Editorial Note on the Margin of Error in the Calculation of the Cost of Cultivation and Profit.

The actual statistical data on which the various estimates in the text are based are given in Tables 8—11.

TABLE 8(a). HUMAN LABOUR IN MAN-DAYS PER ACRE.

Holding	Area	Tillage	Sowing	Weeding	Total	Holding	Area	Tillage	Sowing	Weeding	Total
N. 1	7·62	11·0	3·7	8·8	23·5	L. 1	9·16	8·5	5·4	6·2	20·1
2	7·03	7·7	7·0	3·4	18·1	2	6·51	8·0	6·4	6·9	21·3
3	7·55	8·9	6·8	5·3	21·0	3	12·76	7·8	4·2	4·5	16·5
4	8·83	10·8	5·7	10·1	26·6	4	10·94	10·0	5·8	3 9	19·7
5	8·16	6·0	3·7	3·4	13·1	5	8·31	7 6	5·2	2·8	15·6
6	7·37	10·3	5·4	5·2	20·9	6	5·27	12·9	13·5	10·6	37·0
7	6·89	8·3	5·1	5·8	18·7	7	7·94	7·7	9·2	7·0	28·9
						8	12·55	7·4	7·2	3·7	18·8

TABLE 8(b). HUMAN LABOUR IN MAN DAYS PER ACRE.

Holding	Area	Harvesting	Threshing	Total	Holding	Area	Harvesting	Threshing	Total
A. 1	8·10	11·3	4·5	15·8	N. 1	7·62	6·5	3·2	9·7
2	5·90	10·2	4·7	14·9	2	7·03	8·9	3·9	12·8
3	8·86	11·1	2·2	13·3	3	7·55	7·7	2·7	10·4
4	4·95	12·7	2·8	15·5	4	8·83	10·5	3·6	14·1
5	7·29	9·7	4·2	13·9	5	8·16	5·7	1·6	7·3
6	7·58	10·5	4·6	15·1	6	7·37	8·6	2·1	10·7
7	7·89	9 6	3·6	13·2	7	6·89	4·8	1·2	6·0
8	2·71	12·4	5·3	17·7	8	6·26	6·6	1·4	8·0
S. 1	8·93	14·5	5·8	20·3	L. 1	9·16	14·1	4·4	18·5
2	6·30	18·8	5·0	23·8	2	6·51	15·9	4·5	20·4
3	4·80	12·3	3·2	15·5	3	12·76	11·6	3 1	14·7
4	7·02	14·8	4·4	19·2	4	10·94	11·6	3·7	15·3
5	6·19	14·2	5·6	19·8	5	8·31	6·0	2 4	8·4
6	5·32	13·4	4·0	17·4	6	5·27	13·6	4·3	17·9
7	8·89	15·2	5·3	20·5	7	7·94	12·2	4·0	16·2
8	4·98	16·3	9·5	25·8	8	12·55	14·8	4·0	18·8
	95·71	207·0	74·7	281·7		133·15	159·1	49·9	209·2

TABLE 9. HUMAN LABOUR FOR MAINTAINANCE OF BULLOCKS.

Holding		November	December	January	February	March	April	Average
S.	8	40¾	39½	84½	39¾	41	32½	38·0
S.	7	10	52	51½	44½	39	35¾	38·6
S.	6	48	48¾	46¼	48	52¾	47½	48·0
S.	4	50½	50½	37	43½	52½	40	45·0
N.	4	32	31	32	31¾	33	30¾	31·0
N.	6	32½	30	31	28½	31¼	30	30·0
N.	7	32½	31¼	31½	28½	31	30	30·0
N.	8	32¾	30¾	30¾	29¼	31	30	30·0

TABLE 10. VALUE IN RUPEES AND RENT PER ACRE OF LAND.

Holding	Area	Value	Rent	Holding	Area	Value	Rent
L. 1	9·41	127·5	Rs. 5 10 9	S. 1	8·98	—	Rs. 3 7 5
2	6·92	130·0	4 1 3	2	6·30	—	2 9 0
3	18·17	136·7	4 5 0	3	4·80	—	3 3 5
4	11·91	138·5	5 6 0	4	7·02	—	3 9 0
5	8·98	128·8	4 1 0	5	6·19	—	2 14 4
6	5·26	161·6	4 3 0	6	5·32	—	4 2 6
7	9·66	176·0	4 10 6	7	3·89	—	4 3 7
8	14·15	141·3	3 13 0	8	4·89	—	3 8 2
J. 1	11·25	160·0	4 1 11	G. 1	10·86	117·9	—
2	12·28	154·7	4 8 9	2	28 30	120·1	—
3	9·00	150·0	4 1 9	3	9·30	120·4	—
4	7·77	137·2	4 4 9	4	7·37	119·4	—
5	4·88	150·0	5 10 3	5	8·65	120·2	—
6	4·44	146·4	5 2 9	6	12·79	118·8	—
7	5·97	179·2	2 6 9	7	6·66	120·1	—
8	3·56	140·4	3 7 3	8	6·35	120·0	—

TABLE 11. YIELD OF PADDY IN MAUNDS PER ACRE.

Holding	Area	Yield	Holding	Area	Yield	Holding	Area	Yield
L. 1	9·01	12·9	S. 1	3·93	21·4	A. 1	8·10	15·7
2	6·51	16·5	2	6·34	17·3	2	5·90	16·9
3	12·76	15·7	3	4·90	14 9	3	8·86	14·0
4	10·94	21·2	4	6 90	18·3	4	4·95	14·0
5	8·31	13·5	5	6·47	18·2	5	7·29	17·6
6	5·27	17·7	6	5·85	23·7	6	7·58	15·8
7	7 94	18·0	7	4·37	22·9	7	7·89	14·6
8	12·54	16·8	8	5·60	19·3	8	2·71	16 7

The author has estimated that the average cost of cultivation of one acre of paddy is Rs. 34/4/-, and the gross value of the paddy and straw Rs. 34/8/- leaving a profit of four annas per acre (or less than three-fourths of one per cent.) on the gross turnover). He has used two different kinds of quantities in his calculations, one directly based on the statistical data given in the above Tables 8—11, and the other derived from general economic considerations. The sampling errors of the first set of quantities can be easily calculated and are shown in the following Table 12.

The first thing to be noticed is the large variability, of the order of 20 or 30 per cent., in practically every item. This introduces a correspondingly large degree of uncertainty in the estimates. For example, we find that the average total human labour required for cultivating one acre of paddy is 36.3 man-days with a standard error of about 1.67 man-days ; at the rate of four annas per day, the probable error of the estimate of the cost of human labour is over four annas. Similarly, the probable error of the yield of paddy is about 0.4 md. per acre, which at the rate of Re. 1/8/- per maund means an uncertainty of nearly ten annas in the gross value of the produce. These are practically the two items directly based on statistical data. Using these we can easily calculate the uncertainty of the difference between the value of the produce and the cost of human labour. Including straw, the gross value may be taken as Rs. 2.03 per maund of paddy (on the basis of 1½ *kāhans* of straw at Rs. 6/- for each 17 maunds

of paddy at Re. 1/8/- per maund) ; the total money-value of the average yield of 17.24 maunds thus comes to Rs. 35/- with a standard deviation of Rs. 5.7 (n=24). The cost in money of 36.3 man-days comes to Rs. 9.08 with a standard deviation of Rs. 2.79 (n=45). The average difference is thus Rs. 25.92 with a standard error of Re. 1.25 or a probable error of Re. 0.83 or about 13 annas. In other words, all we can say on the basis of the present data is that the difference between the gross value of the produce and the cost of human labour is likely to lie between Rs. 25/2/- and Rs. 26/12/-. The margin of error is thus about Re. 1/10/- or nearly five per cent. of the gross value. To reduce it to under one per cent., we shall require samples of the order of at least 25 times larger size, or of the order of at least 500 holdings.

TABLE 12. SAMPLING ERRORS.

Item	Size of Sample	Mean = (m)	Estimated S. D. (s)	$\frac{100\,s}{m}$	S. Error of Mean
Tillage (in man-days)	15	8·85 man-days	1·78	20	0·46
Sowing ,,	15	6·28 ,,	2·45	39	0·63
Weeding ,,	15	5·82 ,,	2·46	42	0·64
(1) Sub-total ,,	15	20·95 ,,	5·59	27	1·44
Harvesting ,,	32	11·45 ,,	3·42	30	0·60
Threshing ,,	32	8·90 ,,	1·58	41	0·28
(2) Sub-total ,,	32	15·35 ,,	4·70	31	0·83
Total labour (cultivation)	(45)	(36·30) ,,	(11·17)	31	1·67
(3) Labour for bullocks	8	19·63 man-days	2·70	14	0·95
(4·1) Rent per Acre	24	Rs. 4·06	0·91	22	0·19
(4·2) Value of Land	24	Rs. 138·1	18·4	13	3·76
(5) Yield of Paddy	24	17·24 munds per acre	2·85	17	0·58

We may now consider some of the indirect estimates. It will be noticed that the cost of maintaining a pair of bullocks estimated at Rs. 11/9/- is the largest item in the total cost of Rs. 34/4/-. The cost of human labour required for this purpose is the only item based on statistical data, and even here the standard deviation is quite large (14 per cent.) which introduces a considerable margin of error in the final calculations. The uncertainty in the other items is completely indeterminate. For example, the author states that the average price of a pair of bullocks was found to be Rs. 49 ; he however considered this an over-estimate and assumed that the normal price for a pair of bullocks may be taken as Rs. 40. This introduces an adjustment of 18 per cent. in the gross price, or with depreciation at 20 per cent., a net adjustment of the order of four per cent. which might be perfectly justified, but which nevertheless it is impossible to check. In the case of rent and cess, the actual average value was found to be about

Rs. 4/1/- per acre ; but as this referred to both single and double-cropped land, the author adopted an adjusted figure of Rs. 3/12/- for single-cropped lands. In this case it is of course possible to find the actual average by direct statistical methods ; in the present calculations we have however an undetermined margin of uncertainty. The same remarks apply to such items as the cost of seed, fertiliser, and implement charges.

An altogether different kind of estimate enters in the calculations in the item 'interest on value of land.' Where most of the holdings have not changed hands for generations, the question of value per acre is a partly hypothetical entity which it is difficult to settle on direct statistical evidence. The proper rate of interest (here taken as 6¼%) is again a question in which a good deal of personal appreciation is bound to enter.

In view of the various margins of uncertainty in the estimates, all we can say in the present instance, I think, is that the margin of profit is very small, and that it varies very greatly from holding to holding.

Speaking generally, in making a statistical approach to the problem, it is necessary to recognise clearly that the statistical method can be used for estimating directly only such measurable quantities as the amount of human labour required for cultivating the land ; human labour required for the maintenance of bullocks ; feeds and other direct charges for bullocks ; cost of seed, fertiliser, and implement charges etc. Sufficiently large samples must also be taken to allow the statistical averages being estimated with the required degree of reliability. For example, in assessing the gross yield it is obviously necessary to take into account the variations in yield from one season to another, and this can only be done by taking the average over a number of years. In calculating the cost of human labour, a different kind of difficulty comes in ; and the problem of defining the average wages rate is not easy, for the simple reason that in most cases the greater part of the labour is contributed by the cultivator himself, and there are no direct payments either in cash or kind. Again in estimating the money value of the crop, there are serious difficulties in defining the average price owing to seasonal and other fluctuations in prices ; however, even in this case, it is possible to make some kind of a statistical estimate based on actual market rates. Interest charges on the capital value of land, apportionment of overhead charges and depreciation are still more difficult questions. Direct statistical data are almost never available, and some amount of hypothetical adjustment is practically inevitable. The distinction between cost to the cultivators as cultivators, cost to cultivators who are also land-owners, cost to the consumers, cost to society as a whole etc. are questions of a theoretical and economic rather than a statistical nature, and need not concern us here.

The chief points to be emphasized, I think, are that (1) the statistical method can only be used with advantage for estimating directly observable or measurable quantities ; (2) such directly observable quantities must be defined in clear and objective terms ; and (3) owing to the great variability of almost all the factors entering into the cost of cultivation or of profit, it is essential to use samples of a large size and of a sufficiently representative character to allow averages being calculated with a fair degree of accuracy

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