>Number of Blocks</th>
<th>Name of Development Blocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>Above 104.35</td>
<td>342099</td>
<td>10.57</td>
<td>8</td>
<td>Shahabad, Saidnagar, Milak, Bilaspur, Chamraon, Suar, Nahtau, Lalaurikhera</td>
</tr>
<tr>
<td>High</td>
<td>98.63-104.35</td>
<td>931493</td>
<td>28.81</td>
<td>22</td>
<td>Afzalgarh, Kotwali, Dhampur, Seohara, Najibabad, Kiratpur, Noorpur, MdpurDeomal, Bilsanda, Puranpur, Marori, Amaryia, Bisanpur, Barkhera, Jaitipur, Kalan, Sindhaul, Banda, Jalalabad, Mirzapur, Powayan, Dadrol</td>
</tr>
<tr>
<td>Medium</td>
<td>92.91-98.63</td>
<td>922604</td>
<td>28.52</td>
<td>27</td>
<td>Haldor, Jailipur, Asmoli, Bhagatpur Tanda, Mundapandey, Dhanaura, Gangeshwar, Thakurdwara, Chajlat, Dili, Gajraula, Joya, Bilari, Sambhal, Hasanpur, Dingarpur, BaniyaKhera, Panwasa, Bahjoi, Amroha, Khutar, Nighoi, Katra, Tilhar, Kanth, Bhawalkhera, Ramnagar</td>
</tr>
<tr>
<td>Low</td>
<td>87.19-92.91</td>
<td>908381</td>
<td>28.08</td>
<td>29</td>
<td>Dhagavan, Rajpura, Gunnaur, Junaibai, Bisauly, Qadarchowk, Ujhani, Asafpur, Sahaswan, Ambiapur, Islamnagar, Usawa, Wazirganj, Salarpur, Jagat, Alampur-Jafarabad, Kyara, Bithrichainpur, Baheri, Dumkhada, Faridpur, Shergarh, Bhadpara, Bhuta, Mirganj, Fatehganj, Bhojipura, Nawabganj, Moradabad</td>
</tr>
<tr>
<td>Very low</td>
<td>Below 87.19</td>
<td>129159</td>
<td>3.99</td>
<td>4</td>
<td>Sanrer, Dataganj, Mion, Majhgawa</td>
</tr>
</tbody>
</table>
Shahjahanpur and Pilibhit district are namely, Jaitipur (99.31), Kalan (99.28), Sindhauli (99.25), Banda (99.13), Jalalabad (98.96), Mirzapur (98.89), Powayan (98.88) and Dadrol (98.77), Bilsanda (100.59), Puranpur (100.54), Marori (100.30), Amaryia (99.99), Bisalpur (99.83) and Barkhera (99.56) of Rohilkhand region.

### iii. Medium Productivity Region

The areas of medium agricultural productivity form a contiguous region in northern part of the Rohilkhand. These areas include the blocks of Moradabad district namely, BhagatpurTanda (98.12), Asmoli (97.79), Mundapandey (97.14), Dhanaura (97.36), Gangeshwari (97.21), Thakurdwara (97.15), Chajlat (97.06), Dilari (97.05), Gajraula (96.91), Joya (96.74), Bilari (96.55), Sambhal (96.40), Hasanpur (96.23), Dingarpur (96.04), BaniyaKhera (95.96), Panwasa (95.72), Bahjoi (95.15) and Amroha (93.29).

Apart from these, there is a sizeable number of scattered blocks which fall under medium agricultural productivity. They are namely, Ramnagar block (93.26) in Bareilly district, and in Shahjahanpur district namely, Khutar (98.61), Nighoi (98.29), Katra (97.91), Tilhar (97.59), Kanth (96.97) and Bhawalkhera (96.71) blocks lying in the southeastern part of the Rohilkhand region.

### iv. Low Productivity Region

Low agricultural productivity areas occur in 29 development blocks of the region. They form two big contiguous belts extending to southwestern and central parts of the region (Fig. 12). One belt lies in southwestern part
ROHILKHAND REGION
Productivity Regions - Based on Composite Yield Index
1994-95 to 1998-99

Fig. 12
and includes the blocks of Budaun district are namely, Dhagavan (91.59), Rajpura (91.27), Gunnaur (91.08), Junabai (90.99), Bisauli (90.91), Qadarchowk (90.91), Ujhani (90.90), Asafpur (90.78), Sahaswan (90.55), Ambiapur (89.90), Islamnagar (89.69), Usawa (89.17), Wazirganj (88.01), Salarpur (87.31) and Jagat (87.26). The other low agricultural productivity areas comprise the 13 blocks of Bareilly district and cover the central parts of the region.

v. Very Low Productivity Region

Very low agricultural productivity region cover four blocks in the form of a small region consisting the blocks of namely, Samrer (84.97), Dataganj (84.71) and Mion (84.41) of Budaun district which lies in southern part of the region. A single block of Majhgawa in Bareilly district lying in the central part (with a yield index value of 86.62) is also included among the areas marked with very low productivity.