Vol XIX
No. 1

ISSN 0019-5014

CONFERENCE
NUMBER

JANUARY-
MARCH
1964

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

of works projects in rural areas to relieve unemployment and disguised under-employment in areas like Region I where the productivities of both human and bullock labour are low and where there are definite slack seasons.

Further, it is seen in the present study that a careful classification of various input factors is an important point to be borne in mind when production analysis is attempted.

It may be noted that the regression analysis followed here gives in a certain sense the best estimate of dependent variable if the independent variables are known. It is not designed to give the best estimates of the regression coefficients but they are very useful for broad policy purposes.

It may also be noted here that production functions estimated on the basis of cross-section data restricts the use of the results as a guide to policy. To derive any useful conclusions, time series should be utilised particularly because agriculture is highly seasonal in character.

INTER-DISTRICT VARIATIONS IN AGRICULTURAL EFFICIENCY IN MAHARASHTRA STATE

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The present paper attempts to study the variations in the agricultural efficiency between different districts in the State of Maharashtra. As Stamp points out, there are at least three methods of measuring agricultural efficiency. The first method regards efficiency as indicated by output per unit of area; the second method measures efficiency in term of output of labour, that is per man-hour; and the third is the input-output ratio and the profitability of farming measured in terms of the return for the sum-total of human effort. Stamp, however, prefers the first method. "In the world short of food it is surely clear that what matters in many countries, perhaps most, is the actual amount of food produced."[1] He further argues that, making allowance for quality, the higher the output per unit area the greater the efficiency.

In the present analysis, we have adopted the same criterion for determining agricultural efficiency, *i.e.*, the relationship between physical output and land. The problem faced in such a study is the one of preparing a composite index of productivity since a region produces many crops and the productivity in respect of these crops differs from one crop to another. Kendall attempted to solve this

* The authors are grateful to Prof. P. N. Mathur, Gokhale Institute of Politics and Economics, Poona, for making helpful suggestions.

1. L. Dudely Stamp: Our Developing World, p. 104.

problem by devising a method of 'Ranking co-efficients'. Stamp applied this method for determining agricultural efficiency of several countries. In India the use of this method was made by Shah for determining agricultural efficiency of the districts comprising the State of U.P. The procedure, in brief, is as follows. First, the areas or the regions are ranked in the order of output per acre for each of the selected crops. Then the ranks, *i.e.*, the places occupied by each region in respect of the selected crops are averaged to obtain ranking coefficients of each region. This gives a measure of crop productivity per acre which is the result of natural advantages and partly of farming efficiency.

This simple method of ranking regions according to per acre output has, however, one major defect, *viz.*, it does not give weightage to the area under different crops. Thus, in the present analysis, a particular district may be the most efficient producer of a crop which is also a major crop in the district; however, its overall ranking may go down because it devotes a small area to other crops in respect of which it has a very low ranking. It seems, therefore, necessary to give weightage to the rank in respect to each of the crop according to its proportion in the total cropped acreage of the district.

Table I gives the ranking coefficients for each of the districts in Maharashtra. The eight most important crops in the State are taken into account, *i.e.*, paddy, wheat, jowar, bajri, gram, groundnut, cotton and sugarcane. To even out year to year fluctuations in the production due to seasonal factors, the quinquennial averages have been taken into account. The table gives the per acre yield, the proportion of land under the crop, the rank of the districts in respect of each of the crop and the ranking coefficient. The districts are classified into four groups on the basis of the rainfall since it is one of the main determinants of agricultural productivity. The first group contains districts with 75″ or more rainfall, the second group represents districts with rainfall between 50″ and 75″, the third group contains districts with rainfall between 30″ and 50″ and the last group includes the districts with less than 30″ rainfall. It was noticed that there were marked variations in the average rainfall as between the constituent talukas within a few districts. However, such areas within a district having a markedly different rainfall than the district average, were very small. Such deviations were, therefore, ignored and the district was treated as a homogeneous unit.

The first group, *i.e.*, the high rainfall districts stand as the most productive in the whole State. These districts more or less grow only one crop, *i.e.*, paddy, and the per acre yield of this crop is also very high. In the second group, Kolhapur district is remarkably better off than the remaining two districts because it is highly efficient in the production of all the important crops which it grows. In Bhandara and Chanda, paddy and jowar are the two important crops but their performance in respect of both these crops is very moderate. The average rank obtained by both these districts is, therefore, brought down considerably. Most of the districts in the third group show a poor performance. The case of Satara is, however, unique. It can be seen that in respect of the production of three out of the eight selected crops, this district ranks first in the whole State. It may be also remembered that, though it is included in the third rainfall group, it has a fairly high precipitation (49″ average rainfall) as compared to most of the districts in the third

2. *Economic Geography*, Vol. 36, 1960, p. 296.

TABLE I—PRODUCTION EFFICIENCY IN DIFFERENT DISTRICTS

Rainfall Group	Name of the District	Rice			Wheat			Jowar			Bajri			Groundnut		
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
I	Thana	1268	1	98.90	—	—	—	—	—	—	—	—	—	—	—	—
	Ratnagiri	975	4	99.88	—	—	—	—	—	—	—	—	—	809	2	0.06
	Kolaba	1123	2	99.60	—	—	—	—	—	—	—	—	—	—	—	—
II	Kolhapur	983	3	38.82	335	11	0.93	920	1	24.71	218	11	1.37	749	3	20.41
	Bhandara	812	5	75.01	289	20	9.13	392	13	11.77	—	—	—	442	14	0.19
	Chanda	810	7	46.45	312	16	8.41	416	10	38.50	—	—	—	386	17	0.05
III	Nasik	758	10	5.22	331	13	14.11	376	14	10.49	260	7	51.62	490	13	11.40
	Satara	817	5	4.85	594	1	2.80	568	4	41.24	263	5	33.68	822	1	12.18
	Parbhani	413	19	1.56	372	8	7.11	472	8	50.56	233	9	0.46	297	21	6.13
	Nanded	376	21	3.20	335	11	4.33	440	9	50.20	233	9	0.19	411	16	3.62
	Buldhana	453	16	0.41	362	9	6.90	528	6	39.60	311	3	0.99	376	19	6.39
	Akola	429	17	1.05	379	7	7.30	408	11	35.40	78	15	0.88	378	18	6.47
	Amravati	512	14	0.89	438	4	6.27	416	10	31.61	262	6	0.94	417	15	3.25
	Yeotmal	515	13	1.47	309	18	2.84	376	14	43.20	402	1	1.61	349	20	4.69
	Wardha	453	16	0.51	333	12	12.35	392	13	39.88	—	—	—	442	14	0.50
	Nagpur	787	9	4.88	336	10	18.57	376	14	56.07	—	—	—	521	10	1.41
IV	Jalgaon	522	12	0.85	447	3	4.86	832	2	24.74	252	8	12.91	605	6	20.86
	Dhulia	382	20	5.39	451	2	7.26	496	7	28.79	393	2	22.29	648	4	19.60
	Bhir	334	22	1.25	317	15	6.99	544	5	47.15	164	14	15.95	515	11	11.33
	Ahmednagar	725	11	0.85	326	14	4.82	416	10	52.13	221	10	29.21	531	9	3.70
	Sholapur	502	15	0.85	384	6	2.34	400	12	73.98	67	16	9.39	511	12	8.58
	Sangli	758	10	2.12	407	5	2.59	680	3	47.72	173	13	26.85	593	8	14.96
	Aurangabad	326	23	0.52	294	19	8.75	472	8	37.02	196	12	18.08	262	22	8.12
	Poona	793	8	8.89	266	21	4.14	344	15	71.44	298	4	3.87	612	5	3.73
	Osmanabad	415	18	3.98	311	17	7.55	496	9	52.54	233	9	3.04	599	7	16.21

(Contd.)

Rainfall Group	Name of the District	Cotton			Gram			Sugarcane			Total	Average Ranking Coefficient
		1	2	3	1	2	3	1	2	3		
I	Thana ..	—	—	—	296	7	0.69	1568	22	0.05	104.8	1.0
	Ratnagiri ..	—	—	—	300	6	—	2763	16	0.06	398.6	4.0
	Kolaba ..	—	—	—	300	6	0.38	2240	20	0.03	202.1	2.0
II	Kolhapur ..	132	3	1.86	313	4	1.62	6626	4	10.28	283.9	2.8
	Bhandara ..	41	20	—	285	10	3.64	2746	17	0.26	829.2	8.3
	Chanda ..	32	21	3.88	246	20	2.59	3629	12	0.11	980.2	9.8
III	Nasik ..	83	9	1.30	283	11	4.56	5799	5	1.30	960.4	9.6
	Satara ..	173	1	0.36	347	2	3.60	5399	7	1.29	389.2	3.9
	Parbhani ..	51	18	28.75	288	8	5.22	3792	10	0.21	1185.2	11.9
	Nanded ..	61	15	33.46	228	21	4.71	3573	14	0.29	1231.1	12.3
	Buldhana ..	71	12	44.06	254	19	1.49	2309	19	0.15	990.5	9.9
	Akola ..	79	10	47.09	256	18	1.79	2688	18	0.02	1091.5	10.9
	Amravati ..	75	11	55.67	287	9	1.36	2240	20	0.01	1032.8	10.3
	Yeotmal ..	63	13	44.79	242	21	1.37	2150	21	0.03	1382.1	13.8
	Wardha ..	50	19	45.54	275	14	1.04	2688	18	0.01	1561.8	15.6
	Nagpur ..	50	19	16.58	274	15	2.40	2688	18	0.01	1379.9	13.8
IV	Jalgaon ..	89	7	34.71	313	4	0.90	3640	11	0.17	551.1	5.5
	Dhulia ..	86	8	13.97	336	3	2.43	3575	13	0.27	593.6	5.9
	Bhir	62	14	11.48	279	13	5.61	3470	15	0.24	953.8	9.5
	Ahmednagar	95	6	3.78	305	5	2.84	7651	2	2.67	965.8	9.7
	Sholapur ..	98	5	1.46	262	16	2.55	7366	3	0.85	1218.4	12.2
	Sangli ..	116	4	1.63	358	1	3.24	5773	6	0.89	661.1	6.6
	Aurangabad ..	57	16	22.40	228	21	4.49	3878	9	0.62	1328.2	13.3
	Poona ..	142	2	0.89	280	12	5.24	7658	1	1.80	1330.3	13.3
	Osmanabad ..	55	17	8.59	258	17	7.50	4530	8	0.59	987.6	9.9

1 = Per acre yield (in lbs.). 2 = Rank of the district. 3 = Percentage of land under the crop to the total acreage under the eight selected crops.

Source : Report, Maharashtra State Irrigation Commission, Government of Maharashtra, 1962, pp. 251-254 and 318.

group. As regards the districts in the fourth group, some of the districts show better performance than the districts in the third group having a higher rainfall average. Thus, broadly, it appears that the high rainfall group is more efficient than the low rainfall groups. However, it is necessary to bear in mind the limitations of the method employed for the present analysis. The method would yield meaningful results only when all the districts grow a variety of crops. If each district specialises in a different crop then it would be difficult to get a comparative picture since all the districts would get first ranking. To some extent it seems that the first three districts, *viz.*, Thana, Kolaba, Ratnagiri have acquired first rank due to this limitation of the method. The method, however, gives a broad productivity index since most of the districts grow a variety of crops.

In order to ascertain the influence of the three important factors, *viz.*, rainfall, irrigation and soil fertility we fitted a regression equation with productivity as the dependent variable and the three factors as independent variables. The relevant data are given in Table II. The symbols are defined as follows :—

Y = productivity as indicated by the Average Ranking Coefficient obtained from Table I.

X_1 = normal average rainfall in terms of inches.

X_2 = proportion of irrigated land in the district.

X_3 = soil fertility.[3]

The final regression equation was found to be

$$Y = 2.277687 - 0.110390\ X_1 - 0.024956\ X_2 - 0.195860\ X_3.$$

$$R^2 = 0.4771.$$

Multiple correlation coefficient between Y and X_1, X_2, X_3 is found to be 0.69 which is significant at 1 per cent level. This means that 48 per cent of the variations in the productivity rankings are explained by the three factors together. Of the three factors, rainfall alone explains about 40 per cent variations. Relation between productivity and soil index was found to be statistically not significant. Similarly there was hardly any relationship between irrigation and the variations in the productivity rankings.

Classification of districts according to rainfall reveals one significant fact, namely, the districts falling into the same group also have more or less a similar cropping pattern. Broadly speaking, the first two groups which enjoy relatively high rainfall produce paddy as the main crop occupying most of the area. The

3. As regards soil fertility very little work is available in the published form. In the present analysis soil index prepared by S. R. Ray Chaudhary and K. B. Shome has been used. These authors have attempted to formulate soil index rating in respect of all the districts in the country, using three main factors, *viz.*, Factor A : Character of the soil profile ; Factor B: Topography, texture and structure; Factor C : Degree of climatic suitability, salinity, stoniness and tendency to erode. For further details please refer to the article, "Rating of Soils of India," *Proceedings of the National Institute of Sciences of India*, Vol 26(*a*) (Supplement I), 1960.

TABLE II—PRODUCTIVITY, RAINFALL, PROPORTION OF IRRIGATED LAND AND SOIL INDEX OF INDIVIDUAL DISTRICTS

Name of the District	Productivity (Average ranking coefficient)	Rainfal (in inches)	Proportion of irrigated land	Soil index
Thana	1.0	87.98	1.4	57.6
Kolaba	2.0	122.23	0.9	72.7
Kolhapur	2.8	79.84	7.5	57.6
Satara	3.9	49.44	11.5	57.6
Ratnagiri	4.0	123.15	3.2	72.2
Jalgaon	5.5	28.18	4.6	61.2
Dhulia	5.9	25.46	5.0	61.2
Sangli	6.6	25.45	5.8	54.4
Bhandara	8.3	57.21	27.5	64.8
Bhir	9.5	26.70	4.6	54.4
Nasik	9.6	41.67	5.9	61.2
Ahmednagar	9.7	22.62	10.3	61.2
Chanda	9.8	55.37	18.1	56.6
Osmanabad	9.9	29.68	4.0	54.4
Buldhana	9.9	31.46	1.2	57.6
Amravati	10.3	36.37	1.0	72.2
Akola	10.9	32.81	0.3	72.7
Parbhani	11.9	33.54	1.7	54.4
Sholapur	12.2	23.87	9.7	57.6
Nanded	12.3	33.68	1.0	54.4
Aurangabad	13.3	27.64	3.9	54.4
Poona	13.3	36.56	8.5	61.2
Yeotmal	13.8	38.84	0.3	64.8
Nagpur	13.8	46.17	4.9	64.8
Wardha	15.6	43.43	1.1	72.7

N.B.: (1) Data in respect of rainfall and the proportion of irrigated land are quoted from *Maharashtra Krishijeevan, Sankhyikiya Darshan*, 1960, Gokhale Institute of Politics and Economics, Poona.

(2) Data in respect of soil index are quoted from "Rating of Soils of India" by S. R. Ray Chaudhary and K. B. Shome. *Op. cit.*

third group of districts with rainfall between 30″ and 50″ grows mainly jowar and cotton. The last group of districts with rainfall less than 30″ grows mainly jowar and bajri. This similarity in the cropping pattern between districts with the same rainfall is significant particularly when the districts so grouped together do not necessarily form a contiguous region. The relevant data in this connection is given in Tables III and IV. Table III gives the cropping pattern of the four groups of districts and Table IV gives the major crops in the individual districts together with the crops in which the districts are most efficient, moderately efficient, and least efficient and the proportion of area under each of the categories. This would also give a basis for demarking the most promising districts in respect of the important crops for the concentration of efforts for increasing production. For instance Poona ranks very low in respect of jowar which occupies about 37 per cent of the total cropped area of the district; in respect of bajri, however, it ranks fairly high but only about 19 per cent of the land is devoted to it.

TABLE III—PERCENTAGE AREA UNDER CROPS (MAHARASHTRA)
(YEAR 1957-58)

Name of the Crop	Rainfall Group			
	I	II	III	IV
Rice	46.34	36.88	1.90	1.79
Jowar	0.05	17.68	30.17	36.09
Bajri	—	0.20	7.85	13.84
Ragi	11.39	2.99	0.94	0.34
Wheat	—	4.41	6.23	3.97
Other Cereals	7.64	2.31	0.56	1.58
Pulses	4.59	13.12	12.94	14.42
Sugarcane	0.02	1.75	0.29	0.74
Other Food Crops	1.77	1.88	1.85	1.59
Oilseeds : Groundnut	0.01	3.39	4.76	8.32
Others	1.93	7.64	3.50	5.13
Fibre Crops	0.18	1.49	25.79	8.34
Fodder Crops	26.03	5.33	3.14	3.65
Other Non-Food Crops	0.05	0.93	0.08	0.20
Total Cropped Area (acres)	2,220,940	3,521,640	17,664,940	22,314,270
	100	100	100	100

Source : *Maharashtra Krishijeevan, Sankhyikiya Darshan,* 1960, Gokhale Institute of Politics and Economics, Poona-4.

TABLE IV—CLASSIFICATION OF THE EIGHT CROPS ACCORDING TO PRODUCTIVITY IN EACH DISTRICT

1	2	3	4	5	6	7	8	9
District	Important Crops	Percentage of area under these	High productivity crops	Percentage of area under these	Moderately high productivity crops	Percentage of area under these	Low productivity crops	Percentage
Thana	Rice	49	Rice	49	—	—	Sugarcane	*
Ratnagiri	Rice	36	Groundnut, Rice	36	Gram	*	—	—
Kolaba	Rice	60	Rice	60	Gram	*	Sugarcane	*
Kolhapur	Rice, Jowar, Groundnut, Sugarcane, Gram	54	Rice, Jowar, Groundnut, Sugarcane	53	Cotton, Gram	2	Wheat, Bajari	1
Bhandara	Rice, Jowar, Wheat	66	—	—	Rice, Gram	54	Wheat, Jowar, Groundnut, Cotton, Sugarcane	14
Chanda	Rice, Jowar, Wheat	68	—	—	Rice, Jowar	62	Wheat, Gram, Groundnut, Cotton, Sugarcane	11
Nasik	Bajari, Groundnut, Jowar, Wheat	61	—	—	Rice, Bajari, Gram, Sugarcane	44	Wheat, Jowar, Groundnut, Cotton	26
Satara	Jowar, Bajari, Groundnut	57	Wheat, Gram, Groundnut, Cotton	12	Sugarcane, Rice, Jowar, Bajari	53	—	—
Parbhani	Jowar, Cotton, Groundnut, Wheat	71	—	—	Wheat, Jowar, Gram	48	Rice, Groundnut, Cotton, Bajari, Sugarcane	28
Nanded	Jowar, Cotton	65	—	—	—	—	Rice, Wheat, Gram, Jowar, Bajari, Groundnut, Cotton, Sugarcane	77

(Contd.)

TABLE IV—(*Contd.*)

1	2	3	4	5	6	7	8	9
Buldhana	Jowar, Cotton	71	—	—	Jowar, Wheat, Bajari	41	Rice, Gram, Groundnut, Cotton, Sugarcane	43
Akola	Jowar, Cotton	72	—	—	Wheat	6	Rice, Jowar, Bajari, Gram, Groundnut, Sugarcane, Cotton	82
Amravati	Jowar, Cotton	75	Wheat	5	Bajari, Gram	2	Rice, Groundnut, Jowar, Cotton, Sugarcane	80
Yeotmal	Jowar, Cotton	75	Bajari	1	—	—	Rice, Wheat, Jowar, Groundnut, Gram, Cotton, Sugarcane	83
Wardha	Jowar, Cotton	71	—	—	Gram	1	Rice, Wheat, Jowar, Groundnut, Cotton, Sugarcane	81
Nagpur	Jowar, Wheat, Cotton	71	—	—	Rice, Gram	6	Jowar, Cotton, Wheat, Sugarcane, Groundnut	70
Jalgaon	Cotton, Groundnut, Jowar, Bajari	72	Wheat, Jowar	23	Groundnut, Gram	17	Rice, Bajari, Cotton, Sugarcane	38
Dhulia	Jowar, Bajari, Groundnut, Cotton	68	Wheat, Bajari, Gram	26	Jowar, Groundnut	39	Rice, Sugarcane, Cotton,	15
Bhir	Jowar, Bajari	47	—	—	Jowar, Gram	39	Rice, Wheat, Bajari, Cottont Groundnut, Sugarcane	35
Ahmednagar	Jowar, Bajari	66	Sugarcane	2	Rice, Gram,	3	Wheat, Bajari, Jowar, Groundnut, Cotton	76
Sholapur	Jowar, Bajari	70	Sugarcane	1	Wheat	2	Rice, Jowar, Bajari, Gram, Groundnut, Cotton	79
Sangli	Jowar, Bajari, Groundnut	70	Gram, Wheat	5	Rice, Groundnut, Sugarcane, Jowar, Cotton	53	Bajari	21

(*Contd.*)

TABLE IV—(*Contd.*)

1	2	3	4	5	6	7	8	9
Aurangabad	Jowar, Bajari, Cotton	56	—	—	—	—	Rice, Wheat, Bajari, Gram, Groundnut, Cotton, Jowar, Sugarcane	71
Poona	Jowar, Bajari	56	Sugarcane	1	Rice, Bajari, Groundnut, Cotton, Gram	29	Wheat, Jowar	39
Osmanabad	Jowar, Groundnut	47	—	—	Jowar, Sugarcane, Groundnut	47	Rice, Wheat, Gram, Cotton, Bajari	21

(1) * Negligible.

(2) Percentage under the crop relates to the total cropped area.

Source : Maharashtra State Irrigation Commission, Government of Maharashtra, 1962, pp. 251-259.

Productivity has been classified into high, moderate and low as follows:

	Rice	Wheat	Jowar	Bajari	Groundnut	Cotton	Gram	Sugarcane
High Productivity (per acre lb.)	975 and more	400 and more	830 and more	393 and more	749 and more	173 and more	336 and more	6,626 and more
Moderate Productivity (per acre lb.)	725-975	360-400	496-830	260-311	593-648	116-142	274-313	5,399-5,799
Low Productivity (per acre lb.)	Lesser than yield given in the preceding columns.							

In conclusion, the following points may be briefly stated. First, the method of 'ranking coefficient' shows that the high rainfall districts are relatively more efficient in agricultural productivity. Second, the regression analysis also shows that rainfall is the major factor influencing productivity. Third, districts in the same rainfall group also have similar cropping pattern.