As regards uncultivated fields, the two investigators had agreed in the case of 189 out of 196 fields. There was agreement in 315 (or 94·3 per cent.) out of 334 fields. This may be contrasted with the agreement in the case of only 106 (31·9 per cent.) out of 332 fields in the previous table. Such differences show the wide variation in the quality of field work done by different investigators. The importance of providing statistical controls like duplicated grids can be therefore easily appreciated.

I may now give a quantitative example. In the sample survey of crops the field staff is required to estimate the proportion of land in each field which is under a particular crop. These estimates are made in terms of the Indian coin anna, sixteen of which make up a rupee. In other words, crop estimates are made in units of 6¼ per cent.

Table 6 shows a comparison of results of such estimates of the proportion of land sown with rice on the same group of 56,193 fields which were surveyed independently by two sets of investigators. The comparison between the two sets of records has been made with increasing latitude of discrepancy. For example, if the two entries (estimates of the proportion of field under rice) relating to the same field (made by the two different parties of investigators) agree within 1 anna, (or 6¼ per cent.), then the latitude of comparison is 1 anna, or 6¼ per cent. In the same way, if the two entries agree within 4 annas, then the latitude of comparison is 25 per cent.; and if they agree within 8 annas, the latitude is 50 per cent. Finally for a 16-anna (or 100 per cent.) latitude of comparison two entries relating to the same field would be considered to be in agreement if both the parties record the field to be under rice irrespective of the quantitative proportion.   ·

TABLE 7

Bihar Crop Survey, 1944, Bhadoi (monsoon) rice. Comparison of complete enumeration by two sets of investigators

Latitude of comparison	Number of plots surveyed			Total number of plots compared	Percentage of plots surveyed		
	In agreement		Not in agreement		In agreement		Not in agreement
	No crop	With rice			No crop	With rice	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1 anna (6¼%) ...	23,988	20,699	11,506	56,193	42·69	36·84	20·47
4 anna (25%) ...	23,988	21,269	10,936	,,	,,	37·35	19·46
8 anna (50%) ...	23,988	21,742	10,463	,,	,,	38·69	18·62
16 anna (100%) ...	23,988	22,657	9,548	,,	,,	40·32	16·99

A glance at the summary Table 7 would show that if a 6¼ per cent. latitude of comparison is permitted, then records relating to 11,506 (or 20·47 per cent.) of 56,193 fields were discrepant. Increasing the latitude of comparison to 25 per cent., the number of discrepant fields is only slightly reduced to 10,939, or 19·46 per cent. Allowing a much higher margin of comparison of 50 per cent. the number of discrepant fields is again only very slightly reduced to 10,463, or 18·62 per cent. Finally, allowing the maximum possible latitude of comparison—that is, considering merely whether the field is recorded to have rice or not—it is seen that no fewer than 9,548 or 16·99 per cent. of fields still show discrepant entries. The latitude of comparison thus makes very little difference, which shows that mistakes usually occur in the identification of the fields rather than in making quantitative estimates of " p " (the proportion of land under a crop).

Comparison of " duplicate " grids. It has been already mentioned that in the same survey of crops the present practice is to have a certain proportion of grids enumerated in duplicate by two independent sets of investigators. This supplies a valuable check on the quality of the field survey. The field investigators make an entry for each grid of the proportion (called " p ") of the total land included within each grid (namely, 2·25 acres in the Bengal crop survey of 1945–46) which is estimated to be under *aman* (winter) rice. Such estimates were prepared twice by independent parties of field staff so that for each grid there are two values of " p ," one estimated by party A and the other by party B. The two sets of records can therefore be shown in the form of a two-way table as in Table 8.

TABLE 8

Bengal Crop Survey, 1945–46. Comparison of two independent estimates of p *(proportion of grid under* aman *rice) by two parties of investigators*

Half-sample (B)

p (in %)	0	1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–99	100	Total
0	1,159	84	50	33	30	17	18	15	27	24	28	62	1,547
1–10	74	150	39	22	13	9	11	11	4	14	3	13	363
11–20	31	35	88	14	14	12	10	11	9	3	5	16	248
21–30	26	20	22	65	18	18	16	6	5	7	6	8	217
31–40	15	10	16	25	97	42	15	15	13	16	11	11	286
41–50	17	11	7	14	31	85	32	14	17	12	14	9	263
51–60	17	6	9	8	18	29	71	30	24	11	16	30	269
61–70	22	6	7	6	13	10	27	78	37	31	22	25	284
71–80	24	7	7	8	11	23	17	45	91	45	32	45	355
81–90	28	7	9	11	9	9	25	15	45	129	52	57	396
91–99	29	4	7	6	13	11	12	17	29	48	264	143	583
100	68	13	11	14	13	23	23	31	54	64	152	927	1,393
Total	1,510	353	272	226	280	288	277	288	355	404	605	1,346	6,204

(Row labels on left are "Half-sample (A)")

Frequency constants: mean $p(A)$ = 52·0 per cent., mean $p(B)$ = 51·9 per cent.
s.d. of A = 40·9 per cent., s.d. of B = 41·2 per cent., coefficient of correlation = 0·739.

TABLE 8A

Summary table of proportion of agreement with different latitudes of comparison

	Number of grids	Accumulated totals	Accumulated percentage
Complete agreement	3,204	3,204	51·6
1–10% margin	1,069	4,273	68·9
11–20% „	511	4,784	77·1
21–30% „	367	5,151	83·0
31–40% „	225	5,376	86·7
41–50% „	185	5,561	89·6
51–60% „	142	5,703	91·9
61–70% „	96	5,799	93·5
71–80% „	106	5,905	95·2
81–90% „	86	5,991	96·6
91–99% „	83	6,074	97·9
100% „	130	6,204	100

If the two sets of crop enumeration made by the two different parties (A and B) were in complete agreement, then the entries would occur only in the diagonal cells and the coefficient of correlation between the two sets of records would be +1. This of course cannot happen in practice, as different investigators would have different "personal equations" of observation and estimation. In the table shown above it would be noticed that in 3,204 (or 51·6 per cent.) out of 6,204 grids, the two sets of records are in complete agreement. If agreement is defined to include a margin of variation up to 10 per cent. on either side then 4,273 (or 68·9 per cent.) of all grids are in agreement. In the same way about 83 per cent. of the grids would be in agreement if a latitude of comparison up to 30 per cent. is permitted. This is not unsatisfactory.

The agreement between two sets of records can also be expressed in the form of a coefficient of correlation of +0·739. Owing to the cancellation of positive and negative errors the two mean values $p(A)$ = 52·0 per cent. and $p(B)$ = 51·9 per cent. are in entirely satisfactory agreement. Duplicated readings thus show two things—namely, (a) detailed agreement, plot by plot or grid by grid, can never be attained in practice even when the field work is done with reasonable care:

TABLE 9

Bengal Crop Survey, 1940–41.   Yield of jute (green plant) in lbs. per acre

Size of cut (sq. ft.)	Dacca (n = 80)	Mymensingh (n = 80)	Rangpore (n = 94)	Tipperah (n = 66)	Combined (n = 320)
(1)	(2)	(3)	(4)	(5)	(6)
1 (1 × 1)	36,603 ± 2,288	24,893 ± 2,535	23,453 ± 1,860	24,292 ± 2,370	27,271 ± 1,160
9 (3 × 3)	20,466 ± 1,317	15,462 ± 872	15,800 ± 749	18,598 ± 1,259	17,462 ± 535
48 (12 × 4)	10,188 ± 576	20,145 ± 774	16,293 ± 650	19,997 ± 848	16,080 ± 411
144 (12 × 12)	9,784 ± 494	19,305 ± 905	18,038 ± 617	20,309 ± 856	16,763 ± 428
256 (16 × 16)	9,332 ± 593	18,836 ± 774	17,552 ± 617	20,433 ± 790	16,828 ± 395

aus (monsoon), and, _aman_ (winter) rice in different provinces of India.   An account of the first series of experiments on jute in 1940 was given in a report submitted to the Indian Central Jute Committee, which had financed the work.   The report was printed by this Committee for official use, but was not released to the public owing to war-time restrictions.   Other reports on crop-cutting work were submitted by us in subsequent years, but the Government restricted these also for official use.   Although a good deal of material has been accumulated, it has not yet been possible to publish a comprehensive account.*   I am giving a few typical results in Table 10.

TABLE 10

Crop Survey.   Percentage yield rates based on sample cuts of different sizes

Size of cut (sq. ft.)	Bengal jute, '40 320	Bengal jute, '41 185	U.P. wheat, '41 178	U.P. wheat, '42 346	Bengal rice, 1943–44 40	Average index (unweighted)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
9	103·8	116·1	121·4	118·1	113·3	114·7
18	—	—	111·6	109·4	—	110·5
25, 27	—	100·7	—	109·0	—	105·0
36	—	—	100·1	99·0	112·1	103·7
48, 49	95·5	95·3	—	—	—	95·4
54	—	—	—	96·0	—	96·0
64	—	105·9	—	—	—	—
81	—	—	—	93·6	—	—
135	—	—	99·9	—	—	—
144	99·6	96·4	—	—	101·2	—
225	—	100·0	97·4	—	—	—
256	100·0	—	—	—	—	—
324	—	—	—	100·0	—	—
576	—	—	100·0	—	100·0	—

In this table the results have been expressed as percentages of the yield rate based on sample cuts of the largest size used in different series of experiments.   On the whole, the above table indicates that the bias decreases as the size of the cut is increased from 9 sq. ft. to probably something of the order of 40 or 50 sq. ft., and becomes negligible with cuts of larger size.

The results given in Table 10 all refer to sample cuts which were located in the field with pegs and ropes.   Experiments were also made with rigid and semi-rigid frames made of wood or of wood and iron   I have no time here to discuss these results, beyond stating that there was evidence of over-estimation with small cuts in such cases also.

I may mention at this stage that in the paper " On Large-Scale Sample Surveys " written at the end of 1942 I referred to the over-estimation arising from the use of sample cuts of small sizes, and explicitly stated (_Phil. Trans._, Vol. 231(B), No. 584, p. 409):

" It was found that there was persistent over-estimation in working with units of very small size.   In the case of field survey the obvious explanation is that the investigator has a tendency to include rather than to exclude plants or land which stand near the boundary line or perimeter of the grid.   This boundary effect naturally becomes less and less important as the size of the

* A few observations have been made in _Sankhyā_, Vol. 7, part 3, April 1946, pp. 269–80.