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errors are the sampling error, the specification error and the aggregation error. The standard error of the estimated yardsticks varied from about 2 to 10 per cent generally.

The formula for bias involved has been worked out under certain assumptions. It was found that the bias due to aggregation and standardization can be considerably reduced if the standardization level is chosen as somewhat higher than the sum of the average rates of application in the base year and the current year. The calculations are illustrated with the data obtained in fertilizer survey carried out in a few selected districts. It has been brought out that it is essential to use different standardization levels in different areas if substantial errors in the use of the yardsticks have to be avoided.

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MEASUREMENT OF SIZE OF FARM AND EFFICIENCY—SOME ALTERNATIVE APPROACHES*

Objective

The article attempts to examine the definition of the 'size of farm' and to show that measures of size and efficiency other than those currently used for measuring size (namely, geographical area) and efficiency (namely, the yield per acre) lead to different conclusions. An analysis of this problem has also been made by Raj Krishna.[1]

SIZE OF FARM

In practically all the available studies relating to agriculture whether by census of land holdings, cost data or input/output analysis, the size of the farm is invariably measured by its geographical area. The size of a farm can, in fact, be measured either in terms of physical output, gross receipts (total and per acre), total inputs, etc. It is of importance to choose the concept of size correctly, because the size distributions of farms according to different measures of size are not similar.

The classifications of farms according to the land and labour input would be useful provided that classifications by value added and by each of the other major input groups such as, say, seeds, manures, fertilizers, etc., are also given. But such data are rarely available together. However, classification according to inputs only, ignoring the aspect of output, is not wholly satisfactory. This flows from the fact that the scale distribution proper and the effect of relative efficiency of different farms are mixed up. This prevents identification of size and efficiency magnitudes and analysis of the relation between them.

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* The views expressed in this paper are the personal views of the author and not necessarily of the organization he has the privilege to serve.

1. Raj Krishna, "The Optimum Firm and the Optimum Farm," *The Economic Weekly*, Vol. XIV, Nos. 40 and 41, October 6 and 13, 1962.

It can be argued that the current measures of size of farms is administratively convenient. Also that it is a good measure because land is the 'scarcest' input. However, it is easy to see that output can be tabulated farmwise along with the data on inputs, as has been done in various cost studies.

EFFICIENCY

Raj Krishna[2] points out that when we turn from the measurement of size to the measurement of efficiency or the criteria for determining the optimum farm size, we come across a multiplicity of these in the current literature. The size of the 'basic holdings,' 'economic holdings,' etc., are determined by asking how many acres of land of different qualities will keep a normal family reasonably fully occupied or provide a reasonable net income or reasonably keep a pair of bullocks fully occupied. A. M. Khusro,[3] on the basis of the farm management data concludes that holdings of 7.5 to 10 acres would more or less meet the bullock pair, family employment and minimum income criteria. The minimum income norm is an equity norm and not an efficiency norm. It is, of course, desirable that rural households should be assured of a certain minimum income. However, the current discussions are concerned with examining the different approaches to measurement of size and efficiency.

The single most important test of efficiency in agricultural policy discussions so far has been the yield per acre test. Farm Management Studies have indicated that output per acre is inversely proportional to farm area. This has weakened the case for the enlargement of the holdings.

In the theory of the firm, the optimum firm is defined as one whose short-run average cost curve is tangential to the envelope curve at its lowest point. If the average cost of any one particular input is the dominant component of the total average cost and provided further that the elasticity of substitution between inputs is negligible, it should be all right to suppose that the average cost of the dominant input would vary more or less in the same way as total average cost and would therefore be good approximation to it.

However, it has been seen from the various Farm Management Studies that the (imputed) cost of the land input is quite low being around 20 per cent. Therefore, we cannot use the average cost of one of the inputs as an approximation to total average cost as a test for efficiency.

CONCLUSION

Where farm size is measured in terms of geographical acreage, efficiency is measured in terms of yield per acre. Thus as Raj Krishna[4] points out, on the basis of simple and theoretically undefended methods of measurements, 'optimal' firm sizes are sought to be determined and often enforced. Size policy is applied more in the agricultural sector, where the asymmetry of the optima indicated by the different criteria is maximum. What is really needed is measurement of sizes in

2. Raj Krishna, "The Optimum Firm and the Optimum Farm," *op. cit.*
3. A. M. Khusro : An Analysis of Agricultural Land in India by Size of Holding and Tenure, Institute of Economic Growth, New Delhi, as quoted by Raj Krishna, *ibid.*
4. Raj Krishna, *op. cit.*

terms of net value added and in the estimation of statistical cost relations which indicate the effect of scale on costs excluding effects of factors other than the scale. In the meanwhile, the prevailing judgment about sizes and efficiency and the policies based on them must be held to be unsatisfactory and inefficient.

EMPIRICAL EXERCISES

The holdingwise data available from the Farm Management report relating to Andhra Pradesh were examined, and some empirical illustrations of the above theoretical discussions are presented below.

Size of Farm

Table I presents the distribution of holdings during the three years of study (1957-58, 1958-59 and 1959-60), according to (i) geographical area and (ii) gross output (value), in respect of the paddy crop (Season I—irrigated).

TABLE I—DISTRIBUTION OF HOLDINGS ACCORDING TO (i) AREA AND (ii) GROSS OUTPUT (VALUES) (I SEASON—PADDY, IRRIGATED, WEST GODAVARI DISTRICT, ANDHRA PRADESH: 1957-58 to 1959-60)

(i) Holdings size (in acres)	Number of holdings			(ii) Gross output (value in Rs.)	Number of holdings		
	1957-58	1958-59	1959-60		1957-58	1958-59	1959-60
0.01 — 1.25	22	22	17	0 — 500	19	15	19
1.25 — 2.50	11	10	14	500 — 1,000	18	23	16
2.50 — 5.00	16	16	12	1,000 — 2,500	22	24	21
5.00 — 7.50	9	8	10	2,500 — 5,000	11	14	10
7.50 — 10.00	4	7	5	5,000 — 7,500	9	8	8
10.00 — 15.00	8	12	14	7,500 — 10,000	6	5	7
15.00 — 20.00	12	8	3	10,000 and above	4	4	7
20.00 and above	7	10	13				
Total	89	93	88	Total	89	93	88

It is seen that the distribution of holdings by the two criteria is very different. Thus, the size of farm, if defined by the geographical area gives a completely different picture of concentration of holdings as compared to the one obtained by considering gross output. It is easy to see that a similar situation will arise if we consider the other definitions of size, *viz.*, gross input, total human labour, etc.

Efficiency

The average cost of any single input cannot be approximated to the total average cost, while in search of the optima. This is because no single item of cost approximates to total average cost. Table II gives the break-up of total cost.

TABLE II—BREAK-UP OF TOTAL COST

(percentages to total)

State	Human labour	Bullock labour	Seed	Manures and fertilizers	Depreciation	Rent and rental value	Interest on fixed capital	Land revenue charges, etc.	Irrigation charges, etc.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Madras (Irrigated Paddy-I)	19.96	36.15	3.39	13.87	2.99	15.57	6.85	0.46	—
Uttar Pradesh (Wheat Irrigated)	21.06	53.71	6.72	0.53	6.49	3.16	3.40	—	5.93
Bombay (Ahmednagar-Wheat Irrigated)	34.63	23.09	11.04	3.56	4.67	14.01	5.69	1.27	—
Andhra Pradesh (Paddy-I Season)	20.69	12.40	5.72	3.42	1.33	51.62	0.65	3.58	—
Madhya Pradesh (Paddy)	32.94	18.55	11.23	4.88	1.48	24.69	2.29	0.76	2.17

Source : Farm Management Studies in the respective States published by the Directorate of Economics and Statistics, Ministry of Food and Agriculture, Government of India.

Therefore, no single input, like acreage of the holding, or labour input, can be considered, while arriving at the optimum size of the farm.

We could now illustrate that the optimal size of the farm varies when we consider different efficiency criteria. Table III may be examined.

The striking result of Table III is that the accepted definition of size, *viz.*, geographical area, comes out to be different for each of the efficiency criterion. Similarly, the accepted concept of efficiency, *viz.*, highest yield per acre, indicates that farm number 23 of size 3.22 acres is the most efficient, while farm number 68 of size 33.80 acres is the least efficient. Similarly, the rate of return on capital investment is maximum for a larger sized (acreage) farm than smaller farm. Again, the farm number 78 is both the most efficient (minimum per acre cost) and the least efficient (minimum gross output per acre). The asymmetry of the optima on the different bases of efficiency is very pronounced.

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TABLE III—SIZE OF FARM, EFFICIENCY OF RESOURCE USE AND COST OF PRODUCTION

IRRIGATED PADDY (SEASON-I) ANDHRA PRADESH: 1957-60*

Efficiency basis	Size						
	Holding identification number	Farm size (acres)	Area under the crop (acreage)	Gross value of output (Rs.)	Gross value of output per acre (Rs.)	Total input (value) (Rs.)	Total yield (maunds)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Maximum gross output per acre	10	0.29	0.29	364.38	1,256.48	214.73	11.12
2. Minimum gross output per acre	78	11.20	2.00	340.70	30.42	366.58	14.00
3. Maximum cost per acre	21	5.51	0.51	2,480.20	450.13	11,915.02	13.61
4. Minimum cost per acre	78	11.20	2.00	340.70	30.42	366.58	14.00
5. Maximum return per man-day (total) (farm)	15	3.99	3.59	1,922.10	481.73	696.43	84.01
6. Minimum return per man-day (total) (farm)	21	5.51	0.51	2,480.20	450.13	11,915.02	13.61
7. Maximum rate of return on capital investment } Basis	12	8.89	8.85	4,690.46	527.61	2,858.14	237.00
8. Minimum rate of return on capital investment } I ..	21	5.51	0.51	2,480.20	450.13	11,915.02	13.61
9. Maximum rate of return on capital investment } Basis	15	3.99	3.59	1,922.10	481.73	696.43	64.01
10. Minimum rate of return on capital investment } II ..	44	2·21	2.21	545.13	248.67	637.89	41.99
11. Maximum input–output ratio (farm)	15	3.99	3.59	1,922.10	481.73	696.43	84.01
12. Minimum input–output ratio (farm)	21	5.51	0.51	2,480.20	450.13	11,915.02	13.61
13. Maximum input–output ratio (cropwise)	18	1.06	1.06	782.87	738.56	428.05	38.00
14. Minimum input–output ratio (cropwise)	62	2.20	2.18	1,390.09	631.86	1,166.60	80.98
15. Maximum yield per acre	23	3.22	3.00	2,896.70	899.60	1,513.19	150.00
16. Minimum yield per acre	68	33.80	3.00	9,572.83	283.22	7,076.69	13.98
17. Maximum cost @ per maund (cropwise)	62	2.20	2.16	1,390.09	631.86	1,166.60	80.98
18. Minimum cost @ per maund (cropwise)	23	3.22	3.00	2,896.70	899.60	1,513.19	150.00
19. Maximum return per man-day (total) (cropwise) ..	18	1.06	1.06	782.87	738.56	428.03	38.00
20. Minimum return per man-day (total) (cropwise)	56	0.80	0.80	183.20	229.00	252.78	8.00

* Farm Management data, relating to West Godavari district.