A METHOD FOR ANALYSING AGRICULTURAL PRODUCTIVITY

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ABSTRACT: A new method of analysing agricultural productivity is suggested in this paper. The method takes into account not only the yield of crops but also their areal spread. Based on intensity of use, reflected in yield, and areal spread of the crops, the author has devised nine categories by a combination of high, medium and low yield intensity with high, medium and low spread of crops.

Agricultural productivity refers to the quantum of return from arable land; the quantity of produce denotes its intensity and the spatial expansion shows the spread. Several crops are grown which differ in nature, quantity and quality. So, their quantification on one level requires a common denominator, as such, some times they are converted into rice or wheat equivalents or in calories or in price values which are further converted into calories. It is in vogue since long, and only some methodological improvements were made from time to time to assess the agricultural efficiency and productivity.

There has been a general consciousness to measure the agricultural efficiency and productivity by considering the output per man hour by several scientists. The yield ranking coefficient of principal crops for a unit area was used in analysing and estimating the agricultural productivity by Kendall (1939). This method was applied by Stamp (1952) for the study of agricultural efficiency. In India Shafi (1960) did similar work on Uttar Pradesh. In measuring the agricultural efficiency, Ganguli (1938) considered the percentage of crop's share into the percentage of crops yield in an areal unit and thereafter average them into one.

Sapre and Deshpande (1964) refined the Kendall's method to some extent by multiplying the rank values of all crops in an areal unit by the percentage of crop land share and divided by the percentage shares to the total cropped area. Bhatia (1967) further modified this method by applying Ganguli's percentages of crop yield as a substitute for yield ranking of a particular crop. This method was used by Sen Gupta (1960) to analyse the agricultural efficiency in India. Here the relative crop significance of the district in respect of the total cropped area was not considered.

Buck (1937) contributed to this field by converting the total production in rice grain equivalent. The grain equivalent value was converted into caloric significance which was used by Stamp (1960) and Shafi (1972). Bhat and Learmonth (1968) worked on agricultural prices and their regional differentiations which presented crop patterns and their yields for analysing the agricultural productivity per unit area. Hussain (1976) converted the agricultural production into money value of an areal unit in ratio with the whole region.

These methods concentrate on analysing the general productivity or efficiency of land in the form of intensities. They do not throw any light on the relative relationships of

intensity and spread. In the study of an area the question arises, if the agricultural productivity is high or low in intensity, then, what is the contribution of the area covered by these categories? Whether the whole unit area also has high or low spread or only a part of that unit has that expansion? If the productivity has high intensification, then, what is the spread value? Whether it is high or low? To know this is necessary because an area with low or medium or high spread may have high intensity of productivity. In other words, productivity with high intensification may have high, medium as well as low spread, and it will not be justified if all of them are put into one category as high agricultural productivity without taking into account the spread. There must be some measure by which the spread can also be made responsible in categorising the agricultural productivity.

A Method

In this paper an attempt is made to evolve a method for the purpose of presenting a two-dimensional picture of agricultural productivity comprising two components, namely intensity and spread. This method will solve all the questions raised above by putting them into three different categories as (i) high-intensity-high spread, (ii) high intensity-medium spread and (iii) high intensity-low spread and not in one category as expressed earlier. This method will provide productivity categories in a relative term which will present a better picture than the absolute figures.

In determining agricultural productivity the intensity and spread indices of three variables (i) yield, (ii) grain equivalent, and (iii) cropping systems have been computed, interpreted and mapped to show the reciprocal correlations and interactions. Finally, they are computed to formulate the agricultural productivity. The terms and equations which come across in this method are explained hereunder.

(1) Yield Index

The crop production depends upon per hectare yield and its cultivated area. Therefore, the per hectare yield on one hand, and the crop expansion in percentage on the other, have been considered to compute the yield intensity (Iyi) and spread (Isy) along with their mutual interactional categories.

(i) **Intensity** :– In calculating the yield intensity index (Iyi), the per hectare yield of crops of a micro (district) unit are separately divided by per hectare yield of those crops of the macro (State) area. Such ratios of all the crops are summed up and multiplied by 100 and divided by the total number of crops. It can be equated as follows :

$$Iyi = \frac{100}{n}\left(\sum_{j=1}^{n} \frac{Ypj}{Yrj} \right) \qquad \ldots(1)$$

where :

 Iyi = Yied intensity index
 Ypj = Per hectare yield of crops in a micro unit
 Yrj = Per hectare yield of crops in a macro area
 n = number of crops.

(ii) **Spread:-** In measuring the yield spread index (Isy) the percentage of crop land share of a micro unit is divided by such shares of a macro area and the resultant is multiplied by the yield ratio of the same crop. Thereafter they are added together and multiplied by 100 and divided by number of crops. It may be formulated as follows :

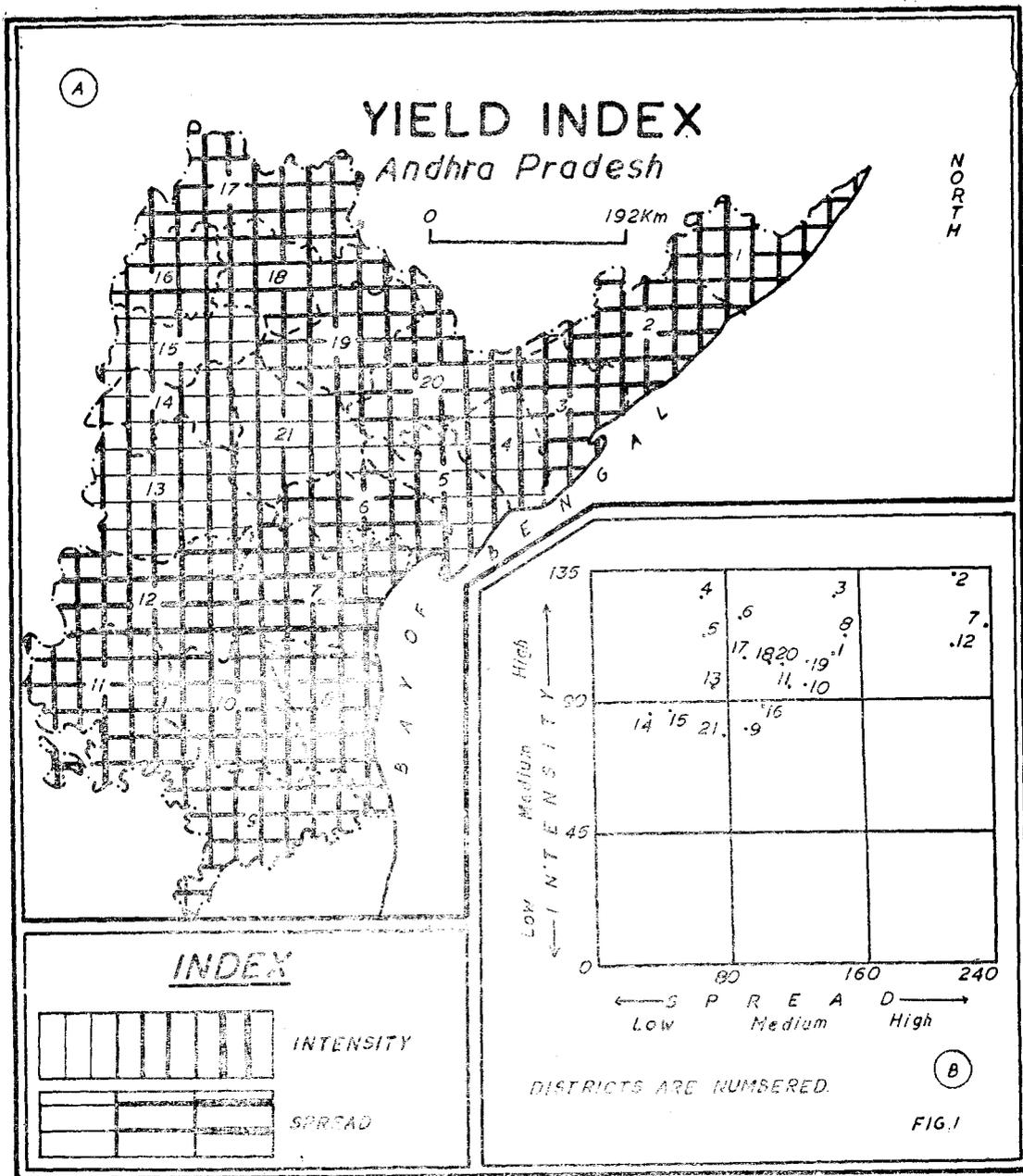$$Isy = \frac{100}{n}\left(\sum_{j=1}^{n} \frac{Cpj}{Crj} \cdot \frac{Ypj}{Yrj} \right) \ldots (2)$$

where :

 Cpj = Percent of cultivated land in a micro unit
 Crj = Percent of cultivated land in a macro area
 Ypj/Yrj = Yield ratio
 n = number of crops

FIG.1

Thus, the results obtained can be represented by a scattered diagram and chropleths can be drawn to show the intensity and spread indices of yield index. It is proposed that the maximum value of these indices be raised to higher units divisible by three (Table-1). In the scatter diagram the X and Y axis will respectively represent the spread and intensity values. Then the X and Y axis be divided into three equal parts-high, medium and low. This division will give nine categories (Fig. 1b) i.e., (i) high intensity, high spread, (ii) high intensity-medium

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spread, (iii) high intensity-low spread, (iv) medium intensity-high spread, (v) medium intensity-medium spread, (vi) medium intensity-low spread, (vii) low intensity-high spread, (viii) low intensity-medium spread, and (ix) low intensity-low spread. These indices of intensity and spread values put together will fall within these categories (Fig. 1b).

They may be shown by choropleths method and horizontal and vertical shades should be used to identify the intensity and spread. In figure 1 (a) an explicit represent-ation of the same has been given for clarity. This method can be adopted for grain equivalent and cropping indices. Similarly, even minor details of different sub-variables like individual or group of crops i. e., Rice yield Index, rice grain equivalent index, yield index for cereals etc., may be drawn for a minute analysis.

(2) Grain Equivalent Index

Three parameters viz., (i) crop production (ii) crop land share in percent, and (iii) simplified weight of grain equivalent (w) units have been taken for the assessment Kostrowicki (1976).

(i) **Intensity** :- The Crop production of a micro areal unit is divided by the macro area production of that crop and multiplied by the grain equivalent unit to obtain the grain equivalent coefficient. They are further added up then multiplied by 100 and divided by the number of crops. The resultant is called as grain equivalent intensity index which is obtained by the following method.

$$Igei = \frac{100}{n} \left(\sum_{j=1}^{n} \frac{Pkj}{Prj} . Wkj \right) \quad \cdots (3)$$

where :

    Igei = Grain equivalent intensity index

    Pkj = Production of a crop in a micro unit

    Prj = Production of the crop in a macro area

    Wkj = Grain equivalent unit of the crop

    n = Number of crops.

(ii) **Spread** :- A similar method is followed to obtain the spread of grain equivalent. In this system the percentage share of a crop of a micro unit is divided by the macro area percentage of the same crop. It is further multiplied by the grain equivalent coefficient which is obtained while processing the intensity of the grain equivalent. Thereafter, it is multiplied by 100 and divided by the number of crops. It may be calculated by using the following equation :

$$Isge = \frac{100}{n} \left(\sum_{j=1}^{n} \frac{Ckj}{Crj} . \frac{Pkj}{Prj} . Wkj \right) \quad \cdots (4)$$

where :

    Isge = Grain equivalent spread index

    Ckj = Percentage share of a crop in a micro unit

    Crj = Percentage share of the crop in a macro area

    $\frac{Pkj}{Prj}$. Wkj = Grain equivalent coefficient

    n = Number of crops.

(3) Cropping Index

It denotes the relative interaction and the resultant of area cropped more than once on the one hand and irrigated areas on the other. These two variables are analysed for assessing the intensity and spread respect-ively.

(i) **Intensity** :- For measuring the in-tensity of cropping index the percentage share of area cropped more than once in a micro unit is divided by the macro area percentage of area cropped more than once. Then the result is multiplied by 100 to find the cropping intensity. It may be formulated as under :

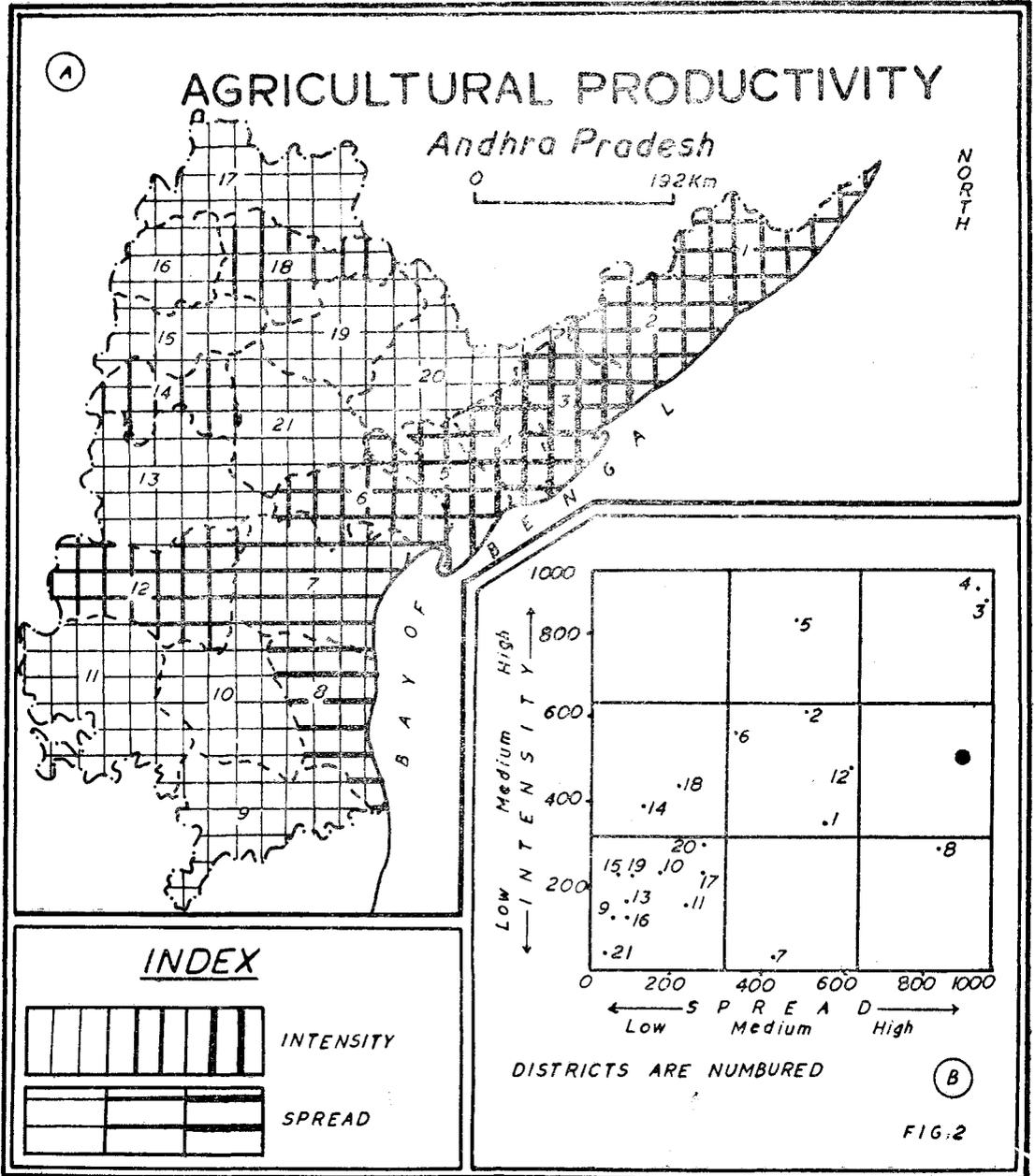$$Ici = \frac{dcu}{dcr} . 100 \quad \cdots (5)$$

where :

    Ici = Cropping intensity index

    dcu = Percentage of area cropped more than once in a micro unit

    dcr = Percentage of area cropped more than once in a macro area.

Table: I. Index of Agricultural Productivity Components

S. No.	District	Yield Index		Grain equivalent		Cropping Index		Agricultural General		Productivity Index Standardised	
		Iyi	Isy	Igei	Isge	Ici	Isci	Iapi	Isap	Iste	Ists
1.	Srikakulam	101	144	18	25	122	125	74	106	373	540
2.	Visakapatnam	134 (135)	193	14	14	152	103	112	107	613	546
3.	East Godavari	128	152	33	61	226	185	181	196	906	1000
4.	West Godavari	124	73	41	93 (93)	223	232 (234)	184	192 (1000)	925	980
5.	Krishna	111	79	34	42	242	163	175	99	879	505
6.	Guntur	118	84	25	32	(243)	131	105	76	528	388
7.	Prakasm	116	239 (240)	90	5	197	72	2	88	10	449
8.	Nellore	126	144	17	26	74	185	56	157	281	801
9.	Kurnool	84	83	79	11	47	40	24	19	121	97
10.	Anantapur	96	120	124 (126)	29	29	53	42	39	211	199
11.	Cuddapah	94	106	44	5	38	98	26	54	131	276
12.	Chittoor	120	208	85	20	93	109	95	124	477	633
13.	Hyderabad	94	75	23	2	57	56	33	22	166	112
14.	Nijamabad	88	50	33	3	119	146	72	39	362	199
15.	Medak	88	69	31	2	96	73	43	26	216	133
16.	Mahaboobnagar	90	85	67	6	28	45	22	20	111	102
17.	Nalgonda	111	94	59	5	235	117	199 (1000)	58	1000	296
18.	Warangal	104	92	67	4	148	94	80	45	402	230
19.	Khammam	106	91	31	3	62	53	42	25	211	128
20.	Karimnagar	100	94	48	3	84	102	65	49	326	250
21.	Adilabad	81	93	20	3	21	24	11	10	52	51

AGRICULTURAL PRODUCTIVITY

Andhra Pradesh

0   192Km

INDEX

INTENSITY

SPREAD

DISTRICTS ARE NUMBERED

FIG. 2

(ii) **Spread** : Area cropped more than once is mainly the consequence of the expansion of irrigational facilities. There- fore, to measure the spread index similar method is followed where the percent share of irrigated area in a micro unit is multiplied by 100 and the product is divided by the percent share of the irrigated land of the macro area. It can be represented as follows :

$$Isci = \frac{isu}{isur} \cdot 100 \qquad \cdots (6)$$

where :

Isci = Cropping spread index

Isu = Irrigated area in percent of a micro unit

Isur = Irrigated area in percent of the macro area.

(4) Agricultural Productivity Index

The above analysis presents three parameters, intensity and spread indices of yield, grain equivalent and cropping systems. They are grouped together to obtain the intensity and spread of agricultural productivity. They may be separately analysed.

(i) **Intensity** : The yield and grain equivalent intensities indices of crops are added and divided by two which is further multiplied by the cropping intensity index and divided by 100. It may be given as follows :

$$api = \frac{Ici}{100} \left(\frac{Iyi + Igei}{2} \right) \quad \cdots (7)$$

where :

Iapi = Agricultural productivity intensity index

Iyi = Yield intensity index

Igei = Grain equivalent intensity index

Ici = Cropping intensity index.

(ii) **Spread** : The spread index of agricultural productivity is calculated by adding the spread indices of yield and grain equivalent which is divided by two. Then the resultant is further multiplied and divided by cropping spread index and 100 respectively. It may be indicated in the following equation :

$$Isap = \frac{Isci}{100} \left(\frac{Isy + Isge}{2} \right) \quad \cdots (8)$$

where :

Isap = Agricultural productivity spread index

Isy = Yield spread index

Isge = Grain equivalent spread index

Isci = Cropping spread index.

The intensity and spread indices of agricultural productivity may range from zero to infinity according to the value of the nine categories already suggested. In this pattern,

naming a category will have no meaning unless the index values limiting a particular category are expressed quantitatively.

It will also be difficult to compare different areas. The same category will have different values i.e., the ninth category, low intensity-low spread may have index below 138-380 in one case, and in the other, it may have below 600-1084 respectively. To overcome this problem, the index values of the agricultural productivity have been standardised so that the categories may have definite values and by this method everywhere the ninth category will have index value below 333.33 in both the cases i.e., intensity and spread.

(i) **Intensity** : In standardising the indices all the index values of intensity (excepting the highest index number which is presumed as 1000) is multiplied by 1,000 and is divided by its highest number or maximum index value (Fig. 2). This may be calculated as under :

$$Isti = \frac{Iapi}{Ihapi} \cdot 10^3 \quad \cdots (9)$$

where :

Isti = Standardised intensity index value

Iapi = Intensity index of agricultural productivity

Ihapi = The maximum intensity index of agricultural productivity.

(ii) **Spread** : In standardising the spread values similar method is used where all the spread values of agricultural productivity (excepting the maximum index value which is presumed as 1,000) is multiplied by 1,000 and divided by its maximum spread index value. In can be completed by the following formula :

$$Ists = \frac{Isapi}{Ishapi} \cdot 10^3 \quad \cdots (10)$$

where :

Ists = Standardised spread index value

Isapi = Spread index of agricultural productivity

Ishapi = The maximum spread index of agricultural productivity.

This system will provide 1,000 as the maximum index values for intensity and spread of agricultural productivity. Thus the X and Y axis will have the same value everywhere. It will not range like that of yield, grain equivalent and cropping indices as expressed earlier where even the nine categories have different index values at different places.

These results can finally be represented by a scatter diagram and may be drawn on the same lines as suggested earlier. Isopleth maps can also be drawn, but in this case two separate maps for intensity and spread of agricultural productivity will have to be drawn. Later on they will have to be superimposed for identifying the categories.

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