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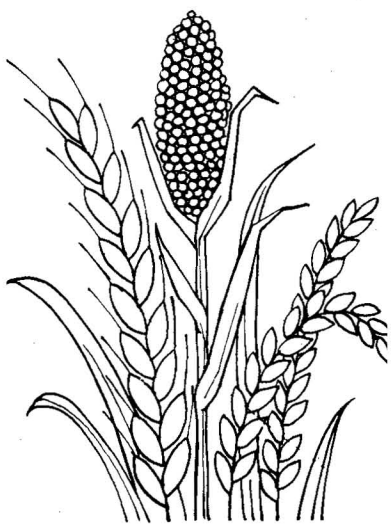

INDIAN SOCIETY OF
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# INDICES OF YIELD IN AGRICULTURE*

*Introduction*

The concept of productivity has found wide usage in current economic literature. While its significance in industry is greatly stressed it is no less important in agriculture. In fact, agriculture can also be regarded as an industry for purposes of productivity analysis. Productivity may generally be defined as a measure of the overall efficiency of industry. While several factors have a bearing on the overall efficiency of an industry, it is possible to measure this in terms of only one factor at a time.[1] The productivity of a specified factor (*e.g.*, labour or land) is therefore measured by the ratio of output to the input of the factor.

The productivity of land assumes great importance in agriculture for the simple reason that land is a scarce commodity ; the area under cultivation cannot be indefinitely increased especially in countries like India where land has been already fully exploited. It is therefore necessary to produce the maximum output from the land available for cultivation. Raising the productivity of agriculture (used synonymously for productivity of land) has been one of the major objectives of our Five-Year Plans. Agricultural productivity in a broader sense can be measured in terms of the yield per acre. The present study therefore attempts to define certain indices for measuring changes in yield per acre in India and to evaluate the agricultural production programme in the light of these indices.

The limitations of Indian agricultural statistics are well known. Considerable efforts have been made in recent years to effect an improvement in the accuracy of agricultural statistics. Whether or not any improvement has occurred, it has to be borne in mind that any analysis based on the data suffers from the limitations of the data themselves. The data on which the indices are based are the statistics of area and yield of principal crops published in the annual season and crop reports.[2] Two different procedures have been outlined in this paper.

*Framework of the Indices*[3]

(*a*) *The first approach :* The first approach consists of the computation of the yield per acre of the principal crops and to express the yield per acre for any year 't' in terms of the yield per acre in the base year. Denoting by $a_{it}$' $p_{it}$ the area and production of crop 'i' in the year 't' and $a_{io}$, $p_{io}$ the corresponding figures for the base year, then the yield per acre of the crop 'i' in the base year and the current year 't' are given by

$$\frac{p_{io}}{a_{io}} \quad \text{and} \quad \frac{p_{it}}{a_{it}} \quad \text{respectively.}$$

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1. See "Measurement of Industrial Productivity," K. E. Vaidyanathan, *Finance and Commerce*, December, 1959.

2. Taken from the Monthly Abstract of Statistics, Government of India Central Statistical Organization, January 1960, pp. 63-65.

3. *Vide* Pearson and Bennet : Statistical Methods Applied to Agricultural Economics.

The yield index for the specified crop in respect of year 't' will be

$$\left(\frac{p_{it}}{a_{it}} \div \frac{p_{io}}{a_{io}}\right) \times 100$$

The crops have been classified into two broad groups, *viz.*, food crops and non-food crops. The food crops have been further divided into two sub-groups, *viz.*, cereals and pulses and the non-food crops have been divided into 4 sub-groups, *viz.*, oilseeds, fibres, plantation crops and miscellaneous. The group and sub-group indices are obtained by weighting the specific indices by the areas under the crops in the base year. The general form of the index is given by

$$I_y^t = \frac{\Sigma \left(\frac{p_{it}}{a_{it}} \times \frac{a_{io}}{p_{io}}\right) a_{io}}{\Sigma a_{io}}$$

This can be interpreted in another way also. Expressing the numerator in the form

$$\frac{\frac{p_{it}}{a_{it}} \times a_{io}}{p_{io}} \times a_{io} = \lambda_{it}\, a_{io} \text{ (say)},$$

where $\lambda_{it}$ expresses the productivity relative for the year 't'. Thus

$$I_y^t = \frac{\Sigma \lambda_{it}\, a_{io}}{\Sigma a_{io}} \times 100$$

is the weighted average of productivity relatives for individual crops, the weights being the area under each crop in the base year. The agricultural year 1951-52 has been chosen as the base year as this year marks the beginning of planned development and hence this year will be suitable for comparison.

(*b*) *The second approach :* In the second approach the All-India index numbers of agricultural production (compiled by the Directorate of Economics and Statistics, Ministry of Agriculture) has been used in studying changes in yield per acre. The all-India index of agricultural production covers 28 crops divided into two main groups and six sub-groups. Weights have been assigned to the different commodities in proportion to the total value of production of each commodity during the base period, *viz.*, year ending June, 1950. The output has been evaluated at the annual harvest prices prevailing during the year, except in some cases where wholesale prices have been used with appropriate adjustment. The index numbers have been constructed by the chain base method in order to provide for changes in the estimated production due to extension in the geographical coverage or to variation in the method of estimation over time. The sub-group and the group index numbers are the weighted arithmetic averages of the production indices of the crops covered; the concept of production for the series is gross, no allowance being made for seed or wastage.

The first step in making use of the index number of agricultural production was to shift the base from 1949-50 to 1951-52 to ensure comparability with the first approach. To measure changes in yield per acre, the production indices have to be deflated by the changes in area. The change in area of any crop, group or sub-group relative to the base year is given by

$$I_a^t = \frac{a_{it}}{a_{io}} \times 100$$

If $I_p^t$ denotes the index numbers of agricultural production for year 't', then

$$\frac{I_p^t}{I_a^t} \times 100 = I_y^t$$

is a measure of the change in yield per acre in year 't' in relation to the base year.

These two approaches do not give the same figure in respect of $I_y^t$ in view of the fact that the first approach is based on area as weights whereas in the second approach value of crop output has been used as weights in the construction of $I_p^t$. While studying the trends over a period one has to make use of one of these two methods. But the first method is preferable for the following reasons : (1) it takes into account the changes in the yield of different crops; (2) area has been used as weights and hence it is more relevant to the study of yield of land.

*Recent Trends in Yield*

The trends in productivity revealed by the two methods indicate considerable fluctuations in yield per acre since 1951-52. The overall picture is that yield has been at a high level since 1951-52 when compared with 1951-52 and the peak has been reached in 1958-59. While there are differences in the group and sub-group indices obtained by the two methods, one may expect the first approach to portray the situation more accurately. Table I compares the yield indices ($I_y^t$) obtained by the first approach with the corresponding indices of area ($I_a^t$).

TABLE I—COMPARATIVE TRENDS IN YIELD AND AREA: 1951-52 TO 1958-59

(Base 1951-52 = 100)

| Year | Food Crops | | Non-Food Crops | | General Index | |
|---|---|---|---|---|---|---|
| (t) | $I_y^t$ | $I_a^t$ | $I_y^t$ | $I_a^t$ | $I_y^t$ | $I_a^t$ |
| 1951-52 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1952-53 | 109.4 | 105.3 | 101.6 | 96.6 | 107.9 | 103.7 |
| 1953-54 | 122.0 | 112.5 | 113.2 | 96.4 | 120.3 | 109.4 |
| 1954-55 | 119.9 | 111.2 | 115.4 | 106.9 | 119.0 | 110.4 |
| 1955-56 | 112.6 | 114.0 | 105.8 | 109.7 | 111.3 | 113.2 |
| 1956-57 | 115.1 | 114.9 | 113.2 | 112.7 | 114.7 | 114.5 |
| 1957-58 | 110.7 | 112.1 | 108.2 | 112.0 | 110.2 | 112.1 |
| 1958-59 | 124.9 | 115.4 | 120.2 | 112.8 | 124.0 | 114.9 |

It is seen that the overall yield per acre increased by 24 per cent between 1951-52 and 1958-59, the increase in yield of food and non-food crops being 24.9 per cent and 20.2 per cent respectively. The rise in the yield of cereals was 26.8 per cent during this period when compared to 17 per cent in respect of pulses. (*Vide* Appendix). Among the non-food crops, oilseeds and fibres have recorded an increase of approximately 22.5 per cent in productivity. The corresponding increases for plantation crops and miscellaneous crops were 11 per cent and 8 per cent respectively. There has been considerable fluctuations from year to year and hence these percentages reveal that seasonal conditions were favourable in 1958-59 when compared to 1951-52.

The productivity indices specific for each crop show that the maximum gain (51.3 per cent) in yield has been recorded by gram, whereas there has been actually a decline in yield in respect of tur, other pulses, black pepper and chillies. India's staple food crops, *viz.*, rice and wheat have recorded an increase in yield of 28.1 per cent and 20.4 per cent respectively. The specific indices also reveal considerable fluctuations from year to year mainly due to differences in seasonal conditions.

The trend in the yield and area have been projected to 1960-61 by fitting a linear equation

$$y = a + bx$$

for the observed yield and area indices, choosing 1951-52 as the origin and

$$x = t - 1951\text{-}52$$

using the data given in Table I, the following trend lines were obtained :

| | Trend lines |
|---|---|
| Food Crops | |
| Yield | $107.96 + 1.82x$ |
| Area | $104.35 + 1.81x$ |
| Non-Food Crops | |
| Yield | $102.83 + 1.96x$ |
| Area | $96.79 + 2.60x$ |

Using these trend lines the "expected values" of the yield and area indices were arrived at for 1951-52 to 1960-61. Table II gives the expected values for 1959-60 and 1960-61.

TABLE II—EXPECTED VALUES OF $I_y^t$ AND $I_a^t$

| | 1959-60 | 1960-61 |
|---|---|---|
| Food Crops | | |
| Yield ($I_y^t$) | 122.52 | 124.34 |
| Area ($I_a^t$) | 118.83 | 120.64 |
| Non-Food Crops | | |
| Yield ($I_y^t$) | 118.51 | 120.47 |
| Area ($I_a^t$) | 117.59 | 120.19 |

*Implications on Planning*

The above analysis shows that it is possible to express agricultural production in terms of two components, *viz.*, yield and area. With the usual notation,

$$p = y \times a$$

expresses this relationship. If $\delta_p$, $\delta_y$ and $\delta_a$ denote the gains in production, yield and area respectively during the plan period, then

$$\frac{p + \delta_p}{p} = \frac{y + \delta_y}{y} \times \frac{a + \delta_a}{a}$$

or

$$(1 + \frac{\delta_p}{p}) = (1 + \frac{\delta_y}{y})\ (1 + \frac{\delta_a}{a})$$

This model has enabled the estimation of the probable levels of output in 1960-61. Using the expected values of $I_y^t$ and $I_a^t$ given in Table II, the results are set out in Table III.

TABLE III—ANTICIPATED LEVELS OF AGRICULTURAL OUTPUT: 1960-61

| Item | Percentage increase over 1955-56 |
|---|---|
| Food Crops | |
| Yield | 7.90 |
| Area | 8.11 |
| Output | 16.64 |
| Non-Food Crops | |
| Yield | 8.86 |
| Area | 12.13 |
| Output | 22.05 |

This shows that the production of foodgrains is likely to increase by 16.64 per cent during the Second Plan period as against the target of 23 per cent contemplated in the plan. The situation regarding non-food crops is more sanguine but even here the targets are not likely to be achieved.

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## APPENDIX

### INDICES OF AGRICULTURAL YIELD BY GROUPS AND SUB-GROUPS

(Base 1951-52 = 100)

| Groups / Sub-Groups | 1952-53 | 1953-54 | 1954-55 | 1955-56 | 1956-57 | 1957-58 | 1958-59 |
|---|---|---|---|---|---|---|---|
| | | | *1st Method* | | | | |
| Foodgrains .. .. .. | 109.4 | 122.0 | 119.9 | 112.6 | 115.1 | 110.7 | 124.9 |
| Cereals .. .. .. | 110.9 | 125.0 | 122.3 | 114.3 | 117.2 | 114.6 | 126.8 |
| Pulses .. .. .. | 103.2 | 109.7 | 109.8 | 105.4 | 106.3 | 94.6 | 117.0 |
| Non-Food Crops .. .. .. | 101.6 | 113.2 | 115.4 | 105.8 | 113.2 | 108.2 | 120.2 |
| Oilseeds .. .. .. | 101.2 | 115.6 | 117.0 | 107.9 | 111.8 | 102.5 | 122.4 |
| Fibres .. .. .. | 105.0 | 116.2 | 116.5 | 104.2 | 120.5 | 119.8 | 122.5 |
| Plantation Crops .. .. | 103.4 | 98.7 | 104.3 | 109.2 | 111.0 | 111.0 | 111.0 |
| Miscellaneous .. .. .. | 94.9 | 99.2 | 108.5 | 101.6 | 101.0 | 101.2 | 108.0 |
| General Index .. .. .. | 107.9 | 120.3 | 119.0 | 111.3 | 114.3 | 110.2 | 124.0 |
| | | | *2nd Method* | | | | |
| Foodgrains .. .. .. | 105.4 | 116.2 | 113.5 | 111.1 | 115.1 | 105.8 | 121.9 |
| Cereals .. .. .. | 105.7 | 117.8 | 114.2 | 112.8 | 117.0 | 108.0 | 122.8 |
| Pulses .. .. .. | 104.0 | 107.2 | 112.4 | 106.1 | 109.9 | 96.5 | 120.9 |
| Non-Food Crops .. .. .. | 97.2 | 98.3 | 102.3 | 99.1 | 104.3 | 103.3 | 109.6 |
| Oilseeds .. .. .. | 98.7 | 113.2 | 117.4 | 107.8 | 114.5 | 111.1 | 125.7 |
| Fibres .. .. .. | 100.9 | 98.7 | 97.7 | 95.0 | 107.7 | 104.1 | 112.5 |
| Plantation Crops .. .. | 106.2 | 93.9 | 101.8 | 100.9 | 103.2 | 105.3 | 109.9 |
| Miscellaneous .. .. .. | 94.8 | 100.2 | 107.3 | 101.9 | 101.6 | 100.7 | 105.6 |
| General Index .. .. | 100.9 | 107.1 | 108.7 | 105.9 | 110.7 | 104.8 | 117.0 |