PART II

THE CONCEPTS AND METHODOLOGICAL FRAME
CHAPTER IV

THE CONCEPT OF AGRICULTURAL PRODUCTIVITY

Before reviewing the methodological procedure of agricultural productivity it would be worthwhile to elucidate the concept of productivity and to clarify a number of questions associated with it and its measurement.

Productivity is not a synonym of 'fertility'. It is generally used to express the power of agriculture in a particular region to produce crops without regard to whether that power is due to the bounty of nature or the efforts of man. On the other hand, fertility denotes the ability of soil to provide all the essential plant nutrients in available form and in a suitable balance for the plant growth.

In recent years many attempts have been made to define the connotation of agricultural productivity, and a considerable amount of literature exists on this subject.¹


(Contd...)
Agricultural productivity may be defined as the ratio of the index of total agricultural output to the index of total input used in farm production. Agricultural productivity is therefore, a measure of the efficiency with which inputs are utilized in production, other things being equal. According to Dewett, "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 born in mind, that productivity is physical rather than a value concept.

The connotation of the term productivity engaged the attention of many an economist at the 23rd Annual Conference of the Indian Society of Agricultural Economics. Some economists suggested that, the yield per acre should be

(Reference 1 contd.)


considered to indicate agricultural productivity. A number of objections were raised against this view because it considered only land which is just one factor of production while other factors are also responsible for the same. Another suggestion was to consider the returns per unit of the scarce resource to present agricultural productivity. It was pointed out, that the average returns per unit of scarce resource does not depict the true picture, therefore, instead of it, the marginal returns per unit of the scarce resource should be considered. This definition appears to be more meaningful than others, but gives rise to a lot of practical difficulties.

After a thorough discussion, it was generally agreed, that the yield per acre may be considered to represent the agricultural productivity in a particular region, and that other factors of production be considered as the possible causes for the variation while comparing it with the other regions.\(^4\) Pandit, stated 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 input."\(^5\) He further

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suggests, that increases in productivity, whether in industry or agriculture, is generally the result of a more efficient use of some or of all the factors of production, viz., land, labour, and capital. According to Saxon, basically, productivity is a physical relationship between output and the input which gives rise to that output. Horring, defines the term productivity, that it is generally use rather broadly to denote the ratio of output to any or all associated inputs, in real term.

There are different other concepts of productivity, and still more ways for computing it. The Chairman, of the International Commission on Agricultural Typology, Prof. Kostrowicki, attempted to invite different views on this problem and sent a questionare to over 100 scholars throughout the world, which embodied the following two questions:

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 opinion of some of them are given in the Appendix II. The Chairman of the Commission while evaluating the different views pointed out, that a special study testing various methods and techniques to be used in the studies of various scales were needed.  

Productivity of agriculture so far has been looked from different points of view, such as productivity of land, labour and of capital. These are the best known partial productivity ratios.

Attention may specially be focussed on the productivity of land, because it is the most permanent and fixed among the three conventional categories of inputs (land, labour and capital), and in recent times has assumed special importance with the population explosions. Land on regional or unit basis expresses yield of crops in terms of output, and from a national point of view, it is desirable to secure the employment of a greatest number of persons.

Whereas, the productivity of land is of primary importance as a determinant of the total level of food and

agricultural production, the productivity of labour is mainly important as a determinant of the income of the population engaged in agriculture. Labour productivity in agriculture has two important aspects. First, it profoundly affects national prosperity i.e., the national income; secondly, it principally determines the standard of living of the agricultural population. National prosperity in the economic perspective is largely synonymous with the high output per man hour. Therefore, if a country intended to increase its prosperity it needs: (a) to encourage technical assistance and improvements to the labour population, which help to increase productivity in the agricultural economy, and (b) to stimulate a continual transfer of labour from low productivity to high productivity regions. So far as raising the farmer's standard of living is concerned, there are two ways, either he may be paid more than the prevailing world prices for a given amount of work, or the steps can be encountered to raise his output e.g., productivity from the same resources. Output per man can be improved in the agricultural economy: (i) by giving each farm worker more land and livestock to look-after, and (ii) by making each unit of land and livestock capable of yielding a bigger output.

10. ibid., p.153.
Productivity measures of capital are particularly complicated to compute and difficult to interpret. This is largely because of both diversity of farms, and forms in which capital may be utilized in agricultural purposes in the production process. It is generally utilized for the purchase of land, for land improvement, land reclamation, drainage, irrigation purposes, livestock purchase, feeds, seeds, fertilizers, agricultural implements and machinery, crop protection chemicals etc.

Measurement of agricultural productivity depends upon conceptually consistent measures of aggregate agricultural output and input. The concept of inputs in productivity studies includes the resources committed to agriculture by the farmers. These inputs are subjected to control by the decisions of the farmers under the framework of government's policies. And, these inputs may be classified as labour and tangible capital (including intermediate products which are purchased annually from the nonfarm sources, such as fertilizer and processed feed and seed). Land, building, machinery, pesticide, livestock and purchased production services are tangible capital inputs. Choice of inputs mainly determines the increases in agricultural productivity depending upon the qualities of inputs in a relative sense, the techniques and skills which are utilized in production process.
Prof. Stamp, while attempting to measure crop productivity per unit area emphasized, that areal differences in productivity are the result partly of natural advantages of soil, and partly of farming efficiency. Farming efficiency, refers to the properties and qualities of various inputs, the manner in which they are combined and utilized in production.

In the United States, various hypotheses about the causes of increase in agricultural productivity have been advanced. For instance, Henry, in *The American Experience* has mentioned, that it is primarily the result of an unusual abundance of land and natural resources. Loomis and Barton suggested that, real causes of increased in productivity have been, 'new knowledge and technical change, and 'such closely related forces as changing relative prices, increased specialization, increased size of farm operation, changes in institutional structure of education, credit, transportation, processing and the economic activity etc.'

CHAPTER V

APPROACHES TO THE MEASUREMENT OF AGRICULTURAL PRODUCTIVITY

The assessment of agricultural productivity has engaged the attention of scholars in various fields: geographers, economists, and agricultural scientists for a long time. Attempts have been made to measure and quantify agricultural productivity in India as well as in other countries of the world.

Thompson (1926), while measuring the relative productivity of British and Danish farming emphasized and expressed it in terms of gross output of crops, and livestock. He has considered the following parameters to examine productivity: (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.

Kendall (1939), treated it as a mathematical problem and initiated a system of four coefficients - a

productivity coefficient, a ranking coefficient, a money value coefficient, and a starch equivalent or energy coefficient. The second of those, the ranking coefficient does not involve the use of higher mathematics, and the purpose of which is to arrange in sequence any given number of units growing the same range of crop and then assess their agricultural efficiency. He took the acre yields 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 than 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 counties concerned.

Ganguli⁴ (1935), presented a theoretical discussion for computing productivity in agriculture. Firstly, he took into account the area under any crop A, in a particular unit area belonging to a certain region. This area is expressed as a proportion of the total cropped area under all the selected crops. Secondly, he tried to obtain the

3. Terms productivity and efficiency are used synonymously here.
index number of yield. This is found by dividing the yield per hectare of the crop A in that unit by the corresponding yield per hectare for the entire region as the standard. This yield may be expressed as a percentage and 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 come to light by using this formula 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 with 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.

Hirsch\(^5\) (1943), has suggested, 'Crop Yield Index' as the basis of productivity measurement. It expresses the average of the yields of various crops on a farm or in a locality relative to the yields of the same crops on another farm in a second locality. Zobel\(^6\) (1950), has attempted to determine the labour productivity. He considered productivity of labour as the ratio of total output to the total man-hours.

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consumed in the production of that output resulting in output per man-hour. This has been designed with the equation:

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

where

\[ \lambda = \text{productivity of labour}, \quad P = \text{production}, \quad \text{and} \]

\[ L = \text{labour utilized}. \]

Stamp\textsuperscript{7} (1952 and 1960), adopted, the ranking coefficient technique of Kendall, and applied on an international basis in order to determine agricultural efficiency of a number of countries as well as some major crops. Huntington and Valkenburg\textsuperscript{8} (1952), considered the measurement of productivity of land on the basis of eight very widely raised crops in Europe. They selected average yield per acre of each crop for Europe as a whole, and assumed as an index of 100 for it. Thus, they calculated the specific yield index of each country accordingly.

Stamp\textsuperscript{9} (1958), suggested another method for measuring the agricultural productivity i.e., to convert the total agricultural production in calories. The caloric intake

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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 caloric intake among adults from 2100 calories a day for a woman in sedentary occupation to 4250 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 3400 calories for teen-age boys. 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 2460 calories a day or about 900,000 calories per year. Stamp, called it as a 'Standard Nutrition Unit'. Shafi (1960), applied the technique 'ranking coefficient' of Kendall for measuring the agricultural efficiency in Uttar Pradesh, taking into account eight food crops grown in each of the forty-eight districts of the State. He applied the method to acre yield figures for the two quinquennial years ending 1952 and 1957.

Loomis, and Barton (1961), have measured United States agricultural input and productivity in the aggregate.

To them, aggregate productivity depends upon conceptually consistent measures of agricultural output and input. The measure of inputs includes all production factors that depend directly on the decisions by the farmers. Meiburg, and Brandt (1962), have surveyed the earlier indices relating to the United States agricultural output e.g., output per worker and per man-hour, and several other estimates of total productivity. They considered eight indices of agricultural production which cover various phases of the period between 1866-1960. Mackenzie (1962), has measured the efficiency of production in Canadian agriculture by using the 'coefficient of output relative to input'. He describes, that this concept is difficult to define and even more difficult to quantify.

Oommen (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 (1964), while describing Geographical Types of Agriculture in Hungary, refers to a formula for determining

agricultural productivity. His productivity coefficient
would be read thus:

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

where

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

Horring\(^{17}\)(1964), has suggested that the concept
of productivity is based upon not only on the single relation­
ship 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.

\(^{17}\) Horring, J., Concept of Productivity Measurement
in Agriculture on a National Scale, OECD,
Documentation in Food and Agriculture 57,
The Indian Society of Agricultural Economics, seized the problem and in its journal, viz., Indian Journal of Agricultural Economics published a series of articles under the broad head of - Regional Variations in Agricultural Development and Productivity. Among the contributors Chaterji, 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 principal 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 foodgrain 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 in the aforesaid two districts of eastern and western regions. The study period, from 1951-52 to 1960-61 i.e., covering the First and Second Five-Year Plans was taken into account. Gopalkrishnan and Ramakrishna\textsuperscript{22}(1964), have studied in Andhra Pradesh (India), to measure the degree of variation with respect to (a) agricultural output per acre (Rs.), (b) output per head of agricultural population (Rs.), and causes of variations in each district of the State during 1959-60. The variables related to the level of output per acre are selected in each district as follows: normal level of rainfall, percentage of current and old fallows, percentage of area under irrigation, percentage of literacy, percentage of population depending on agriculture, intensity of cropping, percentage of gross value other than food grains and fodder, percentage of area under all crops excluding fodder and foodgrains, density of agricultural population per acre, and percentage of total area under commercial crops including rice. Sancheti\textsuperscript{23}(1964), has examined the productivity of principal cereals in the dry areas of the Rajasthan State for the two periods starting from 1956-57 to 1958-59, and

\textsuperscript{22} Gopalkrishnan, M.D. and Ramakrishna, R.T., "Regional Variations in Agricultural Productivity in Andhra Pradesh", ibid., pp.227-36.

1959-60 to 1960-61 respectively and the changes occurred therein. He accounted average yield per acre as the basis of productivity assessment.

Sapre and Deshpande\(^2^4\)(1964), have attempted to refine further the Kendall's ranking coefficient method. For this they used 'weighted average of ranks' instead of the simple average ranks. Thus, it incorporates the proportion of the crop (area) to the total cropped area of the district. In order to assess the weighted ranks, the ranking position of a crop is multiplied by the magnitude of it to the total cropped area. For example, an enumeration unit A has rank 5 on the basis of yield for wheat, and wheat occupies 33 per cent of area to the total cropped land; jowar ranks 3, and occupies 16 per cent of area; rice ranks 4, and occupies 30 per cent of the total cropped land. Thus, the weighted average of ranks for different crops would be \((5 \times 33) + (3 \times 16) + (4 \times 30) = 333\), divided by the sum of the weights as \(333/79 = 4.21\). Kendall's ranking coefficient should work out as follows \(5 + 3 + 4 = 12\), divided by the number of crops taken into consideration as \(12/3 = 4\).

Indian Society of Agricultural Statistics, organised a symposium on the topic, 'Measurement of Agricultural

\(^{24}\) Sapre, S.G. and Deshpande, V.D., "Inter-District Variations in Agricultural Efficiency in Maharashtra State", op. cit., p.243.
Productivity at the 17th annual conference of the society, held at Jaipur, Rajasthan in 1964. The research papers contributed by different scholars appeared in society's journal, viz., Journal of the Indian Society of Agricultural Statistics, in the succeeding issue i.e., in 1965. Sarma (1965), while defining the concept of agricultural productivity has 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, and sugarcane and edible seeds he suggests, to equate output of these in terms of 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, farm harvest or wholesale prices have the definite significance. He also emphasises productivity of labour as the basis of productivity measurement in agriculture e.g., the total number of labour force, in order to take into account the intensity of labour, as the number of man-hours worked in agriculture.

Agricultural productivity according to Sarma, can also be measured with respect to all the resources committed

26. ibid., p.254.
to agriculture including all the inputs: land, labour, building, machinery, fertilizers etc. These should be aggregated and compared with the gross output of the entire region. He further suggests, that productivity studies are more useful when they are made over a period of time. Whenever, a comparable series of required data are available, different techniques of time series analysis can be employed. Productivity comparisons might also be made over at different regions or for different crops.

Khusro (1965), has linked productivity measurement with the output per unit of a single input, and output per unit of cost of all inputs in the agricultural production. Saran (1965), has applied Cobb-Douglas, 'Production Function' approach for the measurement of productivity. The common purpose of this function is to express the input/output relationship between several inputs and one output in the agricultural systems. The function takes the following form:

\[ Y = a x_1^b x_2^c x_3^d x_4^e \]

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

27. ibid., p. 254.
28. ibid., p. 255.
Tambad\textsuperscript{31} (1965 and 1970), has adopted 'Crop Yield Index' technique for measuring agricultural productivity. He explains that the purpose of this technique is to express the average yield of various crops on a farm or in a region relative to the yield of same crops on another farm or in a second region. It can be expressed in the equation form as:

\[
\text{Crop Yield Index} = \frac{\sum_{i=1}^{n} \frac{y_i}{y_{io}} A_i}{\sum_{i=1}^{n} A_i}
\]

where

- \( i = 1, 2, 3, \ldots n \) are the number of crops on a given unit area or year,
- \( y_i \) is the yield per acre of crop \( i \), on a given farm area or year,
- \( A_i \) is the weightage of crop \( i \), denoted by the area under the crop as a percentage of total cropped area, and
- \( y_{io} \) is the average yield per acre of crop \( i \), of the group of farms, region or the base year.

Shafi\textsuperscript{32}(1965), has assessed the productivity on the basis of labour population engaged in agriculture. According to him, it can be computed by dividing the gross production in any unit area by the number of man-hours or less precisely by the numbers 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 the number of workers, or a reverse index be applied where the total number of workers per unit of production is assessed\textsuperscript{33}.

Agarwal\textsuperscript{34}(1965), has suggested, a 'Factorial Approach', while measuring the efficiency in Bastar district of Madhya Pradesh. In this approach, a number of human controlled factors relating to agricultural production as, crop superiority, crop commercialization, crop security, land use intensity and power input have selected excluding the environmental factors.

Buck\textsuperscript{35}(1937 and 1967), assessed the agricultural progress in China, adopting the approach of 'Grain Equivalents!' For this, he converted all the agricultural products into

\begin{itemize}
\item \textsuperscript{33} ibid., p.4.
\item \textsuperscript{34} Agarwal, P.C., "Measurement of Agricultural Efficiency in Bastar District A Factorial Approach", ibid.,
\item \textsuperscript{35} Buck, J.L., \textit{Land Utilization in China}, Vol.I, Nanking, 1937,
\end{itemize}
kilograms of grain equivalent in order to select a unit of measure, a kilogram, and whatever kind of grain was predominating the region. A modification in this method was attempted by Clark, and Haswell \(^36\) (1967) by expressing the output in terms of kilograms of 'wheat equivalent' per head of population.

Dovring \(^37\) (1967), has measured the productivity of labour in United States agriculture, in aggregate since 1919 to 1954 as a whole as well as commodity-wise. Bhatia \(^38\) (1967), while assessing the changes and trends in agricultural efficiency during 1953-63 in Uttar Pradesh adopted the Ganguli's method of productivity measurement and has devised a equation which would be read thus:

\[
(1) \quad I_Y^a = \frac{Y_c}{Y_r} \times 100
\]

where

- \(I_Y^a\) is the yield index of crop \(a\),
- \(Y_c\) is the average acre yield of crop \(a\) in the component unit,
- \(Y_r\) is the average acre yield of crop \(a\) in the entire study area.

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and

\[(ii) \quad E_i = \frac{I_ya \cdot ca + I_yb \cdot cb + \ldots \ldots \ldots \cdot I_{yn} \cdot cn}{ca + cb + \ldots \ldots + cn}\]

where

\[E_i = \text{the agricultural efficiency index,}\]

\[I_ya, I_yb \text{ etc. = are the indices of various crops, and}\]

\[ca, cb \text{ etc. = represent the proportion of crop land devotes to different crops.}\]

Shafi\(^{40}\) (1967 and 1969), applied Stamp's 'Standard Nutrition Unit' technique for measuring the efficiency of agriculture in India considering district as an area unit and taking into account a number of crops. Noort\(^{41}\) (1967), considered 'net total productivity' (being the relationship between net product and factor input) as a method for the measurement of field productivity and also to assess comparisons 'in time' or 'in space'. The purpose of this measure is to account changes in labour and capital inputs in agriculture. Shafi\(^{42}\) (1970), attempted to compute the index of productivity coefficient following the formula of Enyedi\(^{43}\) for each district of India with regard to twelve food crops.

Hayami, and Ruttan (1970), accounted agricultural labour productivity differences in Developed Countries (DC's) and of Less Developed Countries (LDC's) for three different periods e.g., 1955 (1952-56 average), 1960 (1957-62 average), and 1965 (1962-66 average) by using Cobb-Douglas, 'Production Function'. They incorporated the independent variables like; land, labour, livestock, fertilizer, machinery, education and technical manpower.

Shafi (1972), attempted to modify Enyedi's, 'Productivity Coefficient Index' as to measure agricultural productivity of Great Indian Plains. In which he incorporated the areal magnitude of the crop concerned. The formula would be read thus:

\[
\left( \frac{y_W}{t} + \frac{y_F}{t} + \frac{y_{mi}}{t} \ldots \ldots n \right) : \left( \frac{y_W}{T} + \frac{y_F}{T} + \frac{y_{mi}}{T} \ldots \ldots n \right)
\]

Or

\[
\frac{\sum \frac{y}{t}}{n} : \frac{\sum \frac{y}{T}}{n}
\]


Singh (1972), has evolved a new technique for the measurement of agricultural efficiency. Which consists of the measurement of carrying capacity per unit area in terms of population in relation to output per unit area. The method would be read in the equation form as:

(i) \( C_p = \frac{C_o}{S_n} \)

where

- \( C_p \) = is the carrying capacity,
- \( C_o \) = is the caloric output
- \( S_n \) = standard nutrition for ingestion in calories person/annum.

(ii) \( Iae = \frac{C_{pe}}{C_{pr}} \times 100 \)

where

- \( Iae \) = is the index number of agricultural efficiency,
- \( C_{pe} \) = is the carrying capacity in terms of population in the component enumeration unit, and
- \( C_{pr} \) = is the carrying capacity in the entire region.

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In its 30th Annual Conference the Indian Society of Agricultural Statistics, held at Bhubaneswar (Orissa), India, discussed some aspects on agricultural productivity in the Indian context. Raheja, et al., have measured the impact of highyielding varieties adoption 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 et al. have accounted the level of increase in the yield of different crops during three decadal 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 fertilizer, proportion of area sown more than once, and gross irrigated area.

Nangia et al, conducted a field study in the village Khandewala, of Haryana State. The study takes

into account the productivity levels at different fields 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 variations. Bhalla\textsuperscript{51} (1978), has considered output per person on constant average price for measuring productivity of labour in Indian agriculture in order to account nineteen crops for the trienniums 1962-65, and 1970-73 for each district of the country.