Government of Bengal

A Statistical Note on the Hooghly-Howrah Flushing and Irrigation Scheme

By

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PART I.—GENERAL SUMMARY.

Introduction.

1. In October 1935, Mr. Townend asked me whether I could check certain calculations in connexion with the Damodar Irrigation Scheme. In my D. O. letter No. 133/Sc./35 of the 27th October 1935, I sent him a tentative plan for a statistical examination of the data. After some further correspondence with Mr. Townend, I was asked by Government in February 1936 to prepare a note regarding the extent to which the Damodar flood may be expected to supplement the rainfall in the scheme for flushing and irrigating the area lying between the Damodar and the Hooghly river, and a sum of Rs. 600 was sanctioned for clerical expenses for this purpose. (Irrigation Department, letter No. 373-I.A., dated 3rd February 1936.)

2. Mr. D. N. Sen Gupta, Executive Engineer, sent me a copy of the scheme prepared by him (Irrigation Department, Office of the Executive Engineer on Special Duty, No. 256, dated Calcutta, the 28th February 1936), and a review of the scheme by Mr. S. C. Mazumdar, Superintending Engineer, South-Western Circle. Mr. Sen Gupta supplied me with other relevant data and papers, and very kindly explained and discussed various details of the scheme on five or six occasions between April and September 1936. Through the kindness of Mr. McLean, Director of Agriculture, I also received the help of five agricultural officers who came to the Statistical Laboratory, Calcutta, for a short conference in April 1936 to discuss the water requirement for rice in West Bengal.

3. The object of the scheme is to irrigate from the Damodar an area measuring 916 square miles lying in Burdwan, Hooghly and Howrah districts so as to ensure an adequate supply of canal water not only as regards quantity but also as regards the time when crops require it to meet the deficiency of rainfall. The scheme is also intended to increase the fertility of the soil by depositing the silt of the flood water, and to improve the sanitary condition of the area especially by flood-flushing as an anti-malarial measure. The cost of the total scheme as estimated by the Superintending Engineer is about 2·73 crores.

4. In this note, I have only discussed whether sufficient water will be available in the Damodar to meet the deficiency of rainfall at a time when the crops require water. Subhendu Sekhar Bose and Sudhir Kumar Banerjee of the Statistical Laboratory were in charge of the detailed analysis and assisted me throughout the investigation.

5. I am first giving in non-technical language a summary of the present analysis and a short discussion of the chief conclusions (paragraphs 7-20).

6. The main report is given in Part 2 together with necessary abstract tables. One important table, namely Table 2, which contains a full list of shortage of water during 1901-1935 is given here. Other tables and statistical notes are given in the form of 17 appendices. I have not given the primary rainfall and river height and discharge records or the details of the statistical computations as these would have increased the bulk of the appendices ten or twelve times and would have required a good deal of money for copying.

Summary.

7. Careful estimates of the actual rainfall in successive ten-day periods from July to November 1901-1935 for the whole area were prepared on the basis of records of seven rainfall stations distributed over the whole area. Detailed specifications of the water requirement by ten-day periods for a "full" or 100 per cent. crop were then drawn up. The actual deficiency in rainfall, if any, in any particular period was then determined. [Paragraphs 21-35.]

8. From records of the height of the Damodar at Jujuty and the discharge at Rundia a graduated discharge table was prepared by appropriate statistical methods. With the help of this table the actual amount of water flowing through the river during each ten-day period was calculated both with and without the Damodar Canal in operation with a discharge of 2,000 cusecs. In accordance with the estimate of the Irrigation Department, the water available for irrigation was taken as two-thirds of the water flowing through the river. [Paragraphs 36-45.]

9. It was then possible to determine how far the deficiency in rainfall could be made good by irrigation from the river under existing conditions. It was found that during July, August and September there was almost always enough water in the river for this purpose. Serious shortage however occurred in October on an average on 4 occasions out of 5. On half the occasions the deficiency could be supplied from the river but roughly in 2 years out of 3 the standing crop suffered damage owing to shortage of water in October. It has been proposed to construct a reservoir in the upper reaches of the river to supply this deficiency in October. [Paragraphs 46-48.]

10. Estimates of the improvement likely to result from partial irrigation (that is, irrigation from the river under existing conditions but with the Damodar Canal in operation), as also with complete irrigation after the construction of a suitable reservoir, were then prepared. It is estimated that at present without irrigation the cultivators are getting about 75 per cent. of the full crop. With partial irrigation we may reasonably expect an improvement of about 16 per cent. With complete irrigation a further increase in the yield of about 6 per cent. or a total improvement of about 22 per cent. may be expected. [Paragraphs 49-54.]

11. The percentage improvement may be tentatively converted into maunds per acre by comparison with the quinquennial estimates of normal yields. On an average we may expect an increase of 830,000 maunds of rice with partial irrigation, and about 1,000,000 maunds with complete irrigation. [Paragraphs 55-58.]

12. With the help of harvest prices it is possible to calculate the cash value of the increased yield. In non-technical language we may say that the odds are equal that the average value of the increased yield will lie between Rs. 40 lakhs and Rs. 47 lakhs with partial irrigation, and between Rs. 52 and Rs. 60 lakhs with complete irrigation. We may put the result in a slightly different way. The odds are 20 to 1 that the average value of the increased yield of rice will not be less than Rs. 33 lakhs with partial irrigation, or less than Rs. 44 lakhs with complete irrigation. The order of accuracy of these estimates is about ten per cent. [Paragraphs 59-60.]

13. Even with partial irrigation the improvement in the yield of rice will be considerable. The additional income with complete irrigation, though appreciable, is not large, and is likely roughly to fluctuate between Rs. 9 and Rs. 16 lakhs per year on an average. The odds are 20 to 1 that it will not fall below Rs. 6 lakhs. [Paragraph 61.]

14. Failure of crops will, however, be entirely eliminated by complete irrigation. In 22 years out of 35 there was shortage of water in October. If a reservoir is constructed it will be possible to make good this deficiency every year. But so far as the money value of the additional crop is concerned the improvement will be small in 12 years out of 35. Only in 10 years out of 35 or about once in 3 or 4 years on an average the improvement will be substantial. [Paragraphs 62-63.]

15. The maximum amount of water required for complete irrigation in the month of October is of the order of 4,500 million c. ft. The critical supply required is between 2,000 and 4,500 million c. ft. A reservoir of sufficient capacity to supply up to 5,000 million c. ft. is thus essential to ensure full irrigation in October. [Paragraph 64.]

16. We may sum up the discussion in this way. Even without full irrigation the improvement in the yield of rice will be very substantial. With full irrigation the further improvement, although appreciable, will not be large in amount. With partial irrigation the cultivators will experience a shortage of water in October on an average in 4 years out of 7, although even when such shortage occurs the actual damage to crop in most years will be practically negligible. There will, however, be serious loss of crop in about once in four years. This may cause some dissatisfaction owing to the compulsory nature of the levy. Full irrigation will prevent dissatisfaction.

17. We know that the yield of straw is highly correlated with the yield of rice*. The ratio of the money value of rice to the money value of straw per acre may be taken roughly as. 3 to 1†. There is a good deal of demand for straw in West Bengal, and there will be no difficulty in disposing of the additional yield of straw. Allowing for a margin of error of 50 per cent., it will not be unreasonable to expect that the value of the additional yield of straw with irrigation will add at least a sixth of the value of the additional yield of rice. I have not, however, included this in my estimates.

18. In the present note I have also not taken into consideration the increase in yield, if any, due to the manurial or other beneficial effect of the silt which will be brought down from the river in the irrigation project. In the absence of relevant data I have also omitted to take into consideration any increase in the amount of land which will be brought under cultivation owing to a larger supply of water. All these factors in any case will increase the total yield and hence the total value of the crop. By neglecting them we are erring on the safe side. ‡

19. The scheme is sound so far as the rainfall and discharge are concerned. I should point out, however, a few words of caution regarding some of the assumptions on the technical side of the project. Everything depends on the possibility of drawing two-thirds of the total water in the Damodar, and of maintaining the various channels in proper condition. This is, of course, a purely technical question of engineering and hydrology. Speaking as a student of physics I may say, however, that this appears to be the weakest link in the present project.

20. I think it will be advisable to investigate these questions with the help of suitable scale-models. I may mention here that Dr. N. K. Basu, Mathematical Officer, Irrigation Research Laboratory, Lahore, came to the Statistical Laboratory with a large amount of data relating to the Punjab canals for analysis and was in Calcutta during the last three months. I took this opportunity of inviting Mr. D. N. Sen Gupta to meet Dr. N. K. Basu and we discussed tentatively the possibilities of experiments with scale-models in connexion with the present project. I believe that an expenditure of about Rs. 25,000 for tanks, models and other apparatus and an expenditure of about the same amount spread over a period of a year or 15 months in salaries will enable the problem being studied by scale-models. I hope the proposal of conducting such experiments will be given serious consideration. The Damodar project is a very promising one. It will be worth while ensuring its sucessful working by an expenditure of about Rs. 50,000 which is less than one-fifth of one per cent. of the estimated cost of the project.

P. C. Mahalanobis.

The 16th October 1936.

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* In paragraph 10 of my letter No. 1333/Sc/35, dated the 27th October 1935, the co-efficient of correlation was shown to be of the order of + 0·7.

† Marketing of Rice at Bolpur, *Sankhya* Volume 2 (2) 1935.

‡ It should also be remembered that the maximum discharge in the Damodar Canal has been used throughout the calculations. The actual discharge is likely to be much less, so that the figures for partial irrigation are under-estimates.

PART II.—STATISTICAL ANALYSIS.

Rainfall data: 1901-1935.

21. The area included in the project is covered by seven rainfall stations the names of which together with other relevant data are given in the following table:—

Table 1.—Rainfall Stations.

Stations.	District.	Subdivision.	Latitude.	Longitude.
1. Burdwan ..	Burdwan ..	Sadar ..	23°14′ N ..	87°51′ E.
2. Kalna ..	Ditto ..	Kalna ..	23°13′ N. ..	88°22′ E.
3. Hooghly ..	Hooghly ..	Sadar ..	22°55′ N. ..	88°24′ E.
4. Serampore ..	Ditto ..	Serampore ..	22°45′ N. ..	88°21′E.
5. Arambagh ..	Ditto ..	Arambagh ..	22°53′ N. ..	87°47′ E.
6. Howrah ..	Howrah ..	Sadar ..	22°35′ N. ..	88°21′ E.
7. Amta ..	Ditto ..	Ulubaria ..	22°35′ N. ..	88°1′ E.

22. It was decided to start the analysis from the year 1901, as the river gauge readings for Jujuti (from which the discharge in the Damodar was calculated) were not available before that year. The actual rainfall for each station for each year was tabulated in five-day periods from 1st May to 30th November. These were later added by twos so as to give the total rainfall by ten-day periods. (The actual material is given in Appendix 1).

Water Requirement for a full Crop of Rice.

23. We must now formulate as precisely as possible the actual water requirement for a full crop of rice. In Mr. Townend's "Note on the Possibility of Financing Irrigation in Bengal by a Cess or Improvement Levy," 1934, paragraph 18, page 27, it is stated:—

"There are three criteria by which to judge a year's rainfall as affecting the paddy harvest:—

(*a*) there must be at least 40 inches during the season;

(*b*) there must be 20 inches in June-July, which may be reduced to 16 inches in the impervious clay area; and

(*c*) there must be 10 inches in September-October which may be reduced to 9 in the impervious clay area.

When we see that in a given year these conditions have not been fulfilled we know that it was not a really good year. The converse is not true because distribution is so important: if for instance there were 20 inches in two or three days at the end of July followed by normal August rains, the results would be quite different from those given by the same quantity of rain distributed fairly evenly."

24. A month, which is used as the unit of interval in the above criteria, is certainly too broad. A single day on the other hand is too fine*. A five-day period was adopted at first but was subsequently increased to a ten-day period for the present analysis.

25. Owing to the absence of reliable crop data it was not possible to investigate the influence of rainfall on yield by direct correlational analysis. An indirect method was, therefore, adopted, and the procedure is explained below.

Method of Crop Expectation.

26. The actual rainfall for each station for each year was tabulated in five-day periods May 1-5, May 6-10, etc., up to November 26-30. As already mentioned, we found after exhaustive trials with five-day periods that such detailed analysis was not necessary, and we worked finally with ten-day periods. We also found that for all practical purposes we could start from July 1 rather than from May 1.

27. At the beginning of the season (July 1) we may hope to get a favourable distribution of rainfall in the ensuing season so that we may also hope (so far as rainfall is concerned) to get a full (or 100 per cent.) crop. We then look at the actual daily rainfall which occurred during the first interval July 1—July 10. If the rainfall is favourable, our expectation of the crop still remains 100 per cent. On the other hand if there is a heavy deficit (or a very heavy excess) the chance of obtaining a full crop may be adversely affected. On the basis of actual agricultural experience we now try to assess the depreciation, and put down a number which we think is a reasonable estimate of the crop which we may expect to get on the assumption that the subsequent rainfall will be favourable. Proceeding in this way we can write down at the end of each ten-day period, and finally at the end of November, the expected crop as a percentage of the full (100 per cent.) crop. The final figure then will be determined by and will thus represent the cumulative influence of the actual seasonal distribution of rainfall on the yield of rice as assessed by the estimator.

28. If the agricultural experience of the estimator is perfect then these final estimates will be free from error and will give the over-all influence of rainfall on crop yield. But as agricultural experience is not perfect we shall try to improve our forecasts by pooling together estimates made by several agricultural officers.

Detailed Specification of Water Requirement.

29. A set of rainfall sheets was sent to five agricultural officers whose names are given in Appendix 2. Preliminary estimates made independently* by these officers were then compared in the Statistical Laboratory. It was found that although these estimates were broadly in agreement, there were many discrepancies. By the courtesy of Mr. McLean, the Director of Agriculture, Bengal, a joint conference of the above agricultural officers was then held in the Statistical Laboratory, Calcutta, from April 27 to May 7, 1936. The agricultural officers in conjunction with Mr. Subhendu Sekhar Bose of the Statistical Laboratory discussed the crop estimates in detail, and prepared the final estimates. A note on the water requirement for rice in West Bengal was drawn up which is reproduced in Appendix 3.

The Final Crop Estimates.

30. The final crop estimates for each year for each station prepared by the agricultural officers (working on the basis of the above note) are given in Appendix 4.

31. In certain years the rainfall was excessive and affected the yield adversely either by delaying the transplantation or by actually damaging the standing crop. In all such cases the agricultural officers were asked to assess the actual amount of damage done to the crop. The final crop estimate prepared by the agricultural officers in conjunction with Mr. Subhendu Sekhar Bose and given in Appendix 4 represents therefore

*In tabulating the rainfall data for each station the sheets were given arbitrary numbers so as to disguise the actual year. Thus Burdwan (24) might represent the rainfall for 1931 while Burdwan (101) might represent 1923. The estimators did not therefore have any idea as to the actual year for which they were making estimates. This effectively prevented the agricultural officers from being influenced by any unconscious bias or preconceived notions regarding crop-yields of particular years.

not only the effect of deficiency in rainfall but also of the damage caused by excessive rainfall. The expected yield is, therefore, sometimes less than 100 even when there was not deficiency in rainfall.

Reliability of the Estimates.

32. I had hoped to check the reliability of the estimates by comparing them with actual crop data. The crop estimates made by the Agricultural Department are available for the districts as a whole. Our estimates on the other hand refer to the region covered by each particular rainfall station. If the Director of Agriculture's crop estimates were available for at least each subdivision, a direct comparison could have been attempted. With the data actually available a direct comparison was, however, not possible. Internal checks were, therefore, applied which showed that the estimates made independently by different agricultural officers were in satisfactory statistical agreement. (Details are given in Appendix 5.)

Water required for Irrigation.

33. When the actual rainfall in any ten-day interval was considered to have fallen short of the amount required for a full crop, the agricultural officers were asked to estimate the additional water required for a full crop. When the rainfall was excessive they also made estimates of the amount of water required to be drained away in order to prevent any damage to the crop. In this way estimates of the number of inches of rainfall required to make up for the deficiency (or the amount of water required to be drained away) in a particular ten-day interval were prepared and are given in Appendix 6.

34. These estimates however refer to the area round individual rainfall stations. The next step was to calculate the total amount of water required to make up for the deficiency of rainfall in the whole of the area proposed to be irrigated in the present project. Each rainfall station was allotted a certain proportion of the total area depending on the actual topographical position of the station. (The weights used for this purpose were of course only approximate but it is well-known that small variations in such weights seldom affect the final results appreciably.) The actual rainfall defect for any particular station was then multiplied by the corresponding area-weight for that station, and the weighted rainfall defects were added to give the average rainfall defect for the whole area. (Details of calculation are shown in Appendix 7.)

35. The final estimates of the total amount of water required for irrigation in each ten-day period are given in column (2) of Table 2, and shown in red lines in the accompanying chart 1.

Water available for Irrigation.

36. The next thing required is to estimate how much water was available for irrigation from the Damodar during the periods in which rainfall fell short of actual requirements.

Discharge Records.

37. From the material sent by the Irrigation Department we find that 274 discharge records across Rundia were available for the period July to September, 1933-35. (Certain stray discharge records taken in earlier years were also available across other sections. These were, however, rejected as they were considered unreliable by Mr. D. N. Sen Gupta, Executive Engineer in Charge of the Scheme.)

38. The Rundia discharge readings had been correlated with the gauge heights at Jhanpur by a graphical method by Mr. Sen Gupta. The Jhanpur records were available only from 1915 while Jujuty records were available from 1901. I decided to use the Jujuty records as they covered a much longer period.

Graduated Discharge Table.

39. A parabolic regression of the second degree for the discharge across Rundia on the gauge height at Jujuty was obtained by direct statistical analysis, and the actual formula is given below :—

Let D = discharge (in 100 cusecs) across Rundia,
H = gauge height at Jujuty (in feet) over minus 100 feet.

We have then :

$$D = 801{\cdot}25 - 176{\cdot}63\ (H) + 10{\cdot}860\ (H)^2$$

40. The regression is definitely significant, and the fit is quite satisfactory, as can be seen from Chart 2 and the analysis of variance given in Appendix 8.

41. A discharge table across Rundia for different heights at Jujuty for intervals of one-tenth of a foot was then prepared from the above parabolic regression formula and is given in Appendix 9.

Actual Discharge: 1901-35.

42. With the help of this table the actual rate of discharge across Rundia for each day in July, August, September and October for each year from 1901-35 was directly tabulated*. The total discharge for ten-day periods was then obtained by direct addition, and the final table of the total water passing through the river during each ten-day interval was prepared.

43. The whole of this water is not, however, available for irrigation. According to the estimate of the Irrigation Department two-thirds of the discharge may be drawn for irrigation. The amount of water actually available for irrigation is therefore obtained by taking two-thirds of the total water in the river. This is given in Column (3) of Table 2, and shown in black lines in Chart 1.

Water available for Irrigation.

44. Now Column (2) of Table 2 gives the actual amount of water required during any particular period for making up the deficiency in rainfall. In Column (3) of the same Table is given the amount of water available for irrigation from the Damodar. If Column (3) is greater than Column (2), there will be enough water for irrigation. If Column (3) is less than Column (2), then the difference between these two figures will give the actual shortage of water which is shown in thick type in Column (4) of Table 2 [inserted on pages 9-13], and in the shaded area in red in Chart 1.

Discharge of the Damodar Canal.

45. We must now take into consideration the discharge of the Damodar Canal which was opened in 1934. This canal is designed to take a maximum discharge of 2,000 cusecs. The actual average discharge in 1934 was much less (about 1,000 cusecs), but to be on the safe side I shall use the maximum rate of 2,000 cusecs in my calculations. The total amount of discharge is 1,728 and 1,901 million cubic feet in ten-day and eleven-day periods respectively. Column (3) of Table 2 gives the water actually available for irrigation (which is only two-thirds of the total water flowing down the river). If we now subtract two-thirds of 1,728 and 1,901 million c. ft., that is, 1,152 and 1,267 million c.ft. for ten-day and eleven-day periods respectively from the figures in column (3) of Table 2, we get the water available for irrigation with the Damodar Canal in operation. These calculations were made for all the occasions, but in most cases the shortage figures given in column (4) were not affected. I am therefore quoting within square brackets in Table 2 the figures for only those occasions on which the shortage figures were altered. Thus in column (4) of Table 2 when only

* A sample tabulation sheet for 1933 is given in Appendix 10.

a single figure is given, the shortage is the same whether any allowance is made or not for the Damodar Canal. When two figures are shown, the figure within square brackets gives the shortage after allowing for the discharge in the Damodar Canal, and the other figure the shortage without making any allowance for the Damodar Canal. When a figure is given within square brackets in column (4), a corresponding figure within square brackets is also given in column (3) to show the water available for irrigation after allowing for the discharge in the Damodar Canal.

Shortage of Water.

46. It will be noticed that in most cases the deficiency in rainfall can be made good from the river. On certain occasions, however, the water available in the river is not adequate. The actual position, with the Damodar Canal in operation, is shown in Tables 3 and 4.

Table 3.—Shortage of Water: Number of occasions.

Months.	Total No. of ten-day periods.	Number of occasions on which water is—			Percentage of occasions on which water is—		
		Required.	Available.	Not available.	Required.	Available.	Not available.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
July ..	105	40	35	5	38·1	33·	4·8
August ..	105	43	43	0	41·0	41·0	0·0
September ..	105	56	52	4	53·3	49·5	3·8
October ..	105	84	43	41	80·0	41·0	39·0
Total ..	420	223	173	50	53·1	41·2	11·9

Table 4.—Shortage of Water: Number of years.

Months.	Total number of years.	Number of years in which water is—			Percentage of years in which water is—		
		Required.	Available.	Not available.	Required.	Available.	Not available.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
July	35	23	19	4	65·7	54·3	11·4
August	35	26	26	..	74·3	74·3	..
September ..	35	30	27	3	85·7	77·2	8·5
October	35	33	11	22	94·3	31·4	62·9

47. We find that there is deficiency of rainfall in about roughly 40 per cent. of the ten-day periods in July and August and a little over 50 per cent. in September. But during these three months the deficiency can almost always be made good by irrigation from the existing discharge of the Damodar. In October there is deficiency in 80 per cent. of the ten-day periods. On only about half the occasions the existing discharge is sufficient to meet the deficiency.

48. Table 4 gives the analysis in terms of months as a whole instead of ten-day periods. The shortage occurs in increasing frequency from July to October, the actual values being about 65 per cent. of the years in July, 75 per cent. in August, 85 per cent. in September and nearly 95 per cent. in October. In most years the deficiency in July, August and September can be made good from the existing discharge of the river. But in roughly about 66 per cent. of the years, that is, on an average in two years out of three the shortage of rainfall in October cannot be met from the existing discharge. The proposed barrage or reservoir is intended to meet this shortage.

Table 2.—Shortage of Water.

Year and period. (1)	Water in million c. ft. Required. (2)	Available. (3)	Shortage. (4)
1901.			
July—			
1—10	..	3,004	..
11—20	383	16,666	..
21—31	1,021	5,734	..
August—			
1—10	670	5,892	..
11—20	511	19,248	..
21—31	..	24,624	..
September—			
1—10	..	40,674	..
11—20	255	2,687	..
21—30	..	2,856	..
October—			
1—10	192	1,930	..
11—20	1,532	..	1,532
21—31	287	..	287
1902.			
July—			
1—10	..	3,961	..
11—20	..	3,563	..
21—31	..	20,060	..
August—			
1—10	..	13,388	..
11—20	..	6,892	..
21—31	..	3,924	..
September—			
1—10	..	13,089	..
11—20	..	22,730	..
21—30	192	17,904	..
October—			
1—10	1,085	..	1,085
11—20	2,107	..	2,107
21—31	383	..	383
1903.			
July—			
1—10	..	499	..
11—20	383	..	383
21—31	1,149	1,931	..
		[663]	[486]
August—			
1—10	..	7,828	..
11—20	255	9,574	..
21—31	..	6,119	..
September—			
1—10	798	1,083	..
		[0]	[798]
11—20	..	10,819	..
21—30	..	7,007	..
October—			
1—10	..	23,611	..
11—20	128	4,926	..
21—31	..	..	..
1904.			
July—			
1—10	..	34,866	..
11—20	..	25,456	..
21—31	192	44,778	..
August—			
1—10	128	17,422	..
11—20	..	25,530	..
21—31	128	35,475	..
September—			
1—10	..	9,992	..
11—20	511	3,118	..
21—30	894	1,160	..
		[8]	[886]
October—			
1—10	2,170	..	2,170
11—20	2,298	..	2,298
21—31	..	..	..

Year and period. (1)	Water in million c. ft. Required. (2)	Available. (3)	Shortage. (4)
1905.			
July—			
1—10	..	7,283	..
11—20	..	15,425	..
21—31	..	23,872	..
August—			
1—10	..	21,560	..
11—20	..	27,995	..
21—31	..	5,982	..
September			
1—10	..	4,230	..
11—20	511	25,223	..
21—30	511	12,325	..
October—			
1—10	1,021	13,212	..
11—20	1,277	..	1,277
21—31	255	..	255
1906.			
July—			
1—10	..	4,348	..
11—20	894	2,037	..
21—31	255	5,435	..
August—			
1—10	..	13,086	..
11—20	..	18,086	..
21—31	383	9,963	..
September—			
1—10	128	697	..
11—20	255	9,113	..
21—30	..	..	..
October—			
1—10	638	..	638
11—20	958	..	958
21—31	447	..	447
1907.			
July—			
1—10	..	14,035	..
11—20	128	5,422	..
21—31	383	9,415	..
August—			
1—10	638	33,148	..
11—20	..	18,967	..
21—31	..	33,490	..
September—			
1—10	..	51,784	..
11—20	..	6,855	..
21—30	766	2,967	..
October—			
1—10	894	..	894
11—20	2,330	..	2,330
21—31	1,181	..	1,181
1908.			
July—			
1—10	..	7,924	..
11—20	..	34,843	..
21—31	..	16,777	..
August—			
1—10	383	6,835	..
11—20	..	17,154	..
21—31	..	20,750	..
September—			
1—10	..	26,213	..
11—20	383	11,314	..
21—30	383	7,895	..
October—			
1—10	1,500	6,999	..
11—20	2,298	..	2,298
21—31	479	..	479

Year and period. (1)	Water in million c. ft. Required. (2)	Available. (3)	Shortage. (4)
1909.			
July—			
1—10 ..	..	11,856	..
11—20 ..	830	1,840	..
21—31 ..	255	12,729	..
August—			
1—10 ..	..	19,889	..
11—20 ..	..	21,806	..
21—31 ..	..	43,337	..
September—			
1—10 ..	..	19,648	..
11—20 ..	..	17,350	..
21—30 ..	..	26,824	..
October—			
1—10 ..	383	18,044	..
11—20 ..	..	..	..
21—31 ..	128	..	128
1910.			
July—			
1—10 ..	..	3,949	..
11—20 ..	766	3,632	..
21—31 ..	..	18,527	..
August—			
1—10 ..	128	5,475	..
11—20 ..	255	19,627	..
21—31 ..	..	11,292	..
September—			
1—10 ..	..	22,307	..
11—20 ..	..	14,223	..
21—30 ..	638	5,654	..
October—			
1—10 ..	255	3,511	..
11—20 ..	255	1,481	..
21—31 ..	128	..	128
1911.			
July—			
1—10 ..	..	..	..
11—20 ..	511	10,920	..
21—31 ..	1,532	..	1,532
August—			
1—10 ..	1,851	3,169	..
11—20 ..	192	16,199	..
21—31 ..	287	33,099	..
September—			
1—10 ..	..	7,034	..
11—20 ..	383	28,183	..
21—30 ..	894	21,124	..
October—			
1—10 ..	319	9,649	..
11—20 ..	511	2,957	..
21—31 ..	575	..	575
1912.			
July—			
1—10 ..	..	507	..
11—20 ..	..	8,795	..
21—31 ..	319	8,970	..
August—			
1—10 ..	511	8,245	..
11—20 ..	..	25,655	..
21—31 ..	255	15,224	..
September—			
1—10 ..	128	14,581	..
11—20 ..	638	1,555	..
		[403]	[235]
21—30 ..	192	..	192
October			
1—10 ..	383	..	383
11—20 ..	383	..	383
21—31 ..	255	..	255

Year and period. (1)	Water in million c. ft. Required. (2)	Available. (3)	Shortage. (4)
1913.			
July—			
1—10 ..	..	3,940	..
11—20 ..	..	5,017	..
21—31 ..	..	20,337	..
August—			
1—10 ..	..	41,022	..
11—20 ..	..	17,856	..
21—31 ..	..	7,983	..
September—			
1—10 ..	192	15,453	..
11—20 ..	..	13,413	..
21—30 ..	255	5,082	..
October— ..			
1—10 ..	638	7,507	..
11—20 ..	..	3,626	..
21—31 ..	..	..	..
1914.			
July—			
1—10 ..	..	17,517	..
11—20 ..	..	20,738	..
21—31 ..	..	14,446	..
August—			
1—10 ..	255	30,3[illegible]	..
11—20 ..	192	19,422	..
21—31 ..	255	18,153	..
September—			
1—10 ..	..	23,216	..
11—20 ..	1,449	6,207	..
21—30 ..	830	8,358	..
October—			
1—10 ..	1,532	3,660	..
11—20 ..	1,788	..	1,788
21—31 ..	830	..	830
1915.			
July—			
1—10 ..	..	15,499	..
11—20 ..	383	1,687	..
21—31 ..	575	15,703	..
August—			
1—10 ..	255	9,514	..
11—20 ..	..	7,969	..
21—31 ..	..	8,271	..
September—			
1—10 ..	447	5,513	..
11—20 ..	..	4,531	..
21—30 ..	128	38,365	..
October—			
1—10 ..	192	5,331	..
11—20 ..	830	1,555	..
		[403]	[427]
21—31 ..	..	..	..
July—			
1—10 ..	..	2,476	..
11—20 ..	1,786	10,402	..
21—31 ..	1,724	13,751	..
August—			
1—10 ..	1,149	4,406	..
11—20 ..	..	23,602	..
21—31 ..	..	33,227	..
September—			
1—10 ..	..	14,832	..
11—20 ..	..	5,766	..
21—30 ..	..	43,052	..
October—			
1—10 ..	128	36,115	..
11—20 ..	447	9,055	..
21—31 ..	128		128

Year and period. (1)	Water in million c. ft. Required. (2)	Available. (3)	Shortage. (4)
1917.			
July—			
1—10	..	12,053	..
11—20	638	22,613	..
21—31	638	18,346	..
August—			
1—10	128	63,526	..
11—20	128	36,751	..
21—31	255	16,888	..
September—			
1—10	447	11,751	..
11—20	..	21,211	..
21—30	255	31,229	..
October—			
1—10	..	61,372	..
11—20	..	4,716	..
21—31	..	..	..
1918.			
July—			
1—10	..	2,609	..
11—20	383	4,430	..
21—31	383	..	383
August—			
1—10	192	7,800	..
11—20	..	9,235	..
21—31	..	44,370	..
September—			
1—10	..	23,547	..
11—20	..	14,980	..
21—30	..	443	..
October—			
1—10	1,277	..	1,277
11—20	1,628	..	1,628
21—31	255	..	255
1919.			
July—			
1—10	..	8,246	..
11—20	..	18,737	..
21—31	..	21,774	..
August—			
1—10	..	31,915	..
11—20	128	37,377	..
21—31	..	24,081	..
September—			
1—10	..	57,145	..
11—20	958	20,512	..
21—30	511	7,085	..
October—			
1—10	1,213	9,324	..
11—20	2,171	8,727	..
21—31	894	5,052	..
1920.			
July—			
1—10	..	6,194	..
11—20	..	34,273	..
21—31	128	51,195	..
August—			
1—10	..	42,272	..
11—20	192	18,082	..
21—31	..	8,536	..
September—			
1—10	638	11,557	..
11—20	638	28,983	..
21—30	1,309	5,724	..
October—			
1—10	702	5,842	..
11—20	128	..	128
21—31	128	..	128

Year and period. (1)	Water in million c. ft. Required. (2)	Available. (3)	Shortage. (4)
1921.			
July—			
1—10	..	5,495	..
11—20	766	9,492	..
21—31	..	20,660	..
August—			
1—10	192	14,600	..
11—20	383	18,392	..
21—31	862	39,959	..
September—			
1—10	..	23,137	..
11—20	..	27,178	..
21—30	128	7,592	..
October—			
1—10	766	6,461	..
11—20	2,618	3,847	..
21—31	511	..	511
1922.			
July—			
1—10	..	22,804	..
11—20	766	31,324	..
21—31	447	29,992	..
August—			
1—10	..	55,100	..
11—20	..	16,553	..
21—31	..	33,492	..
September—			
1—10	575	25,225	..
11—20	..	10,165	..
21—30	128	38,190	..
October—			
1—10	..	26,595	..
11—20	1,404	7,762	..
21—31	128	5,533	..
1923.			
July—			
1—10	..	21,667	..
11—20	..	12,378	..
21—31	..	31,271	..
August—			
1—10	..	48,716	..
11—20	..	24,229	..
21—31	..	41,192	..
September—			
1—10	..	26,130	..
11—20	638	14,047	..
21—30	2,043	8,837	..
October—			
1—10	..	11,295	..
11—20	575	3,362	..
21—31	575	..	575
1924.			
July—			
1—10	..	29,869	..
11—20	511	35,749	..
21—31	..	46,004	..
August—			
1—10	766	34,954	..
11—20	..	28,509	..
21—31	..	16,121	..
September—			
1—10	..	27,111	..
11—20	..	47,742	..
21—30	575	26,875	..
October—			
1—10	670	11,700	..
11—20	894	9,703	..
21—31	575	6,161	..

Year and period.	Water in million c. ft. Required.	Available.	Shortage.
(1)	(2)	(3)	(4)
1925.			
July—			
1—10 ..	..	15,411	..
11—20 ..	383	11,230	..
21—31 ..	383	38,201	..
August—			
1—10 ..	1,915	20,438	..
11—20 ..	192	34,538	..
21—31 ..	..	24,739	..
September—			
1—10 ..	447	27,373	..
11—20 ..	..	14,967	..
21—30 ..	1,277	6,810	..
October—			
1—10 ..	766	..	766
11—20 ..	255	..	255
21—31 ..	..	..	..
1926.			
July—			
1—10 ..	..	13,748	..
11—20 ..	..	16,370	..
21—31 ..	..	41,010	..
August—			
1—10 ..	..	34,972	..
11—20 ..	..	45,785	..
21—31 ..	..	29,459	..
September—			
1—10 ..	..	60,794	..
11—20 ..	..	32,320	..
21—30 ..	1,341	32,132	..
October—			
1—10 ..	..	15,267	..
11—20 ..	862	9,423	..
21—31 ..	255	5,399	..
1927.			
July—			
1—10 ..	..	8,646	..
11—20 ..	1,341	16,075	..
21—31 ..	447	27,914	..
August—			
1—10 ..	1,021	23,258	..
11—20 ..	255	16,793	..
21—31 ..	511	21,096	..
September—			
1—10 ..	447	19,024	..
11—20 ..	511	9,957	..
21—30 ..	447	6,633	..
October—			
1—10 ..	192	19,526	..
11—20 ..	2,107	6,427	..
21—31 ..	766	1,308	..
		[40]	[726]
1928.			
July—			
1—10 ..	..	43,491	..
11—20 ..	..	45,215	..
21—31 ..	..	25,619	..
August—			
1—10 ..	..	33,144	..
11—20 ..	..	7,047	..
21—31 ..	..	7,583	..
September—			
1—10 ..	383	10,387	..
11—20 ..	894	5,157	..
21—30 ..	416	5,948	..
October—			
1—10 ..	638	13,445	..
11—20 ..	766	25,512	..
21—31 ..	..	14,639	..

Year and period.	Water in million c. ft. Required.	Available.	Shortage.
(1)	(2)	(3)	(4)
1929.			
July—			
1—10 ..	..	10,909	..
11—20 ..	..	21,063	..
21—31 ..	..	52,884	..
August—			
1—10 ..	..	39,512	..
11—20 ..	..	58,425	..
21—31 ..	255	35,268	..
September—			
1—10 ..	762	12,562	..
11—20 ..	128	21,169	..
21—30 ..	..	6,195	..
October—			
1—10 ..	..	47,315	..
11—20 ..	..	22,791	..
21—31 ..	..	20,790	..
1930.			
July—			
1—10 ..	..	23,012	..
11—20 ..	..	31,795	..
21—31 ..	..	32,085	..
August—			
1—10 ..	383	21,9..	..
11—20 ..	..	37,142	..
21—31 ..	..	18,758	..
September—			
1—16 ..	255	11,256	..
11—20 ..	702	10,377	..
21—30 ..	128	33,518	..
October—			
1—10 ..	383	16,433	..
11—20 ..	1,788	8,544	..
21—31 ..	1,085	5,904	..
1931.			
July—			
1—10 ..	..	16,571	..
11—20 ..	..	12,256	..
21—31 ..	..	25,639	..
August—			
1—10 ..	128	16,820	..
11—20 ..	..	43,873	..
21—31 ..	383	26,786	..
September—			
1—10 ..	..	28,794	..
11—20 ..	..	16,045	..
21—30 ..	..	13,463	..
October—			
1—10 ..	192	7,691	..
11—20 ..	383	7,409	..
21—31 ..	..	4,898	..
1932.			
July—			
1—10 ..	..	5,774	..
11—20 ..	1,021	7,303	..
21—31 ..	253	9,685	..
August—			
1—10 ..	..	49,085	..
11—20 ..	..	37,271	..
21—31 ..	..	17,652	..
September—			
1—10 ..	..	7,738	..
11—20 ..	..	13,195	..
21—30 ..	..	19,004	..
October—			
1—10 ..	1,915	5,929	..
11—20 ..	1,021	480	541
21—31 ..	192	4,349	..

Year and period.	Water in million c. ft. Required.	Available.	Shortage.
(1)	(2)	(3)	(4)
1933.			
July—			
1—10 ..	..	19,865	..
11—20 ..	511	32,959	..
21—31 ..	766	32,102	..
August—			
1—10 ..	..	21,180	..
11—20 ..	255	25,830	..
21—31 ..	..	61,440	..
September—			
1—10 ..	511	22,631	..
11—20 ..	..	5,371	..
21—30 ..	..	26,475	..
October—			
1—10 ..	638	4,474	..
11—20 ..	128	480	..
21—31 ..	..	5,851	..
1934.			
July—			
1—10 ..	..	7,661	..
11—20 ..	1,660	20,866	..
21—31 ..	2,171	9,571	..
August—			
1—10 ..	1,149	7,569	..
11—20 ..	511	13,241	..
21—31 ..	..	34,297	..

Year and period.	Water in million c. ft. Required.	Available.	Shortage.
(1)	(2)	(3)	(4)
1934.			
September—			
1—10 ..	447	13,959	..
11—20 ..	255	14,788	..
21—30 ..	511	12,680	..
October—			
1—10 ..	..	4,633	..
11—20 ..	255	1,725	..
21—31 ..	511	1,895	..
1935.			
July—			
1—10 ..	..	11,362	..
11—20 ..	1,788	5,460	..
21—31 ..	1,788	1,628	160
August—			
1—10 ..	383	7,887	..
11—20 ..	..	45,340	..
21—31 ..	..	27,964	..
September—			
1—10 ..	..	18,074	..
11—20 ..	..	12,561	..
21—30 ..	1,819	22,698	..
October—			
1—10 ..	2,330	2,036	294
11—20 ..	2,458	..	2,458
21—31 ..	1,181	..	1,181

Partial Irrigation.

49. We can now use the above material to form some idea about the increased yield which might be expected with irrigation. When sufficient water is available in the Damodar to make good the whole of the deficiency in rainfall, each area will get complete irrigation. When the water in the river is not, however, quite adequate, we shall assume that the total amount of water available for irrigation will be distributed proportionately to each area, so that each acre everywhere will get roughly the same quantity of water for irrigation. The deficiency in rainfall, however, will not in general be the same in each area. It will, therefore, be necessary to make the calculations separately for each region covered by the different rainfall stations. But knowing the actual amount of water (rainfall *plus* irrigation) available in each area we can make an estimate of the expected crop. The improvement due to irrigation will, however, in general differ from area to area.

Complete Irrigation.

50. A proposal for increasing the amount of water available for irrigation by the construction of either a barrage near the off-take of the irrigation canals or a reservior or retarding basin in the upper reaches of the river or a combination of both is also under consideration. In case this proposal is accepted complete irrigation in October will be always possible as enough water flows down the river in July, August and September. We may, therefore, make a second estimate of the expected crop on the assumption that sufficient water for irrigation will be available on every occasion.

Damage due to Excessive Rainfall.

51. We have so far considered only the deficiency in the rainfall. Occasionally, however, a good deal of damage is done by excessive rainfall. Although something may be done by improving the drainage, I have not, in the absence of relevant data, taken any such hypothetical improvement in consideration. The expected crop yield even with full irrigation will, therefore, remain less than 100 per cent. in certain years owing to excessive rainfall. The final estimated crop without irrigation, the estimated crop with irrigation from the river without a barrage or a reservoir, and

the estimated crop with complete irrigation (on the assumption that sufficient water for irrigation will be made available by the construction of a barrage or reservoir) were prepared for each rainfall station on the basis of the water required and are given in Appendix 11.

Percentage Improvement in Yield.

52. It is now possible by simply taking the difference between the appropriate columns to estimate the percentage improvement due to partial or complete irrigation. These estimates are given in columns (5), (6) and (7) of Appendix 11, while the modified estimates with the Damodar Canal in operation are given within square brackets.

53. The average improvement (allowing for the Damodar Canal) over a period of 35 years together with standard errors for the area surrounding each rainfall station is given in the following Table 5. The weighted average percentage improvement for each district (or rather only that portion of the district which is included in the present irrigation project) as well as for the whole area are given in the same table.

Table 5.—Percentage Improvement due to Irrigation.*

Stations.	N	Weight.	Partial.	Complete.
Burdwan	35	0·10	12·1 ± 1·3	17·7 ± 2·1
Kalna	35	·20	17·9 ± 2·8	23·5 ± 3·0
Burdwan District	35	·30	16·0 ± 2·0	21·5 ± 2·7
Hooghly	35	·20	15·3 ± 1·9	22·2 ± 3·3
Serampore	35	·15	23·0 ± 3·3	28·2 ± 3·6
Arambagh	35	·10	13·1 ± 1·6	16·5 ± 2·2
Hooghly District	35	·45	17·4 ± 1·4	22·9 ± 3·2
Howrah	35	·35	17·3 ± 2·8	21·2 ± 2·9
Amta	35	·10	13·1 ± 2·9	23·4 ± 3·3
Howrah District	35	·25	14·8 ± 2·1	22·5 ± 3·2
Whole Area	35	1·00	16·3 ± 1·0	22·4 ± 3·1
			Difference = 6·1 ± 3·2	

* Standard errors have been given in all cases.

54. It will be noticed that the improvement is quite appreciable in every case. Provided the irrigation project is sound in its technical aspects, we have every reason to expect on an average an increase in yield of about 16 per cent. of the full crop with partial irrigation, and over 22 per cent. with complete irrigation.

Comparison of "normal" and "full" Crops.

55. It will be useful to convert the percentage improvement into actual quantities. In order to do this it is necessary to form some idea of the total yield which represents a full (or 100 per cent.) crop. This can be done tentatively in the following way.

56. The final estimates of the crop made by the Department of Agriculture are given in percentages of the "normal yield" (explained later). The mean values of the official estimates are shown in Table 6 along with the mean values of expected yields in terms of percentage of a "full crop" which were prepared for this investigation.

Table 6.—Mean Values of Crop-Estimates (Percentage).

District.	N	Mean Value.		Standard Deviation.	
		"Normal."	"Full crop."	"Normal."	"Full crop."
Burdwan	35	80·7±3·1	77·6±2·0	18·1±2·2	11·8±1·4
Hooghly	35	80·0±2·3	73·0±2·4	13·8±1·6	14·4±1·6
Howrah	35	83·1±2·2	77·8±2·8	12·8±1·5	16·7±2·0
Whole area ..	35	81·0±(1·5)	75·6±(1·4)	15·1±1·7	14·4±1·6

57. It will be noticed that the average values of the crop estimates made by the Agricultural Department are somewhat higher than the estimates prepared by us. The difference of 5·4 per cent. between the estimates can be explained by the fact that while the official estimate of the condition factor refers to (*a*) the area transplanted (or sown), and (*b*) the normal outturn; our estimate is based on (*a*) the total cultivable area, and (*b*) the full crop. (This point has been more fully discussed in Appendix 12.)

Total Increase in Yield in Maunds.

58. Assuming that the official estimates (of the condition factor in terms of a normal crop" and area transplanted) are in agreement with our estimates of the percentage expectation of production (in terms of a "full crop" and total cultivable area) we find that the "full crop" represents 15·46 maunds per acre in Burdwan, 14·92 maunds per acre in Hooghly, and 13·93 maunds per acre in Howrah. (Details of calculation are given in Appendix 12). With the help of the above figures the additional yield due to irrigation was calculated for each year, and the figures for partial and complete irrigation are given in Appendix 13 and 14 respectively.

Money Value of the Increase in Yield.

59. We may go a step further and try to get a rough idea of the money value of the additional yield due to irrigation. At this stage we have to take into consideration the fluctuations in the price of rice from year to year. I have collected the average harvest prices of cleaned rice for the three districts from 1901-02 which are given in Appendix 15.

60. Multiplying the estimated additional yield (given in Appendices 13 and 14) by the harvest price for the year in each district, we get the estimates of the money value of the additional yield due to irrigation (partial or complete) for each district. Adding the three district figures for each year we get an estimate of the money value of the additional yield of rice due to irrigation (partial* or complete) for the whole area proposed to be irrigated in the present scheme. The actual estimates for the three districts and for the whole area are given in Appendix 16.

Table 7.—Average money value of additional crop per year due to irrigation.

From 1901-1902 to 1935-36 (35 years).

Irrigation.	Mean value (in lakhs of rupees).	Standard Deviation (in lakhs of rupees).
	Rs. Lakhs.	Rs. Lakhs.
Complete	55·9 ± 5·6	33·3 ± 4·0
Partial	43·3 ± 5·0	29·5 ± 3·5
Difference	12·6 ± 3·2	18·8 ± 2·3

* Partial irrigation figures are given after making allowance for discharge through the Damodar Canal.

61. The average money value is given in Table 7. We find that the money value of the additional yield of rice on an average is about Rs. $43 \cdot 3 \pm 5 \cdot 0$ lakhs with partial irrigation and Rs. $55 \cdot 9 \pm 5 \cdot 6$ lakhs with complete irrigation. A rough idea of the reliability of these estimates is given by the respective standard errors. The additional income with complete irrigation, though appreciable, is not large and is likely to be about Rs. $12 \cdot 6 \pm 3 \cdot 2$ lakhs on an average.

Shortage of water in October.

62. One or two points, however, deserve mention in this connection. The following table (arranged in ascending order of magnitude) gives the estimated shortage of water in October required to be supplied together with the estimated cash value of the additional yield of rice expected with complete irrigation.

Table 8.—Water required for meeting shortage in October.

Year.	Water required for October irrigation (in million c.ft.)	Value of additional crop (in lakhs of Rs.)	Year.	Water required for October irrigation (in million c.ft.)	Value of additional crop (in lakhs of Rs.)
1909	128	0·0	1905 ..	1,532	30·8
1910	128	0·7	1901 ..	1,819	9·8
1916	128	0·0	1906 ..	2,143	22·5
1915	427	8·2	1920 ..	2,553	5·6
1921	510	5·8	1914 ..	2,618	22·5
1932	541	1·4	1908 ..	2,777	27·2
1911	575	1·7	1918 ..	3,160	70·1
1923	575	4·9	1902 ..	3,576	30·7
1927	726	6·3	1935 ..	3,933	67·9
1925	1,021	3·8	1907 ..	4,405	52·5
1912	1,213	25·8*	1904 ..	4,469	31·6

*The reasons for this high value have been discussed in Appendix 17.

63. In 22 years out of 35 there was shortage of water in October. If a reservoir is constructed it will be possible to make good this deficiency every year. But so far as the money value of the additional crop is concerned the improvement will be practically negligible in 12 years out of 35. Only in 8 years out of 35 or about once in 4 years on an average the improvement will be substantial.

64. It will also be noticed that during the period 1901-35 the maximum amount of water required in October was about 4,500 million c. ft. (This agrees fairly well but is a little less than the estimate of 5,000 million c. ft. made by the Superintending Engineer). The gain is very small up to about 2,000 million c. ft. In order that irrigation may be really effective in October the critical supply required will be between 2,000 and 4,500 million c. ft. A reservoir of sufficient capacity to supply up to say 5,000 million c. ft. is thus essential to ensure full irrigation in October.

P. C. MAHALANOBIS.

The 16th October 1936.

A Statistical Note on the Hooghly-Howrah Flushing and Irrigation Scheme.

Part 3.—Appendices.

Appendix I.—Total Rainfall in inches in 10-day periods.

Months.	Date.	Burdwan.	Kalna.	Hooghly.	Serampore.	Arambagh.	Howrah.	Amta.
1901.								
May ..	1—10	0·08	2·71	1·15	0·42	0·28	..	..
	11—20	2·79	4·24	4·77	2·75	3·22	3·21	..
	21—30	1·90	2·02	1·24	1·22	5·59	0·71	..
June ..	31—9	1·29	..	1·11	1·86	0·41	2·38	0·61
	10—19	3·39	3·74	3·41	5·49	2·43	3·67	4·82
	20—29	1·48	1·09	1·82	2·30	3·44	3·88	4·58
July ..	30—9	1·47	0·68	1·07	0·38	3·04	0·28	0·22
	10—19	8·80	5·27	5·14	5·69	10·53	7·29	6·46
	20—29	1·23	1·55	0·93	2·68	1·57	2·78	3·73
August ..	30—8	0·31	0·81	0·96	1·56	0·37	0·56	3·27
	9—18	5·03	1·14	7·10	3·13	8·07	5·54	3·88
	19—28	2·18	2·47	3·93	1·31	4·79	1·13	1·89
September ..	29—7	5·95	7·63	15·93	18·42	12·26	13·62	11·17
	8—17	0·16	0·27	0·17	0·03	..	1·90	0·25
	18—27	3·40	2·27	1·87	1·55	5·00	2·98	2·28
October ..	28—7	0·05	2·36	1·41	0·66	1·10	1·88	4·26
	8—17	0·06	0·97	0·63	0·32	1·20	0·38	0·06
	18—27	..	..	..	..	..	..	..
1902.								
May ..	1—10	3·63	2·60	3·39	2·54	2·54	2·55	2·20
	11—20	0·50	0·17	1·11	2·70	1·93	1·59	4·18
	21—30	2·37	1·01	3·23	2·70	3·44	4·55	3·23
June ..	31—9	3·17	2·17	3·15	2·33	2·34	1·16	1·22
	10—19	3·40	6·97	5·26	3·43	1·45	1·29	1·29
	20—29	0·29	0·76	0·36	0·13	2·00	1·50	0·53
July ..	30—9	3·40	2·29	2·54	3·33	2·70	5·15	6·22
	10—19	2·48	1·71	3·46	1·67	1·32	1·96	1·81
	20—29	2·37	3·33	4·15	7·90	5·69	5·05	5·02
August ..	30—8	2·26	3·34	3·95	1·48	1·97	7·29	4·68
	9—18	1·55	2·10	2·01	4·06	2·09	3·07	2·66
	19—28	3·60	2·20	4·56	6·59	3·14	4·88	5·57
September ..	29—7	2·74	0·59	3·40	3·97	4·23	4·35	1·76
	8—17	4·02	4·24	3·39	4·96	2·72	1·37	2·68
	18—27	0·02	1·32	1·55	2·71	3·04	0·79	1·17
October ..	28—7	0·87	0·62	0·86	0·25	1·00	0·68	0·22
	8—17	0·05	..	..	..	..	0·06	..
	18—27	0·58	0·74	0·94	0·05	..	0·55	0·71
1903.								
May ..	1—10	0·72	0·42	0·22	0·50	0·66	0·68	0·06
	11—20	0·14	1·94	0·03	1·72	0·35	0·78	0·11
	21—30	3·08	1·10	3·05	2·63	0·04	0·77	3·85
June ..	31—9	1·23	2·39	0·36	1·38	2·51	1·35	1·15
	10—19	5·35	5·83	1·67	3·75	0·35	2·54	0·57
	20—29	2·21	3·32	4·29	4·68	4·43	6·17	6·13
July ..	30—9	1·77	3·12	5·20	4·93	1·38	6·42	2·01
	10—19	4·71	3·29	1·75	1·50	1·86	2·45	2·25
	20—29	2·58	4·11	2·17	2·14	2·30	3·90	4·88
August ..	30—8	7·87	6·60	4·60	5·77	5·80	2·90	5·71
	9—18	4·87	3·18	1·00	2·15	2·38	1·13	2·18
	19—28	1·49	1·77	1·99	2·47	2·41	1·12	1·93
September ..	29—7	2·23	1·15	0·92	2·92	1·84	2·79	1·03
	8—17	4·31	5·71	5·92	7·17	7·49	8·30	6·70
	18—27	1·30	2·60	0·88	2·82	1·54	2·35	3·37
October ..	28—7	4·01	4·19	3·40	5·18	5·34	5·98	3·03
	8—17	0·42	2·40	1·31	0·67	1·69	1·82	0·85
	18—27	0·05	..	1·37	2·47	..	0·20	0·18
1904.								
May ..	1—10	0·34	3·73	3·78	2·76	1·90	2·08	2·17
	11—20	3·55	4·07	1·83	1·85	0·24	3·66	1·82
	21—30	2·00	1·80	3·16	1·96	0·80	2·95	1·23
June ..	31—9	0·79	0·27	1·53	0·17	1·74	0·21	0·21
	10—19	5·49	4·48	6·71	7·48	5·51	5·19	7·07
	20—29	2·33	6·84	4·64	2·19	2·80	2·77	5·63
July ..	30—9	5·67	7·36	7·26	12·27	9·38	13·37	9·45
	10—19	2·75	6·46	2·65	3·59	0·33	1·16	4·55
	20—29	5·64	8·80	5·55	4·35	3·90	2·68	2·51
August ..	30—8	2·37	1·97	2·86	4·01	1·73	4·15	2·77
	9—18	2·32	2·04	0·56	2·15	1·36	1·44	4·12
	19—28	3·21	2·37	0·62	1·97	1·44	1·72	2·41
September ..	29—7	1·75	2·15	5·89	3·58	0·81	2·09	3·84
	8—17	0·85	0·16	1·31	2·89	0·85	2·35	1·79
	18—27	2·20	2·27	1·73	2·58	1·18	0·40	2·26
October ..	28—7	..	..	..	0·14	0·10	..	..
	8—17	0·03	0·50	0·63	0·15	0·46	0·60	0·53
	18—27	0·02	0·10	0·14	1·00	0·06	1·19	..

Appendix I.– Total Rainfall in inches in 10-day periods.

Months.	Date.	Burdwan.	Kulna.	Hooghly.	Seram-pore.	Aram-bagh.	Howrah.	Amta.
1905.								
May ..	1—10	5·72	4·83	7·15	7·25	2·98	0·08	4·15
	11—20	0·25	0·80	0·18	1·60	0·84	0·78	2·55
	21—30	2·06	0·34	1·12	0·14	0·14	0·77	..
June ..	31—9	2·29	1·24	2·73	0·52	3·19	1·35	0·09
	10—19	0·16	0·48	0·28	0·38	0·52	2·54	1·37
	20—29	0·61	1·65	0·15	0·18	0·94	6·17	..
July ..	30—9	4·64	1·91	1·18	4·13	3·64	6·42	2·61
	10—19	9·71	5·97	3·90	4·85	7·06	2·45	6·83
	20—29	18·83	8·33	12·94	14·55	19·18	15·32	16·52
August ..	30—8	3·14	1·24	2·00	2·92	1·69	2·90	2·42
	9—18	5·80	2·26	4·89	2·42	2·28	1·13	4·13
	19—28	0·89	1·72	0·67	1·04	0·86	1·12	1·57
September ..	29—7	7·48	1·72	3·65	..	3·92	2·79	5·52
	8—17	4·87	3·32	..	..	3·36	8·30	2·15
	18—27	2·11	5·50	..	..	2·30	2·35	1·55
October ..	28—7	1·70	2·53	..	..	4·99	5·98	6·77
	8—17	..	..	..	..	..	2·82	..
	18—27	..	..	..	..	1·27	0·20	1·77
1906.								
May	1—10	1·42	0·63	0·78	0·80	0·99	2·08	1·47
	11—20	3·89	2·15	4·05	2·98	1·38	3·66	2·18
	21—30	0·77	0·81	0·17	0·85	0·90	2·95	0·41
June ..	31—9	1·80	0·96	0·71	0·65	1·69	0·21	1·05
	10—19	1·08	1·87	1·15	1·90	0·94	5·19	1·59
	20—29	2·20	1·35	1·90	0·97	2·79	2·77	2·94
July ..	30—9	4·71	2·80	4·31	3·59	3·03	3·21	3·52
	10—19	2·04	3·17	0·85	1·22	2·45	1·16	5·40
	20—29	5·53	3·05	2·29	6·92	8·17	2·68	8·19
August ..	30—8	8·59	6·29	4·62	3·89	1·28	4·15	..
	9—18	5·83	3·82	1·83	3·62	2·69	1·44	..
	19—28	2·80	0·48	1·02	1·65	2·98	1·72	..
September ..	29—7	0·96	3·52	2·19	4·48	2·10	2·09	..
	8—17	0·85	1·45	3·37	3·86	1·52	2·35	..
	18—27	0·52	1·02	2·95	2·50	0·93	0·40	..
October ..	28—7	12·31	1·49	1·22	2·31	1·91	..	
	8—17	2·87	0·50	0·84	0·13	2·16	0·60	..
	18—27	0·05	0·33	..	0·90	0·02	1·19	..
1907.								
May ..	1—10	1·46	1·05	0·73	0·43	1·26	2·56	0·60
	11—20	2·36	0·68	1·39	0·99	1·22	0·91	2·25
	21—30	2·62	2·38	4·16	1·43	2·91	..	3·37
June ..	31—9	0·80	0·75	0·33	3·29	1·62	0·34	1·74
	10—19	2·40	3·66	4·36	5·00	4·67	0·09	5·39
	20—29	5·20	9·81	5·43	7·56	9·26	8·88	6·47
July ..	30—9	1·69	1·06	4·17	3·54	2·61	5·82	3·68
	10—19	2·74	0·44	0·87	1·49	1·77	4·34	0·80
	20—29	6·70	6·33	3·49	4·60	2·81	2·17	4·02
August ..	30—8	2·42	1·49	3·42	1·86	2·06	2·82	0·61
	9—18	1·55	3·18	4·85	4·42	4·57	2·56	4·55
	19—28	1·14	2·47	1·85	1·76	1·45	1·59	2·87
September ..	29—7	4·34	2·95	3·38	2·35	9·64	0·09	5·88
	8—17	1·80	2·04	2·77	4·31	4·07	..	0·70
	18—27	0·70	3·92	3·21	1·02	1·25	..	0·36
October ..	28—7	0·60	0·89	..	1·97	0·35	..	0·25
	8—17	..	0·23	..	0·34	..	..	0·42
	18—27	..	..	..	..	..	..	..
1908.								
May ..	1—10	3·23	3·09	1·41	0·79	1·61	1·22	0·87
	11—20	0·76	0·04	0·92	0·40	0·79	2·00	0·44
	21—30	3·88	1·35	2·35	2·11	2·53	0·82	3·78
June ..	31—9	0·93	0·56	1·11	0·52	0·58	0·64	0·93
	10—19	8·48	7·23	7·85	15·17	9·27	18·02	18·34
	20—29	8·92	11·25	4·15	5·53	5·97	3·52	2·73
July ..	30—9	13·05	4·53	17·56	12·22	6·99	3·21	5·45
	10—19	5·42	4·48	3·16	5·13	8·65	2·64	3·49
	20—29	1·82	2·42	0·89	4·29	3·37	6·37	4·23
August ..	30—8	3·09	3·43	1·71	3·40	3·13	3·97	2·42
	9—18	1·29	5·39	0·96	2·31	3·50	4·25	1·82
	19—28	3·26	2·57	2·88	4·86	1·90	1·72	4·17
September ..	29—7	2·00	3·59	3·16	2·66	2·95	3·30	1·34
	8—17	5·48	3·41	3·05	6·30	0·46	5·97	0·76
	18—27	0·92	2·56	3·25	3·10	2·51	2·23	0·96
October ..	28—7	0·22	3·32	0·08	0·43	0·23	0·85	0·93
	8—17	..	..	..	0·09	..	0·59	..
	18—27	..	..	..	..	..	1·14	..

Appendix I.—Total Rainfall in inches in 10-day periods.

Months.	Date.	Burdwan.	Kalna.	Hooghly.	Serampore.	Arambagh.	Howrah.	Amta.
1909.								
May ..	1—10	..	1·30	0·25	0·22	0·06	0·71	..
	11—20	2·80	1·88	1·02	0·99	2·72	1·96	0·84
	21—30	2·64	0·77	0·45	2·85	3·11	1·02	2·05
June ..	31—9	4·64	6·04	6·59	6·83	4·15	6·96	6·86
	10—19	3·32	6·27	5·03	4·92	3·63	7·21	7·13
	20—29	2·16	2·51	3·01	3·10	0·76	3·43	2·30
July ..	30—9	1·43	5·57	2·87	2·43	1·23	2·46	1·93
	10—19	2·03	2·61	1·15	2·81	1·64	1·84	1·53
	20—29	1·53	1·09	1·39	2·32	2·10	2·17	3·32
August ..	30—8	6·49	11·67	4·97	5·61	3·98	2·46	6·24
	9—18	4·55	1·53	3·44	1·89	1·86	3·67	3·11
	19—28	7·23	2·77	2·28	3·48	3·90	4·25	3·72
September ..	29—7	18·92	10·46	7·81	7·78	16·14	5·93	8·76
	8—17	2·61	4·40	1·55	2·45	7·71	2·78	5·73
	18—27	4·66	4·07	3·00	6·17	5·97	3·80	3·01
October ..	28—7	2·24	3·89	1·38	5·75	5·24	0·13	3·32
	8—17	0·11	0·06	0·08	0·09	..	1·47	..
	18—27	0·51	2·92	4·11	2·57	0·55	..	0·73
1910.								
May ..	1—10	3·24	3·09	2·86	1·06	3·32	0·65	1·52
	11—20	0·66	0·73	0·82	0·70	0·06	0·21	0·30
	21—30	1·52	1·57	1·12	1·70	0·24	3·57	3·93
June ..	31—9	6·74	1·97	1·23	3·79	3·13	0·15	5·57
	10—19	4·53	4·20	3·89	2·65	5·69	3·01	4·56
	20—29	3·20	1·64	2·22	1·69	0·67	4·13	1·40
July ..	30—9	2·29	2·21	0·98	2·93	2·22	1·69	2·92
	10—19	3·36	4·93	1·67	2·74	0·86	2·87	1·02
	20—29	7·69	4·29	4·14	6·29	7·29	5·31	5·59
August ..	30—8	1·27	4·33	2·34	3·31	2·34	2·68	4·76
	9—18	2·47	3·97	2·49	3·10	2·03	2·03	4·38
	19—28	2·14	2·56	3·66	7·32	2·50	3·33	3·40
September ..	29—7	3·22	2·86	2·91	5·06	3·65	4·27	2·64
	8—17	1·53	3·93	1·44	2·93	1·77	3·26	4·24
	18—27	0·23	3·88	1·76	1·50	..	1·75	2·30
October ..	28—7	0·64	2·04	1·67	4·05	0·55	1·25	1·87
	8—17	..	7·78	5·56	3·32	5·41	0·41	1·45
	18—27	..	0·85	1·05	0·40	0·73	..	1·89
1911.								
May ..	1—10	1·87	1·08	0·19	..	1·83	0·48	0·86
	11—20	1·58	1·25	0·34	0·17	0·72	1·12	0·02
	21—30	0·26	1·87	2·26	1·38	2·58	2·10	3·03
June ..	31—9	2·86	5·40	2·73	4·90	1·47	6·96	0·11
	10—19	6·96	4·48	5·11	4·27	4·48	7·61	3·31
	20—29	1·45	1·93	4·99	2·36	0·53	3·43	0·74
July ..	30—9	1·03	1·37	2·89	0·17	1·11	3·99	0·73
	10—19	2·35	5·05	4·44	5·31	4·13	1·49	3·91
	20—29	1·04	1·76	3·14	1·03	0·62	4·04	1·64
August ..	30—8	2·34	1·46	0·70	1·05	0·78	5·44	0·74
	9—18	4·51	5·01	1·36	1·83	3·67	5·05	1·48
	19—28	1·73	1·88	5·65	2·25	3·67	3·85	1·40
September ..	29—7	1·44	3·58	2·95	1·46	2·00	5·93	7·13
	8—17	3·72	2·33	1·54	1·91	3·79	2·62	1·42
	18—27	5·33	1·72	0·95	1·15	4·09	4·52	0·96
October ..	28—7	2·32	3·28	1·66	0·85	1·10	0·52	0·91
	8—17	0·90	1·60	1·51	3·06	1·46	0·01	2·94
	18—27	..	..	..	..	..	2·38	..
1912.								
May ..	1—10	0·23	1·27	2·76	0·50	1·08	1·53	0·79
	11—20	0·82	2·76	1·17	0·92	2·36	0·61	1·00
	21—30	3·43	2·20	4·72	2·88	4·03	1·54	3·90
June ..	31—9	0·91	1·88	0·41	0·37	1·06	1·21	2·13
	10—19	0·90	0·85	0·64	1·22	0·88	2·01	0·55
	20—29	3·94	5·71	4·43	7·90	2·81	1·45	3·70
July ..	30—9	4·58	4·90	3·25	4·83	6·36	1·69	3·22
	10—19	8·97	4·07	1·77	2·66	3·54	2·87	3·04
	20—29	1·77	4·84	6·41	2·96	3·82	5·80	3·61
August ..	30—8	2·05	0·21	2·04	1·63	2·08	3·60	2·32
	9—18	5·12	..	1·84	2·08	2·93	2·76	3·69
	19—28	1·84	..	2·72	1·73	3·63	3·54	3·24
September ..	29—7	1·12	..	1·63	2·04	1·25	3·66	2·05
	8—17	3·17	..	1·75	3·10	2·01	3·96	2·46
	18—27	0·58	..	0·36	0·75	0·07	1·25	1·64
October ..	28—7	2·91	..	2·36	3·14	3·09	1·34	0·63
	8—17	0·94	..	1·54	1·30	2·41	2·32	..
	18—27	0·01	..	..	0·55	0·08	3·78	..

Appendix I.—Total Rainfall in inches in 10-day periods.

Months.	Date.	Burdwan.	Kalna.	Hooghly.	Serampore.	Arambagh.	Howrah.	Amta.
1913.								
May ..	1—10	0·92	0·35	1·18	1·65	0·40	0·79	2·25
	11—20	2·98	3·41	4·53	8·13	4·06	4·20	2·00
	21—30	1·58	3·42	3·63	3·58	1·32	1·19	2·67
June ..	31—9	6·81	6·85	11·88	14·38	10·33	15·56	15·84
	10—19	5·91	5·91	5·73	8·78	4·04	11·07	7·20
	20—29	5·47	5·47	2·19	3·09	2·99	4·59	3·14
July ..	30—9	2·91		1 65	0·80	2·41	1·65	1·96
	10—19	4·73		3·29	2·11	3·57	2·59	2·97
	20—29	6·53		5·19	5·84	8·39	6·93	9·71
August ..	30—8	7·04	Not recorded.	7·53	6·21	5·46	5·69	6·62
	9—18	4·28		1·72	3·37	1·53	2·16	4·46
	19—28	0·34		0·99	1·40	1·45	1·63	2·30
September ..	29—7	2·52		0·56	1·51	5·16	2·08	8·00
	8—17	6·75		6·55	2·58	3·14	2·91	1·09
	18—27	0·40		2·69	0·93	0·87	0·28	0·53
October ..	28—7	2·36	..	0·80	1·83	1·28	1·28	2·08
	8—17	3·40	3·25	3·05	3·30	3·44	4·77	4·44
	18—27	..	..	..	..	..	..	..
1914.								
May ..	1—10	1·85	..	5·29	2·83	3·00	4·34	..
	11—20	7·17	..	4·20	3·22	5·04	4·19	..
	21—30	0·43	..	0·22	0·05	0·23	..	..
June ..	31—9	2·00	1·68	1·31	0·74	1·57	1·46	1·17
	10—19	4·56	4·11	1·92	1·67	2·72	4·54	1·29
	20—29	1·81	2·53	3·00	2·14	2·68	2·86	2·49
July ..	30—9	10·29	6·34	4·82	6·70	13·69	9·98	7·90
	10—19	3·80	4·64	7·70	5·19	10·35	3·48	6·39
	20—29	1·51	3·99	2·57	2·90	1·36	2·67	3·70
August ..	30—8	3·39	0·33	2·22	2·60	3·36	1·77	3·55
	9—18	2·75	..	1·74	0·82	1·70	1·26	1·21
	19—28	0·74	..	4·36	3·95	0·93	3·80	5·57
September ..	29—7	0·98	3·19	0·99	1·30	0·81	2·26	..
	8—17	2·48	4·03	1·70	1·82	2·00	3·19	..
	18—27	1·90	4·24	3·00	0·57	2·39	1·58	..
October ..	28—7	0·04	..	1·80	0·33	0·06	..	0·07
	8—17	0·95	..	0·46	..	0·29	..	0·15
	18—27	0·01	..	..	..	..	..	..
1915.								
May ..	1—10	·72	..		1·61	4·08	3·12	2·83
	11—20	2·26	..		1·46	2·14	1·31	3·12
	21—30	1·94	..		·37	·60	·35	·07
June ..	31—9	4·83	3·68		·63	1·04	·74	2·22
	10—19	2·28	4·77		3·98	3·23	5·20	7·98
	20—29	6·69	1·11		2·14	1·27	3·57	4·54
July ..	30—9	4·51	4·00		2·66	6·84	4·88	3·69
	10—19	1·30	1·92	No record.	·79	1·84	3·45	4·48
	20—29	6·58	2·06		1·01	5·44	1·59	1·92
August ..	30—8	·75	1·93		2·32	1·75	5·30	5·75
	9—18	2·91	2·10		2·16	3·81	2·07	1·03
	19—28	1·27	1·42		1·67	1·89	3·88	1·33
September ..	29—7	·28	..		2·10	·50	3·23	2·98
	8—17	1·39	..		1·32	1·94	1·62	2·61
	18—27	3·49	..		3·10	5·16	7·10	7·25
October ..	28—7	·79	..		1·07	·75	1·50	·10
	8—17	·85	..		·31	1·52	·57	..
	18—27	3·54	..		·52	1·12	2·14	..
1916.								
May ..	1—10	56	·14	..	·37	·19	1·30	1·78
	11—20	..	..	..	..	·10	..	..
	21—30	·32	·37	·75	·17	1·40	·95	4·31
June ..	31—9	5·94	4·35	3·85	3·34	4·45	5·79	8·60
	10—19	4·88	7·17	3·03	1·79	5·54	7·07	7·33
	20—29	6·02	5·46	4·40	2·26	4·86	3·26	4·28
July	30—9	·99	1·84	1·20	·60	1·46	·53	·89
	10—19	1·07	·89	1·55	1·45	·64	2·52	1·66
	20—29	1·76	1·73	·10	·71	3·29	6·01	2·74
August ..	30—8	4·25	·20	·17	1·05	1·29	1·47	·65
	9—18	5·24	2·65	4·97	1·63	4·96	4·30	5·78
	19—28	5·33	4·56	13·29	7·79	4·88	8·27	8·37
September ..	29—7	7·00	5·68	4·58	3·86	2·88	5·45	3·73
	8—17	6·53	3·89	·88	1·76	2·25	3·85	2·16
	18—27	6·72	6·54	7·00	6·33	7·12	9·06	7·65
October ..	28—7	7·02	2·27	7·14	2·50	6·60	..	..
	8—17	·19	·44	2·35	1·29	·30	..	..
	18—27	3·34	2·56	1·43	·79	1·19	..	..

Appendix 1.—Total Rainfall in inches in 10-day periods.

Months.	Date.	Burdwan.	Kalna.	Hooghly.	Seram-pore.	Aram-bagh.	Howrah.	Amta.
1917.								
May ..	1—10	3·44	1·84	No record.	1·38	2·66	2·61	4·18
	11—20	1·40	2·50		·31	2·10	3·67	3·20
	21—30	1·74	2·01		2·71	2·12	2·16	4·23
June ..	31—9	3·00	2·14		1·54	1·33	3·75	..
	10—19	8·28	5·31		4·85	5·26	4·73	..
	20—29	3·62	2·96		1·86	2·18	6·47	..
July ..	30—9	4·15	7·51		5·25	3·07	4·26	3·39
	10—19	2·70	2·29		1·77	1·47	1·25	2·14
	20—29	1·95	3·01		3·01	4·42	1·39	1·22
August ..	30—8	5·62	5·96		2·37	5·03	2·75	1·87
	9—18	1·78	4·64		5·12	3·53	6·74	5·84
	19—28	·60	2·53		2·48	1·10	2·19	1·72
September ..	29—7	1·24	1·66		·62	3·10	·70	1·39
	8—17	3·74	2·72		4·25	5·25	5·55	4·71
	18—27	1·45	1·87		2·03	4·05	1·52	2·31
October ..	28—7	5·31	6·65		4·06	8·81	6·39	9·93
	8—17	4·23	1·04		·39	·35	..	·60
	18—27	·44	..		·02	·21	·07	·75
1918.								
May ..	1—10	1·59	4·01	5·10	3·57	5·64	1·82	3·85
	11—20	·30	·28	·10	·82	·40	·09	·79
	21—30	2·16	·85	·90	1·43	·92	·40	1·04
June ..	31—9	5·48	5·46	6·79	3·88	6·29	8·23	5·03
	10—19	6·74	3·84	5·86	3·66	7·40	5·72	11·25
	20—29	9·16	3·08	3·30	2·27	3·87	3·88	5·50
July ..	30—9	1·72	1·00	4·87	3·38	3·02	3·43	5·36
	10—19	4·16	3·85	4·75	2·68	4·24	3·15	2·17
	20—29	4·63	1·60	1·35	1·55	3·63	·93	2·41
August ..	30—8	5·71	4·66	6·95	1·83	6·73	1·98	2·35
	9—18	6·00	2·41	2·60	1·96	5·05	3·61	5·24
	19—28	6·18	3·37	3·20	3·16	1·78	2·44	4·84
September ..	29—7	3·75	2·65	2·33	2·60	3·22	2·09	2·23
	8—17	3·99	2·34	4·17	3·03	2·23	5·21	1·17
	18—27	·01	5·75	3·55	1·59	·01	2·52	1·03
October ..	28—7	1·42	·55	·80	·57	·72	·83	·91
	8—17	·01	..	..	..	..	·21	..
	18—27	..	..	..	..	..	..	..
1919.								
May ..	1—10	2·73	6·74	4·63	1·92	1·58	4·43	5·23
	11—20	2·51	·25	·38	·81	1·46	·30	1·11
	21—30	1·12	..	..	..	·73	..	·34
June ..	31—9	2·97	4·87	5·55	5·83	3·98	4·97	7·65
	10—19	1·78	3·83	3·22	2·51	1·56	6·28	4·00
	20—29	2·50	1·20	·84	1·83	1·69	2·07	3·01
July ..	30—9	3·13	2·15	4·76	4·18	3·22	4·95	4·65
	10—19	4·96	5·57	3·76	4·14	5·11	5·47	3·55
	20—29	5·96	3·92	3·12	1·77	2·65	4·72	5·09
August ..	30—8	5·08	3·20	4·88	3·53	7·69	8·70	11·32
	9—18	5·31	2·31	3·49	1·69	4·38	3·31	6·74
	19—28	2·74	2·15	2·20	3·41	6·25	7·31	6·16
September ..	29—7	4·25	2·22	2·71	·96	4·12	1·61	3·68
	8—17	1·05	·40	1·77	1·04	2·55	1·80	3·95
	18—27	..	·22	·62	1·45	·53	·68	·58
October ..	28—7	1·52	3·20	·60	·16	·62	2·22	2·15
	8—17	1·07	1·25	·49	·43	·44	·40	..
	18—27	·30	..	·07	·04	·55	·03	·48
1920.								
May ..	1—10	·33	·55	..	..	..	..	..
	11—20	1·96	..	2·58	1·68	3·51	1·53	1·70
	21—30	1·06	·96	2·32	1·60	1·87	1·29	1·99
June ..	31—9	1·45	·30	·55	·38	·87	·69	2·18
	10—19	·55	2·49	1·00	·37	1·44		·09
	20—29	4·70	3·33	3·11	2·72	3·77	4·70	5·60
July ..	30—9	1·97	1·58	1·78	1·03	1·99	·73	1·17
	10—19	3·00	2·30	3·08	2·80	3·77	7·36	6·62
	20—29	2·25	4·92	3·12	2·41	10·11	3·19	8·74
August ..	30—8	4·70	3·85	6·56	4·96	5·63	12·98	11·17
	9—18	5·81	·61	2·33	·32	2·78	1·31	2·76
	19—28	1·55	3·09	7·98	3·02	5·87	3·70	6·67
September ..	29—7	2·30	1·90	·66	..	·23	·79	1·45
	8—17	4·86	·88	4·55	..	5·78	3·16	4·68
	18—27	..	1·03	·87	..	·96	1·31	..
October ..	28—7	·46	·22	1·47	·31	·12	1·18	·21
	8—17	3·24	3·29	3·53	3·66	4·50	7·37	9·46
	18—27	..	..	..	..	..	..	..

Appendix 1.—Total Rainfall in inches in ten day periods.

Months.	Date.	Burdwan.	Kalna.	Hooghly.	Serampore.	Arambagh.	Howrah.	Amta.
1921.								
May ..	1—10	·82	1·54	1·62	·93	·50	·36	·80
	11—20	·40	..	·03	..	..	..	·03
	21—30	1·30	·71	1·05	·72	·71	73	..
June ..	31—9	2·43	1·54	·87	·34	·99	1·37	2·85
	10—19	3·02	1·73	1·91	1·74	2·01	7·12	1·02
	20—29	4·53	5·54	4·08	3·72	3·90	5·64	2·22
July ..	30—9	·14	·68	·92	·12	·51	·86	·65
	10—19	2·78	3·91	2·90	1·91	3·22	1·81	6·76
	20—29	5·16	1·84	4·98	4·59	5·14	4·57	7·38
August ..	30—8	1·59	1·43	3·13	1·26	1·49	3·59	3·80
	9—18	4·89	1·79	8·02	6·26	11·40	3·18	7·79
	19—28	7·47	4·90	5·00	8·28	3·78	7·19	7·42
September ..	29—7	6·16	5·58	4·35	3·89	4·13	2·65	6·63
	8—17	1·18	5·80	1·64	·82	2·60	1·49	3·09
	18—27	3·51	1·72	6·93	2·54	·72	1·31	3·85
October ..	28—7	1·58	1·05	2·88	·06	1·04	·08	1·45
	8—17	·07	·45	..	..	·67	·86	·30
	18—27	·02	..	·17	..	..	..	..
1922.								
May ..	1—10	2·51	3·63	2·07	1·69	1·87	1·60	2·75
	11—20	·66	..	..	·05	·06	..	..
	21—30	3·35	·87	1·40	·83	·22	·65	·85
June ..	31—9	1·15	2·51	2·30	1·33	2·95	3·09	3·58
	10—19	6·74	5·23	7·97	4·04	9·02	5·48	10·27
	20—29	23·90	11·83	13·87	9·61	17·69	12·09	13·10
July ..	30—9	1·65	2·79	1·05	1·21	1·32	12·57	2·49
	10—19	1·83	1·20	1·34	·99	1·72	1·60	·80
	20—29	5·85	2·58	2·08	2·57	·79	6·45	7·18
August ..	30—8	6·28	1·66	16·12	7·70	16·17	2·08	21·10
	9—18	3·35	5·34	3·63	2·97	7·08	2·94	4·83
	19—28	5·30	2·46	·90	1·00	1·58	13·54	3·21
September ..	29—7	2·20	1·41	·54	1·61	1·46	2·38	·71
	8—17	1·29	1·24	1·43	1·36	1·11	2·69	3·59
	18—27	2·96	3·29	6·77	6·75	2·60	13·88	9·66
October ..	28—7	3·35	2·85	3·77	1·87	4·11	2·20	6·83
	8—17	..	·12	..	..	..	..	..
	18—27	·01	..	..	·03	·01	·06	..
1923.								
May ..	1—10	..	1·02	..	..	..	..	·60
	11—20	2·29	2·61	..	..	..	..	·97
	21—30	4·04	1·45	..	..	..	..	4·17
June ..	31—9	·91	1·10	..	..	..	..	1·47
	10—19	1·60	1·74	..	..	..	..	5·70
	20—29	3·70	·71	..	..	..	..	3·95
July ..	30—9	6·04	2·04	3·13	6·85	4·54	6·12	7·85
	10—19	3·89	3·11	2·52	1·74	·72	·84	3·35
	20—29	11·48	9·16	8·94	7·52	5·54	9·04	7·05
August ..	30—8	3·37	3·89	5·63	7·43	8·46	5·49	8·50
	9—18	·99	1·55	2·23	2·05	2·76	4·59	2·90
	19—28	4·57	3·91	11·65	4·01	2·58	4·25	4·45
September ..	29—7	4·42	3·56	4·37	2·16	2·05	4·07	3·20
	8—17	1·10	·48	·83	2·05	·59	1·34	3·67
	18—27	1·07	·57	..	·52	1·21	·86	·85
October ..	28—7	2·42	8·35	2·54	1·46	·87	·67	3·55
	8—17	1·73	2·39	·49	·43	1·28	3·30	·65
	18—27	·01	..	..	..	..	..	..
1924.								
May ..	1—10	1·10	3·98	4·45	2·05	1·62	·48	1·77
	11—20	·48	·24	1·93	·44	·85	·37	3·00
	21—30	..	·05	·38	·10	·11	..	..
June ..	31—9	..	..	..	..	..	..	..
	10—19	·96	..	2·99	·96	·19	·63	·17
	20—29	10·02	6·20	4·39	3·40	11·84	7·88	7·35
July ..	30—9	10·40	1·74	1·26	3·25	6·87	4·16	4·09
	10—19	3·07	3·28	3·32	3·44	5·80	7·63	5·20
	20—29	2·48	3·06	2·55	3·55	5·48	2·45	6·48
August ..	30—8	4·46	1·62	4·02	1·94	2·62	2·75	1·69
	9—18	3·60	4·18	2·88	1·18	2·10	·85	1·00
	19—28	1·56	2·01	2·57	1·66	4·68	8·56	11·97
September ..	29—7	6·36	2·97	5·74	7·03	8·22	2·07	2·17
	8—17	5·34	5·58	6·00	3·52	8·10	4·19	5·25
	18—27	·58	1·16	..	1·79	·44	1·70	·92
October ..	28—7	·11	·32	·37	·61	·44	·91	·20
	8—17	1·40	1·00	1·78	1·18	·31	1·15	4·10
	18—27	·04	..	·08	·11	·34	·55	1·75

Appendix I.—Total Rainfall in inches in 10-day periods.

Months.	Date.	Burdwan.	Kalna.	Hooghly.	Serampore.	Arambagh.	Howrah.	*Amta.
1925.								
May ..	1—10	·68	·88	·83	·75	·13	1·72	2·21
	11—20	1·85	1·84	3·37	1·11	2·62	1·67	2·30
	21—30	·86	·32	1·47	·83	1·16	1·91	·97
June ..	31—9	1·85	1·57	·36	·29	·66	1·65	·50
	10—19	2·69	1·03	2·29	2·76	1·90	1·00	2·75
	20—29	1·51	4·60	2·53	1·25	..	1·82	2·75
July ..	30—9	·69	1·08	·93	1·44	·35	2·95	·95
	10—19	2·09	4·17	3·47	3·72	5·07	5·57	3·85
	20—29	4·19	4·12	4·56	2·73	4·19	9·92	3·56
August ..	30—8	1·08	·84	·77	·40	·50	1·96	1·37
	9—18	2·73	1·93	·35	1·44	1·95	2·21	1·49
	19—28	·96	2·15	1·66	2·42	1·27	4·22	4·63
September ..	29—7	5·08	1·74	1·75	..	3·73	1·19	2·57
	8—17	4·52	3·54	4·71	..	1·99	2·88	2·13
	18—27	·95	·04	·15	..	1·97	·65	..
October ..	28—7	·31	·15	·36	·29	2·11	·28	2·00
	8—17	6·00	1·98	6·48	8·24	5·35	6·91	6·61
	18—27	..	·09	..	..	1·18	..	..
1926.								
May ..	1—10	·20	·67	1·65	·35	·09	..	..
	11—20	1·25	1·33	2·15	2·13	1·08	1·98	1·45
	21—30	1·89	1·31	1·40	·92	·58	1·78	·80
June ..	31—9	1·16	·94	2·06	1·51	1·77	1·48	·09
	10—19	2·74	2·00	3·92	3·41	1·05	2·89	1·22
	20—29	·36	·25	..	·30	·09	..	·28
July ..	30—9	9·10	2·19	7·16	4·02	14·66	5·11	17·66
	10—19	9·62	7·99	9·60	5·69	8·38	4·04	4·38
	20—29	5·11	7·21	7·04	9·83	11·31	15·97	14·32
August ..	30—8	5·41	4·40	3·56	1·92	1·08	4·28	5·69
	9—18	14·48	9·92	11·78	9·40	16·50	11·95	13·64
	19—28	1·35	·60	1·57	2·46	1·48	3·60	1·55
September ..	29—7	6·38	9·19	13·00	4·17	5·46	8·43	6·18
	8—17	1·15	2·51	2·92	·45	1·66	1·44	1·17
	18—27	1·72	..	·30	2·14	2·16	..	1·14
October ..	28—7	2·16	3·95	4·06	1·31	5·55	2·65	·30
	8—17	1·12	·10	·50	·45	1·02	·52	4·05
	18—27	·01	·10	·42	..	·10	·29	..
1927.								
May ..	1—10	2·36	1·78	No record	..	..	..	..
	11—20	·74	1·84		..	..	..	..
	21—30	1·29	3·63		..	..	..	..
June ..	31—9	1·90	2·16	2·33	4·79	3·14	5·35	3·85
	10—19	3·34	1·87	3·22	3·61	2·87	3·16	3·65
	20—29	3·81	1·57	1·52	2·26	3·35	2·33	·68
July ..	30—9	1·27	1·35	3·40	·97	1·36	2·56	4·23
	10—19	2·35	3·07	1·14	2·90	4·18	3·00	3·15
	20—29	6·56	2·60	6·85	2·87	2·75	1·68	4·14
August ..	30—8	2·45	4·02	·75	2·20	6·35	2·65	2·42
	9—18	3·70	1·75	3·16	3·06	2·35	2·73	3·19
	19—28	1·96	·69	2·01	·90	3·02	1·84	2·47
September ..	29—7	1·45	·55	1·91	3·75	4·36	·80	2·32
	8—17	4·44	1·32	1·10	1·99	·96	3·46	2·65
	18—27	2·51	·99	1·35	·83	·29	1·72	·42
October ..	28—7	2·91	3·53	3·62	2·57	5·90	2·52	5·50
	8—17	1·01	..	..	..	..	..	..
	18—27	..	·05	..	..	..	..	..
1928.								
May ..	1—10	2·35	1·86	2·28	2·76	1·74	4·51	2·95
	11—20	2·72	3·22	1·67	1·59	3·20	·77	·90
	21—30	·79	1·36	·31	..	·51	·01	·40
June ..	31—9	4·70	2·54	1·20	2·78	3·25	·64	·08
	10—19	20·24	13·70	11·46	10·79	8·68	14·49	9·55
	20—29	2·55	4·98	4·24	4·66	1·92	3·74	2·67
July ..	30—9	6·20	9·05	8·14	10·57	5·85	12·90	6·34
	10—19	7·11	5·04	5·82	6·93	4·35	6·35	5·70
	20—29	3·95	1·19	4·19	6·22	3·49	2·42	8·06
August ..	30—8	5·22	3·21	9·16	4·92	10·99	7·98	12·28
	9—18	4·87	4·77	7·05	4·71	4·11	1·15	5·55
	19—28	2·41	3·23	2·24	2·91	2·75	3·28	2·05
September ..	29—7	1·55	·95	1·19	2·78	2·37	3·54	2·42
	8—17	1·55	1·43	·52	·49	1·05	·68	·20
	18—27	·31	2·09	3·33	2·22	1·86	1·02	2·95
October ..	28—7	·01	·19	·78	1·54	1·27	1·88	·25
	8—17	3·54	·64	3·34	4·83	1·11	1·63	1·08
	18—27	·22	·55	·69	·24	1·66	1·36	·92

Appendix I.—Total Rainfall in inches in 10-day periods.

Months.	Date.	Burdwan.	Kalna.	Hooghly.	Serampore.	Arambagh.	Howrah.	Amta.
1929								
May ..	1—10	·47	·38	..	..	·31	·09	..
	11—20	·55	·67	·18	..	·66	1·21	·75
	21—30	·86	2·46	1·16	·28	1·53	·43	·45
June ..	31—9	5·98	2·35	3·09	2·52	5·18	2·79	9·25
	10—19	·18	·73	·28	·67	·66	2·18	1·95
	20—29	4·35	3·89	1·99	1·41	2·01	·68	5·22
July ..	30—9	1·44	4·50	2·29	1·20	4·12	2·62	5·95
	10—19	3·48	9·23	5·33	2·70	3·45	3·90	2·79
	20—29	11·56	3·65	6·40	7·43	6·49	5·83	9·16
August ..	30—8	6·17	1·57	1·04	2·04	2·02	2·54	2·94
	9—18	5·29	·61	2·48	3·75	2·22	4·89	7·80
	19—28	3·99	2·07	2·42	2·54	5·83	5·28	2·99
September ..	29—7	1·09	·15	2·64	1·14	1·55	3·41	·50
	8—17	2·22	..	1·50	·66	4·04	3·31	·93
	18—27	1·76	4·20	3·76	2·37	4·26	2·77	3·75
October ..	28—7	4·87	6·26	9·34	5·30	6·08	5·84	6·51
	8—17	·94	1·15	1·70	3·87	2·07	·15	3·60
	18—27	2·80	·25	2·56	2·60	4·04	4·46	3·83
1930.								
May ..	1—10	1·83	3·09	2·47	2·28	1·53	3·01	2·89
	11—20	2·09	·38	1·20	·75	·39	·11	·12
	21—30	·02	1·84	·17	·63	1·46	·32	·45
June	31—9	2·08	·42	2·83	2·54	·10	1·03	1·82
	10—19	·59	·09	·20	1·57	2·26	1·79	2·85
	20—29	5·52	1·66	4·33	5·23	2·51	3·66	8·13
July ..	30—9	11·98	3·62	9·77	10·17	9·34	10·53	14·02
	10—19	8·51	7·33	7·05	6·31	7·85	6·73	12·38
	20—29	5·46	4·13	5·07	4·09	3·78	2·10	2·28
August .	30—8	4·45	·78	1·62	2·22	2·65	1·43	2·43
	9—18	2·89	3·74	5·62	4·36	1·98	1·92	1·87
	19—28	5·18	2·40	1·63	2·47	5·55	3·31	2·09
September ..	29—7	5·30	2·25	3·32	4·99	3·12	2·84	1·85
	8—17	1·28	·12	1·63	1·09	2·57	2·24	3·00
	18—27	8·89	2·78	3·51	3·76	4·22	1·44	5·23
October ..	28—7	·38	4·47	..	..	·17	·26	..
	8—17	·72	·97	·67	·46	·08	1·80	..
	18—27	..	..	..	·12	..	..	..
1931.								
May ..	1—10	2·75	2·98	2·23	0·78	3·13	0·27	..
	11—20	0·49	0·09	1·78	1·26	0·97	2·70	1·15
	21—30	1·42	1·35	1·97	8·18	1·58	3·03	5·14
June ..	31—9	0·22	..	..	..	0·38	..	..
	10—19	3·66	2·18	3·47	4·54	4·06	4·04	4·12
	20—29	2·20	2·21	1·98	1·70	2·61	3·46	3·05
July ..	30—9	4·13	7·09	5·59	9·08	3·07	8·35	4·42
	10—19	1·33	2·34	1·75	3·26	3·53	5·14	3·87
	20—29	4·75	3·01	6·75	3·66	1·92	2·25	2·65
August ..	30—8	1·98	2·65	2·00	2·14	1·51	1·90	2·65
	9—18	9·21	4·36	5·75	4·99	5·19	2·04	3·25
	19—28	5·76	2·84	6·49	5·08	5·10	3·89	1·77
September ..	29—7	2·19	1·09	4·15	2·45	2·34	6·79	3·45
	8—17	4·37	2·22	3·69	3·64	1·35	2·45	2·05
	18—27	4·58	1·05	2·32	4·31	2·49	2·33	1·95
October ..	28—7	1·99	2·91	1·20	1·63	2·69	3·78	1·27
	8—17	3·57	2·17	2·29	3·76	2·97	2·46	1·78
	18—27	0·20	1·95	1·35	1·49	3·85	6·02	2·35
1932.								
May ..	1—10	1·27	1·96	2·78	2·21	1·59	2·43	1·87
	11—20	..	..	..	..	..	..	..
	21—30	7·35	6·04	7·15	8·75	4·18	9·03	12·60
June ..	31—9	2·12	1·40	0·70	2·19	2·49	1·65	4·08
	10—19	2·52	4·12	8·00	5·53	2·13	2·01	1·90
	20—29	5·69	3·27	2·80	2·39	3·37	3·49	1·77
July ..	30—9	0·36	2·57	2·28	3·31	0·77	0·60	1·10
	10—19	3·39	1·31	2·25	6·56	2·55	1·63	3·80
	20—29	1·91	2·85	2·03	4·24	1·68	5·18	3·90
August ..	30—8	11·40	5·24	6·35	5·16	8·78	3·57	3·30
	9—18	4·61	5·47	4·75	6·92	3·52	3·72	No
	19—28	2·55	1·60	6·70	4·96	1·23	4·71	record.
September ..	29—7	0·69	1·72	2·60	1·68	1·29	2·82	3·50
	8—17	2·84	1·33	2·80	0·60	2·50	1·22	1·20
	18—27	3·13	4·94	0·60	4·16	3·69	2·93	3·10
October ..	28—7	..	0·04	0·55	0·55	0·10	0·91	..
	8—17	0·04	..	0·15	0·47	..	1·86	..
	18—27	2·55	0·66	1·45	1·44	3·09	2·52	1·60

Appendix I.—Total Rainfall in inches in 10-day periods.

Month.	Date.	Burdwan.	Kalna.	Hooghly.	Serampore.	Arambagh.	Howrah.	Amta.
1933.								
May ..	1—10	5·87	2·08	2·61	3·51	4·03	3·78	6·05
	11—20	3·19	1·31	1·05	1·53	4·39	2·12	4·15
	21—30	1·29	1·84	1·00	2·03	0·55	1·46	1·91
June ..	31—9	2·50	2·95	4·76	2·66	2·82	3·66	5·40
	10—19	1·51	1·85	2·88	3·30	2·70	3·05	1·95
	20—29	5·29	5·31	12·38	14·71	10·50	13·86	10·40
July ..	30—9	4·07	2·87	4·70	5·70	3·32	3·36	5·70
	10—19	1·78	1·94	6·40	5·93	3·37	8·67	4·77
	20—29	4·25	1·82	2·79	1·05	4·33	3·01	2·50
August ..	30—8	7·25	2·84	4·12	2·46	4·45	2·71	3·32
	9—18	4·88	2·42	3·41	6·16	4·86	4·41	9·30
	19—28	8·64	4·65	10·45	3·90	5·18	5·41	6·20
September ..	29—7	6·53	5·01	1·72	2·98	1·10	0·78	0·80
	8—17	1·10	0·82	0·44	0·89	1·70	2·71	1·50
	18—27	5·34	8·76	7·36	5·74	5·87	14·56	7·13
October ..	28—7	0·15	..	3·30	1·14	0·03	1·07	0·50
	8—17	1·04	2·19	3·41	6·23	1·31	9·23	4·85
	18—27	1·37	2·05	1·85	1·40	3·18	0·80	1·30
1934.								
May ..	1—10	1·39	1·15	4·59	1·03	1·83	1·90	1·67
	11—20	0·02	..	..	0·38	0·70	1·20	0·80
	21—30	1·71	1·11	0·50	1·33	0·82	1·16	0·80
June ..	31—9	0·80	1·33	1·01	0·53	0·70	0·76	0·80
	10—19	6·15	1·84	4·30	2·92	1·74	1·68	5·65
	20—29	5·56	4·43	4·38	2·79	3·95	6·24	2·70
July ..	30—9	1·48	3·10	1·80	2·51	3·73	4·14	3·65
	10—19	4·00	2·93	2·38	2·32	3·47	4·06	5·10
	20—29	1·51	1·36	1·05	0·37	1·69	0·74	..
August ..	30—8	0·90	1·65	2·17	3·36	0·73	4·93	3·55
	9—18	1·29	1·63	0·98	1·74	2·66	1·65	1·70
	19—28	5·19	2·19	2·66	2·95	3·70	3·09	5·80
September ..	29—7	3·20	1·45	·335	1·39	1·65	4·81	1·34
	8—17	3·70	3·01	2·17	2·26	0·49	3·28	2·28
	18—27	3·78	1·46	2·63	4·36	1·81	4·92	9·35
October ..	28—7	0·03	1·50	2·97	2·68	1·47	1·73	2·30
	8—17	1·27	1·00	2·77	1·75	1·25	3·41	4·55
	18—27	0·56	0·29	0·27	..	0·01	0·12	..
1935.								
May ..	1—10	..	..	..	..	..	..	..
	11—20	1·72	0·17	0·56	0·28	1·73	0·16	1·40
	21—30	0·66	1·37	..	..	0·78	..	0·13
June ..	31—9	0·01	..	..	0·01	..	..	0·05
	10—19	1·89	1·81	3·06	2·65	3·07	2·97	9·05
	20—29	4·43	4·24	1·11	1·28	3·41	0·55	3·13
July ..	30—9	1·88	6·00	6·10	3·34	6·57	3·90	5·60
	10—19	2·91	0·66	0·76	0·62	1·67	2·70	0·73
	20—29	1·87	2·31	2·75	1·58	1·67	2·95	2·73
August ..	30—8	2·75	1·68	1·73	1·02	1·48	2·38	2·35
	9—18	3·73	7·81	5·17	3·54	3·47	6·11	5·64
	19—28	3·04	4·64	1·83	1·94	4·26	2·71	2·35
September ..	29—7	1·69	2·01	2·54	2·71	1·59	5·44	3·85
	8—17	4·24	1·72	3·92	1·03	2·34	2·89	1·75
	18—27	1·47	0·38	0·32	0·47	1·63	0·88	0·85
October ..	28—7	..	..	..	..	..	..	..
	8—17	..	..	..	..	..	..	..
	18—27	..	..	..	0·53	..	1·08	..

Appendix 2.—Agricultural Officers who helped in preparing the note on the Water Requirement for Rice.

(1) K. C. Banerjee—Rice Research Officer, Bankura.
(2) S. B. Bose—District Agricultural Officer, Burdwan.
(3) S. C. Chakravarti—Rice Research Officer, Chinsurah.
(4) K. P. Roy—Assistant Economic Botanist, Bengal.
(5) S. P. Sen Gupta—Superintendent, Chinsurah Farm.

Appendix 3.—Note on the Water Requirement for a Full Crop of Rice in West Bengal.

1. Heavy showers of from two to three inches are required during the last fortnight of June for the cultivation of land preparatory to the puddling operations. This should not be distributed over a number of days but must all take place in the course of 2 or 3 days.

2. The normal transplantation period can be taken as extending from the middle of July to middle of August—a period of 15 days from the 24th July to 7th August being the most favourable for this purpose.

In order to have the optimum water-supply for facilitating transplanting operations during this period, there should be a total precipitation of about eleven inches. Any heavy rainfall immediately previous to this period should also be taken into consideration in reckoning the total water requirement for this period. The precipitation should not occur in small quantities over a large number of days but should be in heavy showers of about two to three inches at intervals of 5 or 6 days.

3. Heavy rainfall immediately after transplantation affects the seedlings adversely by interfering with the proper setting up of the plants and the tillering. Occasional showers at intervals till the end of September supplying from ten to twelve inches in all have a beneficial effect on the growth and development of the rice crop. The showers during the second fortnight of September should be very heavy, say four or five inches within a few days so that there may be some accumulation of water in the fields lasting for a number of days.

4. During the second and third week of October—(*thormukh* stage) there should be about four inches of rainfall—1 to 1½" to facilitate flowering.

5. Generally, no depreciation should be given for slight deficiency or delay in the total precipitation in the June. In very bad or abnormal years slight depreciation may be necessary.

6. If the rainfall within the normal transplanting period (16th July to 15th August) is favourable, and transplanting can be begun even a week later but finished by the middle of August no depreciation should be made. If the rainfall is deficient, or the heavy showers mentioned in paragraph 2 are wanting, depreciation should be given. Amount of depreciation is difficult to formulate, but may be estimated in the following way.

A deficiency of the order of two inches of rainfall during the transplanting period, provided heavy showers are otherwise satisfactory, should not usually require any depreciation. With a deficiency of about four inches of rainfall during the transplanting period (July 16—August 15), provided the occasional heavy showers are available, it would be still possible to have about 75 per cent. of the total area transplanted. A deficiency of six inches of rainfall would enable only 50 per cent. of the total area being transplanted. The first thing necessary would be to estimate on the above basis the proportion of the area transplanted by the middle of August. The crop percentage may then be calculated as follows. From the middle to the end of August depreciation should be given at the rate of 10 per cent. for a delay of five days on the area which is transplanted late.

Suppose the area transplanted is 75 per cent. for which we expect a 100 per cent. crop, the remaining 25 per cent. of area should be given a depreciation for late transplanting. If the rainfall is such that this area can be transplanted within the next five days, a depreciation of 5 per cent. will be given on 25 per cent. (the late portion), and the crop estimate will be $75+23\cdot75=98\cdot75$. If transplantation of the 25 per cent. area be delayed by 10 days, the depreciation on this portion will be 10 per cent. and the crop estimate will be $75+22\cdot50=97\cdot50$, and so on till the end of August. If by the end of August any area remains untransplanted it should be eliminated from the estimate. If however a vast area remains untransplanted at the end of August, and if rainfall at the beginning of September is very favourable for transplanting, the calculations for the area transplanted and the percentage estimate of crop may be carried on up to the middle of September, the rate of depreciation being now made at the increased rate of 20 per cent. (instead of 10 per cent.) for every five days' delay. In this extreme case the crop on the area transplanted during the normal time might have suffered and proper depreciation should be made on that crop also.

7. Bad distribution or insufficient rain during the period from September 1—30 should be given progressive depreciation, the rate depending on the interval between the dates of rainfall.

8. The October rain and its distribution is very important. The total rain in the last fortnight of September and the heaviness of the showers should, however, be taken into account. Total absence of rain in October should be given 1 per cent. depreciation daily, that is, 30 per cent. depreciation for the whole month. If however, the rain in the later part of September is very deficient, the rate of depreciation would be greater.

In this connection it is necessary to remember that every two inches of rain during the last week of September would carry the crop without depreciation for ten days. Roughly two inches of rain every 10 days in October should have no depreciation but early November rain should count if October rain fails. For example, a heavy shower, say four or five inches at the end of September, no rain in October and a shower of two inches early in November should have very little depreciation.

9. Heavy showers over two inches in a day at the end of July and in the beginning of August will delay transplantation. Starting with 5 per cent. depreciation (i.e., 95 per cent. crop), 1 per cent. daily depreciation on area untransplanted should be carried up to the end of August.

10. Any heavy rain above two inches within 15 days from transplanting will have depreciation at the rate of 5 per cent. for every two inches excess of rain. Again any heavy shower over three inches on a crop aged between 15 and 30 days will have a depreciation at the rate of 2 per cent. for every additional two inches of rain.

APPENDIX 3(a).

Rainfall Calendar of Crop-Estimation.

(This covers every form of deficiency in rainfall which actually occurred during the 35 years, 1901-35).

5-day periods.	Rainfall.	Depreciation to be allowed.
June ..	Total rainfall for June at least 6″ of which 2″ to 3″ should fall in the last fortnight in 2 or 3 days.	Slight rainfall discrepancy requires no depreciation.
July 5 ,, 10	3″ to 4″ preparatory to puddling operations.	
,, 15 ,, 20 ,, 25 ,, 30 August 4 ,, 9 ,, 14	1″ rainfall for complete transplantation, but any heavy precipitation immediately before the period should be taken into consideration. Falls of 1½″ to 2″ at intervals of 5 or 7 days are most suitable.	If there is a 2″ deficiency no depreciation will be allowed, ; if the deficiency is 4″ ; 25 per cent. depreciation should be allowed ; if there is 6″ deficiency 50 per cent. depreciation should be allowed.
,, 19 ,, 24	Heavy showers just after transplanting are harmful.	Calculate the area transplanted by August 15 and allow 1 per cent. depreciation on the untransplanted area for each day's delay in transplanting till the end of August and 4 per cent., till the middle of September.
,, 29 September 3 ,, 8 ,, 13	Occasional showers amounting to 8″ to 9″ in all are required for setting up of plants and tillering.	
,, 18 ,, 23 ,, 28 October 3	One heavy shower of 2″ within a few days and a total of 4″ during the whole period.	If there is good rain in September and no rain during the period, allow 1 per cent. depreciation for each day in October till the 20th and 1 per cent. per day from the 21st October till the end of the month.
,, 8 ,, 13 ,, 18 ,, 23	4″ rainfall, with 1″ to 1½″ on one occasion, for flowering.	
,, 28 November 3 ,, 8	2″ rain spread over 5 days.	

Appendix 4.—Estimates of yield of Rice (in percentage of "full" crop).

Year.	Burdwan district.		Hooghly district.			Howrah district.	
	Burdwan.	Kalna.	Hooghly.	Serampore.	Arambagh.	Howrah	Amta.
1901	76	48	69	74	91	78	94
1902	80	72	87	78	85	68	74
1903	90	95	87	90	92	94	97
1904	51	73	73	78	59	62	66
1905	62	75	20	1	90	*	89
1906	87	77	70	93	91	95	*
1907	67	76	62	85	71	81	70
1908	67	92	52	77	67	71	56
1909	78	97	85	93	80	88	94
1910	58	97	88	95	91	93	95
1911	79	85	78	74	81	53	62
1912	90	*	75	91	85	88	62
1913	96	*	87	89	97	87	91
1914	77	*	77	51	62	46	*
1915	85	*	*	25	95	95	90
1916	92	68	78	53	94	79	87
1917	82	95	*	94	92	91	82
1918	72	83	74	48	64	66	66
1919	72	85	77	56	75	62	60
1920	95	76	92	58	93	85	86
1921	82	75	75	51	70	57	74
1922	88	79	70	76	83	88	86
1923	87	86	75	65	65	86	85
1924	88	81	87	70	88	81	97
1925	97	59	68	56	90	78	97
1926	84	64	85	68	85	65	74
1927	87	43	69	49	93	43	85
1928	77	76	92	93	90	81	69
1929	87	79	91	94	96	98	94
1930	87	79	77	69	75	73	77
1931	98	92	97	97	94	98	96
1932	80	79	85	76	76	90	*
1933	88	92	95	97	93	96	98
1934	85	48	75	61	72	97	90
1935	42	36	27	19	50	62	52

*Rainfall records missing.

Appendix 5.—Analysis of Variance of crop estimates.

The following tables give the analysis of variance of estimates of the expected crops for seven regions made independently by agricultural officers.

Variation due to.	Degrees of Freedom.	Variance.	Ratio of Variance. Observed.	Ratio of Variance. One per cent.
Burdwan				
Estimator	4	67	8·37	3·46
Season (year)	34	764	95·50	1·96
Residual Error . ..	136	8	..	..
Kalna—				
Estimator	4	50	0·66	3·48
Season (year)	30	1,326	17·45	2·03
Residual Error	120	76	..	..
Hooghly—				
Estimator	4	210	1·69	3·47
Season (year)	32	1,436	11·58	1·98
Residual Error	128	124	..	..

Variation due to.	Degrees of Freedom.	Variance.	Ratio of Variance.	
			Observed.	One per cent.
Serampore—				
Estimator	3	1,929	9·06	3·97
Season (year)	34	2,029	9·52	2·02
Residual Error	102	213	..	..
Arambagh—				
Estimator	4	453	13·32	3·46
Season (year)	34	775	22·79	1·96
Residual Error	136	34	..	..
Howrah—				
Estimator	2	245	2·66	4·93
Season (year)	34	1,064	11·56	1·81
Residual Error	68	92	..	..
Amta—				
Estimator	4	72	9·00	3·47
Season (year)	32	1,593	199·12	1·99
Residual Error	128	8	..	..

It will be noticed that the observed ratios of variance are invariably greater than the expected one per cent. ratio.

Appendix 6.—Estimate of Rainfall Deficiency and Excess in Inches.

N. B.—Deficiency of rainfall given in ordinary and excess of rainfall required to be drained away given in thick type.

Stations.	July.			August.			September.			October.		
1901.												
Burdwan ..	..	..	..	1·0	..	..	..	..	..	..	..	..
Kalna ..	..	1·5	2·0	1·0	**2·0**	..	..	..	..	..	1·5	..
Hooghly ..	..	..	2·0	..	..	**1·0**	..	**10·0**	..	..	2·0	..
Serampore ..	..	..	..	..	..	**2·0**	..	**8·0**	..	1·0	2·0	1·0
Arambagh ..	..	..	..	**2·0**	..	..	**3·0**	..	..	..	..	..
Howrah ..	..	..	..	..	**1·0**	**2·0**	..	**6·0**	..	..	2·0	..
Amta ..	..	..	..	1·5	..	..	**2·0**	..	..	..	..	1·5
1902.												
Burdwan ..	..	..	..	..	..	..	..	..	..	..	2·0	..
Kalna ..	..	..	..	..	..	..	..	..	..	..	2·0	..
Hooghly ..	..	..	..	..	..	..	..	..	..	1·0	2·0	..
Serampore ..	..	..	..	..	..	..	..	..	..	1·0	1·0	1·0
Arambagh ..	..	..	..	..	..	..	..	..	..	..	2·0	..
Howrah ..	..	..	..	..	..	..	..	..	..	..	..	..
Amta ..	..	..	..	..	..	..	..	..	1·0	2·0	2·0	1·0
1903.												
Burdwan ..	..	..	1·0	**3·0**	..	..	..	..	..	..	..	..
Kalna ..	..	..	..	..	**3·0**	..	1·0	..	..	..	..	..
Hooghly ..	..	..	1·5	**1·0**	1·0	..	1·0	..	..	..	..	..
Serampore ..	..	2·0	2·0	**2·0**	..	..	..	**3·0**	..	..	..	..
Arambagh ..	..	..	2·0	..	..	..	..	..	..	..	..	..
Howrah ..	..	..	..	..	..	..	..	**4·0**	..	..	..	..
Amta ..	..	..	..	..	..	..	1·5	..	..	..	..	..

Estimate of Rainfall Deficiency and Excess in Inches.

Stations.	July.			August.			September.			October.		
1904.												
Burdwan ..	..	..	..	..	..	..	..	2·0	..	2·0	2·0	..
Kalna ..	..	..	3·0	..	..	..	..	..	..	1·5	2·0	..
Hooghly ..	..	..	1·0	..	..	2·0	..	..	2·0	1·5	2·0	..
Serampore ..	..	..	1·0	..	..	..	..	..	..	2·0	2·0	..
Arambagh ..	..	..	..	1·0	..	1·0	..	2·0	1·5	1·0	2·0	..
Howrah ..	4·0	..	1·5	..	..	..	..	..	1·5	2·0	..	..
Amta ..	..	2·0	..	..	..	..	..	..	..	2·0	2·0	..
1905.												
Burdwan ..	..	..	14·0	..	..	..	3·0	..	3·0	..	2·0	..
Kalna ..	..	..	..	..	..	..	..	..	..	1·0	2·0	1·0
Hooghly ..	..	..	10·0	2·0	..	2·0	..	2·0	2·0	3·0	2·0	..
Serampore ..	..	..	10·0	..	..	..	4·0	..	..	..	..	..
Arambagh ..	..	..	8·0	..	..	..	..	..	..	..	..	..
Howrah ..	..	..	11·0	..	..	..	..	..	..		..	..
Amta ..	..	..	12·0	..	..	..	2·0	..	..	..	..	..
1906.												
Burdwan ..	..	..	2·0	3·0	2·0	..	1·0	2·0	..	..	..	..
Kalna ..	..	..	..	..	..	1·5	..	..	..	..	2·0	1·0
Hooghly ..	..	2·0	1·0	..	..	..	..	..	..	2·0	1·0	..
Serampore ..	..	2·0	..	..	..	..	..	..	..	..	1·0	1·0
Arambagh ..	2·0	..	..	..	..	..	..	..	..	..	..	..
Howrah ..	2·0	..	..	1·0	..	..	..	..	..	1·0	..	..
Amta ..	Rainfall data wanting.											
1907.												
Burdwan ..	..	..	..	..	..	..	..	..	2·0	2·0	2·0	1·0
Kalna ..	..	..	..	2·0	..	..	..	..	..	..	2·0	1·0
Hooghly ..	..	..	1·5	..	..	..	..	..	..	..	2·0	2·0
Serampore ..	..	..	..	..	..	..	..	..	..	..	2·0	..
Arambagh ..	..	..	..	1·0	..	..	3·0	..	1·0	..	3·0	..
Howrah ..	..	1·0	..	..	..	..	..	..	..	2·0	..	..
Amta ..	..	..	..	..	..	..	..	..	2·0	2·0	1·5	1·5
1908.												
Burdwan ..	..	..	..	..	..	1·0	..	..	..	2·0	2·0	..
Kalna ..	..	..	..	..	..	..	..	..	..	..	1·0	..
Hooghly ..	..	..	..	1·5	..	..	..	..	..	..	2·0	2·0
Serampore ..	..	..	..	..	..	..	..	..	..	1·0	2·0	1·0
Arambagh ..	..	..	..	..	..	..	..	..	..	2·0	2·0	..
Howrah ..	..	..	..	..	..	..	..	..	..	..	2·0	..
Amta ..	..	..	..	..	..	5·0	..	2·0	2·0	1·5	2·0	1·5
1909.												
Burdwan ..	..	..	2·0	..	2·0	15·0	..	..	..	..	..	1·0
Kalna ..	..	..	..	..	..	..	..	..	..	..	..	..
Hooghly ..	..	2·5	..	..	..	..	..	..	..	1·0	..	..
Serampore ..	..	1·0	..	..	..	5·0	..	..	..	..	..	..
Arambagh ..	..	..	..	..	..	5·0	..	..	..	..	..	..
Howrah ..	..	..	..	1·0	..	..	..	..	..	1·0	..	..
Amta ..	..	..	..	..	..	..	..	..	..	..	..	..
1910.												
Burdwan ..	..	..	..	1·0	..	..	..	..	2·0	2·0	2·0	1·0
Kalna ..	..	..	..	..	..	..	2·0	..	..	..	..	..
Hooghly ..	..	1·5	..	..	1·0	..	..	..	0·5	..	..	..
Serampore ..	..	..	..	..	..	3·0	2·0	..	..	..	..	..
Arambagh ..	..	..	..	..	..	..	..	..	2·0	..	..	..
Howrah ..	..	..	..	..	..	..	..	..	..	..	..	..
Amta ..	..	2·0	..	..	2·0	..	..	..	..	..	..	..
1911.												
Burdwan ..	..	2·0	2·0	..	..	..	..	..	..	..	..	2·0
Kalna ..	..	..	..	1·0	..	..	..	..	..	..	..	..
Hooghly ..	..	..	..	1·0	..	..	..	..	1·5	..	2·0	..
Serampore ..	..	..	2·0	2·0	..	..	..	2·0	..	1·0	..	1·0
Arambagh ..	..	2·0	..	1·0	..	..	..	..	..	..	..	..
Howrah ..	..	2·0	2·0	2·0	..	..	..	..	1·0	1·0	..	1·0
Amta ..	..	..	2·0	3·0	1·0	1·5	..	..	2·0	..	..	..

Estimate of Rainfall Deficiency and Excess in Inches.

Stations.	July.			August.			September.			October.		
1912.												
Burdwan ..	..	..	..	1·0	..	..	..	..	..	..	..	2·0
Kalna ..	Rainfall data wanting.											
Hooghly ..	..	..	..	..	..	1·0	..	2·0	..	..	..	..
Serampore ..	..	1·0	..	2·0	..	..	..	..	1·0	..	..	..
Arambagh ..	..	..	1·0	..	..	..	..	..	..	..	..	..
Howrah ..	..	..	..	..	..	..	1·0	1·0	..	..	..	..
Amta ..	..	..	..	..	..	..	..	..	..	2·0	2·0	..
1913.												
Burdwan ..	..	..	..	2·0	..	..	..	..	..	..	..	..
Kalna ..	Rainfall data wanting.											
Hooghly ..	..	..	..	2·0	..	..	2·0	..	..	1·0	..	..
Serampore ..	..	..	..	..	..	..	1·0	..	..	..	..	..
Arambagh ..	..	..	..	..	..	..	..	..	..	..	..	..
Howrah ..	..	..	..	..	..	..	..	..	2·0	..	..	..
Amta ..	..	..	4·0	..	2·0	..	2·0	..	..	2·0	..	..
1914.												
Burdwan ..	..	3·0	..	..	..	2·0	..	1·0	..	2·0	1·0	..
Kalna ..	Rainfall data wanting.											
Hooghly ..	..	..	..	1·0	..	..	..	1·0	..	..	1·5	1·0
Serampore ..	..	..	..	..	1·0	..	..	2·0	..	2·	1·0	2·0
Arambagh ..	..	..	..	..	..	..	..	..	..	2·0	2·0	..
Howrah ..	..	..	..	..	..	..	..	..	2·0	2·0	2·0	..
Amta ..	..	..	..	..	..	..	..	2·0	3·0	2·0	3·0	1·0
1915.												
Burdwan ..	..	..	3·0	2·0	..	..	2·0	..	1·0	..	2·0	..
Kalna ..	Rainfall data wanting.											
Hooghly ..	..	..	..	..	..	..	..	..	..	..	..	..
Serampore ..	..	2·0	2·0	..	..	..	1·0	..	..	1·0	1·0	..
Arambagh ..	..	..	..	..	..	..	..	..	..	..	..	..
Howrah ..	..	..	..	..	..	..	..	..	..	..	..	..
Amta ..	..	..	1·0	..	1·0	..	..	..	..	..	2·0	..
1916.												
Burdwan ..	..	..	2·0	..	..	4·0	1·0	2·0	..	..	..	..
Kalna ..	..	1·0	1·5	1·5	..	..	2·0	1·0	..	..	..	..
Hooghly ..	..	2·0	2·0	1·5	..	5·0	..	..	2·5	1·5	..	..
Serampore ..	..	3·0	..	2·0	..	3·0	..	..	..	..	..	..
Arambagh ..	..	3·0	..	..	..	..	..	..	..	..	..	..
Howrah ..	..	2·0	3·0	..	..	3·0	..	..	4·0	1·0	2·0	1·0
Amta ..	..	2·0	..	..	..	4·5	..	..	..	..	1·0	..
1917.												
Burdwan ..	..	..	2·0	..	1·0	2·0	1·0	..	..	..	..	4·0
Kalna ..	..	..	..	..	..	..	..	..	1·0	..	..	..
Hooghly ..	..	..	..	..	..	..	..	..	..	..	..	..
Serampore ..	..	1·0	..	..	..	..	1·0	..	..	..	..	..
Arambagh ..	..	..	..	..	..	..	..	..	..	..	..	4·0
Howrah ..	..	2·0	2·0	1·0	2·0	..	1·0	..	..	..	..	3·0
Amta ..	..	1·0	2·0	..	..	..	.	..	..	..	..	3·0
1918.												
Burdwan ..	2·0	..	2·0	..	..	..	..	..	..	2·0	..	2·0
Kalna ..	..	..	1·0	..	..	..	..	..	..	..	..	..
Hooghly ..	..	..	..	2·0	..	..	..	..	.	..	1·0	..
Serampore ..	..	2·0	..	1·0	..	..	..	..	..	2·0	2·0	..
Arambagh ..	..	..	..	..	..	..	..	..	..	·0	2·0	..
Howrah ..	..	..	1·0	..	..	..	..	..	..	..	2·0	..
Amta ..	..	..	..	..	..	..	..	..	..	2·0	2·5	..
1919.												
Burdwan ..	..	..	2·0	..	3·0	..	..	..	2·0	1·0	..	1·5
Kalna ..	..	..	..	..	..	..	..	1·0	..	..	2·0	..
Hooghly ..	..	..	..	..	0·5	..	..	1·5	..	2·0	1·5	..
Serampore ..	..	..	..	..	..	..	..	1·0	..	1·0	2·0	2·0
Arambagh ..	..	..	..	..	2·0	2·0	..	..	2·0	1·0	2·0	..
Howrah ..	..	..	..	7·0	..	..	..	1·0	..	2·0	2·0	1·0
Amta ..	..	..	2·0	4·0	4·0	..	..	..	..	..	2·0	1·0

Estimate of Rainfall Deficiency and Excess in Inches.

Stations.	July.			August.			September.			October.		
1920.												
Burdwan ..	..	..	1·0	..	1·0	..	..	..	..	1·0	..	..
Kalna ..	..	..	..	..	..	..	..	1·0	1·0	1·5	0·5	..
Hooghly ..	..	..	..	2·0	4·0	..	1·0	..	1·0	..	..	..
Serampore ..	..	..	..	..	1·0	..	2·0	2·0	2·0	..	..	..
Arambagh ..	..	..	..	..	..	..	..	..	..	1·5	..	..
Howrah ..	..	..	..	6·0	..	..	..	..	1·0	3·0	..	1·0
Amta ..	..	6·0	..	6·0	2·0	..	..	..	1·5	..	4·0	..
1921.												
Burdwan ..	..	..	..	..	..	5·0	..	..	..	..	2·0	..
Kalna ..	..	2·0	..	..	..	3·0	..	..	..	0·5	2·0	..
Hooghly ..	..	1·0	..	..	3·0	3·0	..	1·0	..	..	2·0	..
Serampore ..	..	..	..	1·0	2·0	4·5	..	..	..	1·0	2·0	1·0
Arambagh ..	..	6·0	..	..	..	..	..	..	..	1·5	1·5	1·0
Howrah ..	..	..	..	..	..	2·0	..	..	1·0	2·0	1·5	..
Amta ..	..	..	3·0	..	4·0	5·0	..	..	..	..	3·0	1·0
1922.												
Burdwan ..	..	..	2·0	1·0	3·0	..	..	..	..	..	..	1·0
Kalna ..	..	..	..	..	..	..	..	..	..	..	1·5	..
Hooghly ..	..	1·5	2·0	5·0	..	..	1·5	..	..	..	1·5	..
Serampore ..	..	2·0	1·0	4·0	..	..	1·0	..	..	..	2·0	..
Arambagh ..	..	..	2·0	10·0	..	..	..	..	1·0	..	..	..
Howrah ..	4·0	..	2·0	..	..	..	..	..	6·0	..	2·0	..
Amta ..	..	..	2·0	1·5	..	..	..	..	..	..	..	..
1923.												
Burdwan ..	..	..	8·0	..	..	..	..	..	2·0	..	..	..
Kalna ..	..	..	..	..	..	..	..	1·0	2·0	..	..	..
Hooghly ..	..	..	3·5	..	..	5·0	..	1·5	1·5	..	..	1·0
Serampore ..	2·0	..	..	..	..	..	..	2·0	2·0	..	3·0	..
Arambagh ..	..	..	..	..	..	..	..	..	2·0	..	..	..
Howrah ..	..	..	2·0	..	..	..	..	..	2·0	..	..	1·0
Amta ..	..	..	..	4·0	..	1·5	..	..	..	..	..	1·0
1924.												
Burdwan ..	..	..	..	..	..	..	2·0	..	..	..	1·0	1·0
Kalna ..	..	..	..	..	..	..	..	..	..	2·0	1·0	..
Hooghly ..	..	2·0	..	1·5	..	..	..	..	1·5	1·0	..	..
Serampore ..	..	..	..	2·0	..	..	..	..	1·0	1·5	2·0	1·0
Arambagh ..	..	..	..	..	..	..	..	..	..	..	..	1·0
Howrah ..	..	..	..	..	..	2·0	..	..	..	1·0	1·0	1·0
Amta ..	..	..	..	..	..	1·5	2·0	..	..	..	..	..
1925.												
Burdwan ..	..	..	..	1·0	..	..	..	..	..	..	..	..
Kalna ..	..	..	..	2·0	..	..	..	..	2·0	1·0	1·0	..
Hooghly ..	..	1·0	..	2·5	..	..	1·0	..	..	1·5	..	..
Serampore ..	..	..	2·0	2·0	1·0	..	1·0	..	2·0	..	3·0	..
Arambagh ..	..	1·0	..	2·0	..	..	..	..	1·0	..	..	..
Howrah ..	..	2·0	2·0	..	..	..	..	..	2·0	1·0	2·0	..
Amta ..	..	..	..	..	..	2·0	..	..	..	..	..	..
1926.												
Burdwan ..	..	..	2·0	..	10·0	..	2·0	..	1·0	..	1·0	..
Kalna ..	..	..	2·0	..	4·0	..	..	..	1·0	..	..	..
Hooghly ..	2·0	3·0	2·0	..	7·0	2·5	4·0	1·0	1·0	..	..	1·0
Serampore ..	..	..	3·0	..	4·0	..	..	..	1·0	..	2·5	..
Arambagh ..	6·0	6·0	2·0	10·0	..	..	..	..	..	..	..	..
Howrah ..	11·0	..	..	..	6·0	4·0	..	..	1·0	..	2·0	..
Amta ..	12·0	..	10·0	..	6·0	..	..	..	2·0	..	..	..
1927.												
Burdwan ..	..	..	..	..	..	..	..	..	..	..	..	2·0
Kalna ..	..	2·0	..	..	1·0	2·0	1·0	1·0	..	..	2·5	..
Hooghly ..	..	..	2·0	1·5	..	..	..	1·0	..	..	2·0	..
Serampore ..	..	2·0	..	2·0	..	..	..	..	1·0	1·0	2·0	..
Arambagh ..	..	1·5	1·5	..	..	..	..	..	1·0	..	..	1·0
Howrah ..	..	2·0	2·0	2·0	..	..	..	..	1·0	..	1·5	..
Amta ..	..	..	..	..	..	..	1·0	..	..	..	2·0	2·0

Estimate of Rainfall Deficiency and Excess in Inches.

Stations.	July.			August.			September.			October.		
1928.												
Burdwan ..	..	**2·0**	..	**3·0**	..	..	1·0	..	2·0	1·0	..	
Kalna ..	..	..	..	..	..	..	..	1·0	..	2·0	1·0	..
Hooghly ..	..	..	..	**2·0**	1·0	..	1·0	..	..	..	..	..
Serampore ..	..	**2·0**	**2·0**	..	..	..	..	1·0	1·0	..	..	..
Arambagh ..	..	..	..	**5·0**	..	..	..	..	..	..	..	..
Howrah ..	..	..	..	**4·0**	..	..	..	**2·0**	..	..	1·0	..
Amta ..	..	..	..	**8·0**	..	..	..	1·0	..	..	2·0	..
1929.												
Burdwan ..	..	..	**4·0**	**2·0**	..	..	1·0	1·0	..	..	..	..
Kalna ..	..	**2·0**	..	..	..	1·0	1·5	..	..	..	..	..
Hooghly ..	..	..	..	..	..	..	..	..	..	..	..	..
Serampore ..	..	..	..	..	..	..	..	..	..	..	..	..
Arambagh ..	..	..	..	..	..	..	..	..	..	..	..	..
Howrah ..	..	..	..	..	..	..	..	..	..	..	..	..
Amta ..	..	..	**2·0**	**4·0**	..	..	1·0	..	..	..	..	..
1930.												
Burdwan ..	..	**3·0**	**3·0**	..	..	**2·0**	..	..	..	..	..	1·0
Kalna ..	..	..	..	1·5	..	..	1·0	2·0	..	..	1·0	..
Hooghly ..	2·0	**2·0**	..	..	..	..	..	..	..	2·0	1·5	..
Serampore ..	..	..	..	..	..	**1·0**	..	1·0	..	2·0	2·0	..
Arambagh ..	..	..	..	..	..	..	..	..	..	..	[illegible]	..
Howrah ..	..	..	..	..	..	**2·0**	..	..	1·0	..	..	1·5
Amta ..	5·0	**7·0**	..	..	..	..	..	..	..	..	2·0	**2·0**
1931.												
Burdwan ..	..	..	..	**3·0**	..	..	..	..	..	..	..	..
Kalna ..	..	..	..	..	..	1·5	..	..	..	..	..	..
Hooghly ..	..	..	..	..	1·5	..	..	..	..	..	1·5	..
Serampore ..	..	**2·0**	..	..	..	..	..	..	..	..	..	..
Arambagh ..	..	..	..	..	..	..	..	..	..	..	..	..
Howrah ..	..	..	..	1·0	..	..	..	..	..	..	..	..
Amta ..	..	..	..	..	..	..	..	..	..	1·0	..	..
1932.												
Burdwan ..	..	..	**2·0**	**4·0**	..	..	..	..	..	2·0	..	..
Kalna ..	..	2·0	..	**1·0**	**2·0**	..	..	..	..	2·0	2·0	..
Hooghly ..	..	2·0	..	..	..	..	..	..	..	1·5	2·0	..
Serampore ..	..	**2·0**	**2·0**	..	..	..	..	..	..	2·0	..	1·0
Arambagh ..	..	..	2·0	..	..	..	..	..	..	2·0	..	..
Howrah ..	..	..	..	..	..	..	..	..	..	1·0	..	..
Amta ..	..	..	..	..	..	..	..	..	..	..	..	..
1933.												
Burdwan ..	..	..	2·0	**2·0**	..	**3·0**	**2·0**	..	..	2·0	1·0	..
Kalna ..	..	2·0	2·0	..	1·0	..	2·0	..	..	1·5	..	..
Hooghly ..	..	..	..	**2·0**	**3·0**	**1·5**	..	..	..	..	..	..
Serampore ..	..	..	..	..	..	..	..	..	..	..	..	..
Arambagh ..	..	..	..	..	..	..	..	..	..	..	..	..
Howrah ..	..	**3·0**	..	..	..	..	..	..	**5·0**	..	**4·0**	..
Amta ..	..	..	..	..	**5·0**	..	..	..	..	..	..	..
1934.												
Burdwan ..	..	..	2·0	1·0	**1·0**	..	..	..	..	..	..	**1·0**
Kalna ..	..	2·0	2·0	2·0	2·0	..	..	1·0	1·0	..	1·0	**1·0**
Hooghly ..	..	2·0	1·5	2·0	..	..	..	..	..	..	..	..
Serampore ..	..	2·0	2·0	..	..	..	1·0	..	..	..		..
Arambagh ..	..	2·0	..	..	..	..	2·0	..	2·0	..	..	1·0
Howrah ..	..	..	2·0	..	..	..	..	..	..	..	..	..
Amta ..	..	..	2·0	..	**1·0**	..	..	..	**2·0**	..	..	..
1935.												
Burdwan ..	..	..	**3·0**	..	..	..	..	..	2·0	2·0	3·0	1·0
Kalna ..	..	2·0	2·0	..	..	..	..	..	..	2·0	2·0	1·5
Hooghly ..	..	2·0	1·5	..	..	..	..	..	2·0	2·0	2·0	1·5
Serampore ..	..	2·0	..	2·0	..	..	..	..	2·0	1·5	1·5	1·5
Arambagh ..	..	..	2·0	..	..	..	..	..	2·0	2·0	2·0	..
Howrah ..	..	..	2·0	..	1·0	..	..	..	1·0	1·0	1·0	..
Amta ..	..	2·0	..	..	..	..	..	..	1·5	2·0	2·0	..

Appendix 7 —Calculation of total amount of water required for irrigation

The estimates of rainfall deficiency in the second period of October, 1902, are as shown in column (3) of the following table. The weights (according to area) are given in column (2).

Station.	Proportion of area.	Rainfall deficiency in inches.	Total.
(1)	(2)	(3)	(4)
Kalna	·20	2	·40
Hooghly	·20	2	·40
Serampur	·15	1	·15
Howrah	·10	0	·00
Amta	·15	2	·30
Arambagh	·10	2	·20
Burdwan	·10	2	·20
	Total ..		1·65

The product of the weight and the rainfall deficiency is shown in column (4). Adding these we get the average deficiency of rainfall for the whole area 1·65 inches.

These estimates given in inches of rainfall were then converted into cubic feet in the following way. The total area to be irrigated was taken as 60 per cent. of 916 square miles according to the estimates of the Irrigation Department. One inch of rainfall f the whole area was, therefore, equal to—

$$\frac{916 \times 60}{100} \times \frac{1760 \times 1760 \times 9}{12} = 1276{\cdot}8307 \times 10^6 \text{ cubic feet of water.}$$

We have seen that the average defect of rainfall during the second ten-day period of October 1902 was 1·65 inches. Multiplying by $1276{\cdot}8307 \times 10^6$ we find that the total amount of water required to meet the deficiency in rainfall was 2,107 million cubic feet.

Appendix 8.—Analysis of Variance: Discharge at Rundia in relation to Gauge Height at Jujuty.

The parabolic regression is given by—

$$D = 801{\cdot}2525 - 176{\cdot}6282\,(H-100) + 10{\cdot}8604\,(H-100)^2$$

where D = Discharge at Rundia in hundred cusecs.
H = Height in feet at Jujuty.

	Degrees of Freedom.	Variance.	Ratio of variance.	
			Observed.	One per cent.
Parabolic Regression	2	17,663,870	319·05	4·686
Deviations	271	55,364	..	..

The observed ratio of variance is definitely significant. This shows that the parabolic regression gives quite a satisfactory fit.

Appendix 9.—Graduated discharge of the Damodar (cusecs) at Rundia at different gauge heights (in feet) at Jujuty.

Gauge.	Discharge.	Gauge.	Discharge.	Gauge.	Discharge.	Gauge.	Discharge.
108·0	8,301	111·3	19,211	114·6	53,747	117·9	111,932
108·1	8,303	111·4	19,910	114·7	55,163	118·0	114,069
108·2	8,315	111·5	20,630	114·8	56,600	118·1	116,223
108·3	8,341	111·6	21,373	114·9	58,059	118·2	118,399
108·4	8,388	111·7	22,136	115·0	59,541	118·3	120,597
108·5	8,457	111·8	22,922	115·1	61,043	118·4	122,816

Appendix 9—*Continued.*

Gauge.	Discharge.	Gauge.	Discharge.	Gauge.	Discharge.	Gauge.	Discharge.
108·6	8,548	111·9	23,729	115·2	62,567	118·5	125,658
108·7	8,66.	112·0	24,560	115·3	64,113	118·6	127,321
108·8	8,795	112·1	25,411	115·4	65,680	118·7	129,606
108·9	8,951	112·2	26,283	115·5	67,269	118·8	131,912
109·0	9,129	112·3	27,177	115·6	68,880	118·9	134,240
109·1	9,328	112·4	28,093	115·7	70,514	119·0	136,590
109·2	9,549	112·5	29,031	115·8	72,169	119·1	138,961
109·3	9,792	112·6	29,984	115·9	73,845	119·2	141,354
109·4	10,057	112·7	30,965	116·0	75,545	119·3	143,769
109·5	10,343	112·8	31,968	116·1	77,265	119·4	146,205
109·6	10,651	112·9	32,992	116·2	79,006	119·5	148,663
109·7	10,981	113·0	34,048	116·3	80,769	119·6	151,143
109·8	11,332	113·1	35,116	116·4	82,545	119·7	153,646
109·9	11,705	113·2	36,806	116·5	84,361	119·8	156,169
110·0	12,101	113·3	37,318	116·6	86,189	119·9	158,714
110·1	12,518	113·4	38,451	116·7	88,039	120·0	161,280
110·2	12,956	113·5	39,606	116·8	89,910	120·1	163,868
110·3	13,416	113·6	40,782	116·9	91,804	120·2	166,478
110·4	13,898	113·7	41,980	117·0	93,722	120·3	169,110
110·5	14,402	113·8	43,200	117·1	95,659	120·4	171,764
110·6	14,927	113·9	44,442	117·2	97,610	120·5	174,440
110·7	15,474	114·0	45,709	117·3	99,591	120·6	177,138
110·8	16,043	114·1	46,994	117·4	101,594	120·7	179,857
110·9	16,633	114·2	48,301	117·5	103,618	120·8	182,598
111·0	17,244	114·3	49,630	117·6	105,664	120·9	185,360
111·1	17,878	114·4	50,981	117·7	107,732	121·0	188,144
111·2	18,534	114·5	52,353	117·8	109,821	..	..

Appendix 10.—Gauge-height at Jujuty (in feet) and Discharge (in cusecs) at Rundia, in 1933.

Vide paragraph 42.

Date.	July.		August.		September.		October.	
	Gauge.	Discharge.	Gauge.	Discharge.	Gauge.	Discharge.	Gauge.	Discharge.
1 ..	110·8	16,043	112·0	24,560	115·8	72,169	109·8	11,332
2 ..	112·3	27,177	111·0	17,244	114·8	56,600	109·6	10,651
3 ..	114·8	56,600	111·4	19,910	116·3	80,769	109·8	11,332
4 ..	112·8	31,968	111·5	20,630	114·5	52,353	109·2	9,549
5 ..	112·5	29,031	111·8	22,922	112·6	29,984	109·1	9,328
6 ..	113·8	43,200	112·5	29,031	111·0	17,244	108·8	8,795
7 ..	114·0	45,709	112·7	30,965	110·7	15,474	108·3	8,341
8 ..	113·8	43,200	112·7	30,965	109·8	11,332	108·1	..
9 ..	111·8	22,922	115·0	59,541	113·0	34,048	108·3	8,341
10 ..	112·5	29,031	117·9	111,932	111·8	22,922	108·1	..
Total ..	..	344,881	..	367,700	..	392,895	..	77,669
11 ..	113·4	38,451	116·4	82,545	110·3	13,416	108·1	..
12 ..	113·3	37,318	115·5	67,269	109·5	10,343	108·0	..
13 ..	114·3	49,630	113·0	34,048	109·0	9,129	108·0	..
14 ..	116·9	91,804	112·5	29,031	108·6	8,548	108·0	..
15 ..	115·1	61,043	114·3	49,630	108·8	8,797	108·0	..
16	114·3	49,630	113·5	39,606	108·5	8,457	108·0	..
17 ..	113·4	38,451	113·5	39,606	108·4	8,388	107·9	..
18 ..	113·2	36,806	112·8	31,968	108·3	8,341	107·9	..
19 ..	116·1	77,265	112·5	29,031	108·3	8,341	107·9	..
20 ..	116·9	91,804	114·0	45,709	108·6	8,548	108·3	8,341
Total ..	..	572,202	..	448,443	..	92,398	..	8,341
21 ..	115·0	59,541	121·4	199,497	108·8	8,795	109·6	10,651
22 ..	110·8	16,043	119·0	136,590	109·9	11,705	111·8	22,922
23 ..	110·5	14,402	119·3	143,769	118·9	134,240	110·8	16,043
24 ..	115·1	61,043	118·3	120,597	116·5	84,361	109·8	11,332
25 ..	116·8	89,910	117·1	95,659	115·4	65,680	110·0	12,101
26 ..	116·6	86,189	116·0	75,545	114·9	58,059	110·2	12,956
27 ..	116·7	88,039	116·3	80,769	113·5	39,606	108·9	8,951
28 ..	116·5	84,361	115·5	67,269	112·0	24,560	108·5	8,457
29 ..	114·6	53,747	116·5	84,361	111·3	19,211	108·2	8,315
30 ..	113·2	36,806	116·0	75,545	110·3	13,416	107·8	..
31 ..	112·6	22,984	117·0	93,722	..	..	107·7	..
Total ..	..	613,065	..	1,173,323	..	459,633	..	111,728

Appendix 11.—Percentage Improvement due to Irrigation : Burdwan.

Year.	Without Irrigation. (w).	Partial Irrigation. (p).	Complete Irrigation. (c).	Improvement due to Irrigation— Partial. (p—w).	Complete. (c—w).	Complete—over Partial. (c—p).
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1901 ..	76	85	100	9	24	15
1902 ..	80	95	100	15	20	5
1903 ..	90	98 [97]	89	8 [7]	8	0 [1]
1904 ..	51	65	100	14	49	35
1905 ..	62	80	90	18	28	10
1906 ..	87	90	90	3	3	..
1907 ..	67	75	100	8	33	25
1908 ..	67	90	100	23	33	10
1909 ..	78	90	90	12	12	..
1910 ..	58	98	98	40	40	..
1911 ..	79	100	100	21	21	..
1912 ..	90	95	100	5	10	5
1913 ..	96	100	100	4	4	..
1914 ..	77	90	100	13	23	10
1915 ..	85	99	99	14	14	..
1916 ..	92	98	98	6	6	..
1917 ..	82	98	98	16	16	..
1918 ..	72	80	100	8	28	20
1919 ..	72	98	98	26	26	..
1920 ..	95	100	100	5	5	..
1921 ..	82	98	98	16	16	..
1922 ..	88	98	98	10	10	..
1923 ..	87	95	95	8	8	..
1924 ..	88	100	100	12	12	..
1925 ..	97	100	100	3	3	..
1926 ..	84	95	95	11	11	..
1927 ..	87	100 [94]	100	13 [7]	13	0 [6]
1928 ..	77	99	99	22	22	..
1929 ..	87	98	98	11	11	..
1930 ..	87	96	96	9	9	..
1931 ..	98	98	98	..	..	..
1932 ..	80	98	98	18	18	..
1933 ..	88	97	97	9	9	..
1934 ..	85	100	100	15	15	..
1935 ..	42	50	100	8	58	50

Appendix 11.—Percentage Improvement due to Irrigation : Kalna.

1901 ..	48	95	100	47	52	5
1902 ..	72	72	100	..	28	28
1903 ..	95	100 [98]	100	5 [3]	5	0 [2]
1904 ..	73	80	100	7	27	20
1905 ..	75	85	100	10	25	15
1906 ..	77	77	100	..	23	23
1907 ..	76	80	100	4	24	20
1908 ..	92	95	100	3	8	5
1909 ..	97	97	97	..	..	..
1910 ..	97	100	100	3	3	..
1911 ..	85	100	100	15	15	..
1912 ..	*	*	*	*	*	*
1913 ..	*	*	*	*	*	*
1914 ..	*	*	*	*	*	*
1915 ..	*	*	*	*	*	*
1916 ..	68	100	100	32	32	..
1917 ..	95	100	100	5	5	..
1918 ..	83	83	100	..	17	17
1919 ..	85	100	100	15	15	..
1920 ..	76	100	100	24	24	..
1921 ..	75	100	100	25	25	..
1922 ..	79	100	100	21	21	..
1923 ..	86	100	100	14	14	..

*Rainfall records missing.

Year.	Without Irrigation. (w).	Partial Irrigation. (p).	Complete Irrigation. (c).	Improvement due to Irrigation— Partial. (p—w).	Complete. (c—w).	Complete—over Partial. (c—p)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1924 ..	81	100	100	19	19	..
1925 ..	59	95	100	36	41	5
1926 ..	64	100	100	36	36	..
1927 ..	43	100	100	57	57	..
1928 ..	76	100	100	24	24	..
1929 ..	79	100	100	21	21	..
1930 ..	79	100	100	21	21	..
1931 ..	92	100	100	8	8	..
1932 ..	79	95	95	16	16	..
1933 ..	92	100	100	8	8	..
1934 ..	48	100	100	52	52	..
1935 ..	36	65	100	29	64	35

Appendix II.—Percentage Improvement due to Irrigation : Hooghly.

1901 ..	69	95	100	26	31	5	
1902 ..	87	87	100	..	13	13	
1903 ..	87	100 [99]	100	13 [12]	13	0	[1]
1904 ..	73	73	100	..	27	27	
1905 ..	20	75	85	55	65	10	
1906 ..	70	85	100	15	30	15	
1907 ..	62	75	100	13	38	25	
1908 ..	52	80	100	28	48	20	
1909 ..	85	100	100	15	15	..	
1910 ..	88	98	99	10	11	1	
1911 ..	78	98	98	20	20	..	
1912 ..	75	85 [83]	98	10 [8]	23	13	[15]
1913 ..	87	100	100	13	13	..	
1914 ..	77	88	88	11	11	..	
1915 ..	*	*	*	*	*	*	
1916 ..	78	95	95	17	17	..	
1917 ..	*	*	*	*	*	*	
1918 ..	74	75	100	1	26	25	
1919 ..	77	100	100	23	23	..	
1920 ..	92	98	98	6	6	..	
1921 ..	75	95	95	20	20	..	
1922 ..	70	90	90	20	20	..	
1923 ..	75	90	95	15	20	5	
1924 ..	87	100	100	13	13	..	
1925 ..	68	100	100	32	32	..	
1926 ..	85	90	92	5	7	2	
1927 ..	69	96	96	27	27	..	
1928 ..	92	100	100	8	8	..	
1929 ..	91	100	100	9	9	..	
1930 ..	77	97	97	20	20	..	
1931 ..	97	98	98	1	1	..	
1932 ..	85	98	100	13	15	2	
1933 ..	95	95	95	..	..	..	
1934 ..	75	100	100	25	25	..	
1935 ..	27	50	100	23	73	50	

Appendix II.—Percentage Improvement due to Irrigation : Serampore.

1901 ..	74	90	100	16	26	10	
1902 ..	78	82	100	4	22	18	
1903 ..	90	95 [94]	95	5 [4]	5	0	[1]
1904 ..	78	90	100	12	22	10	
1905 ..	1	70	85	69	84	15	
1906 ..	93	93	95	..	2	2	
1907 ..	85	90	100	5	15	10	
1908 ..	77	90	100	13	23	10	
1909 ..	93	93	93	..	..	..	
1910 ..	95	95	95	..	..	..	

*Rainfall records missing.

Year.	Without Irrigation. (w).	Partial Irrigation. (p).	Complete Irrigation. (c).	Improvement due to Irrigation—		
				Partial. (p—w).	Complete. (c—w).	Complete—over partial. (c—p).
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1911 ..	74	95	100	21	26	5
1912 ..	91	100	100	9	9	..
1913 ..	89	100	100	11	11	..
1914 ..	51	90	100	39	49	10
1915 ..	25	100 [90]	100	75 [65]	75	0 [10]
1916 ..	53	100	100	47	47	..
1917 ..	94	100	100	6	6	..
1918 ..	48	70	100	22	52	30
1919 ..	56	100	100	44	44	..
1920 ..	58	90	100	32	42	10
1921 ..	51	85	95	34	44	10
1922 ..	76	95	95	19	19	..
1923 ..	65	95	95	30	30	..
1924 ..	70	100	100	30	30	..
1925 ..	56	100	100	44	44	..
1926 ..	68	95	95	27	27	..
1927 ..	49	100	100	51	51	..
1928 ..	93	95	95	2	2	..
1929 ..	94	100	100	6	6	..
1930 ..	69	100	100	31	31	..
1931 ..	97	97	97	..	..	..
1932 ..	76	95	98	19	22	3
1933 ..	97	100	100	3	3	..
1934 ..	61	100	100	39	39	..
1935 ..	19	70	100	51	81	30

Appendix II.—Percentage Improvement due to Irrigation : Arambagh.

1901 ..	91	95	95	4	4	..
1902 ..	85	90	100	5	15	10
1903 ..	92	100	100	8	8	..
1904 ..	59	85 [83]	100	26 [24]	41	15 [17]
1905 ..	90	94	94	4	4	..
1906 ..	91	95	100	4	9	5
1907 ..	71	85	100	14	29	15
1908 ..	67	90	100	23	33	10
1909 ..	80	90	90	10	10	..
1910 ..	91	100	100	9	9	..
1911 ..	81	100	100	19	19	..
1912 ..	85	100	100	15	15	..
1913 ..	97	100	100	3	3	..
1914 ..	62	90	100	28	38	10
1915 ..	95	100	100	5	5	..
1916 ..	94	100	100	6	6	..
1917 ..	92	100	100	8	8	..
1918 ..	64	70	100	6	36	30
1919 ..	75	99	99	24	24	..
1920 ..	93	100	100	7	7	..
1921 ..	70	95	95	25	25	..
1922 ..	83	95	95	12	12	..
1923 ..	65	100	100	35	35	..
1924 ..	88	100	100	12	12	..
1925 ..	90	100	100	10	10	..
1926 ..	85	85	85	..	..	..
1927 ..	93	100 [96]	100	7 [3]	7	0 [4]
1928 ..	90	100	100	10	10	..
1929 ..	96	100	100	4	4	..
1930 ..	75	100	100	25	25	..
1931 ..	94	100	100	6	6	..
1932 ..	76	100	100	24	24	..
1933 ..	93	100	100	7	7	..
1934 ..	72	100	100	28	28	..
1935 ..	50	80	100	30	50	20

Appendix II.—Percentage Improvement due to Irrigation : Howrah.

Year.	Without Irrigation. (w).	Partial Irrigation. (p).	Complete Irrigation. (c).	Improvement due to Irrigation—		
				Partial. (p—w).	Complete. (c—w).	Complete—over partial. (c—p).
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1901 ..	78	95	100	17	22	5
1902 ..	68	70	100	2	32	30
1903 ..	94	98	98	4	4	..
1904 ..	62	85 [83]	100	23 [21]	38	15 [17]
1905 ..	..	70	85	70	85	15
1906 ..	95	95	97	..	2	2
1907 ..	81	90	100	9	19	10
1908 ..	71	85	90	14	19	5
1909 ..	88	98	98	10	10	..
1910 ..	93	100	100	7	7	..
1911 ..	53	100	100	47	47	..
1912 ..	88	90	100	2	12	10
1913 ..	87	100	100	13	13	..
1914 ..	46	92	100	46	54	8
1915 ..	95	100	100	5	5	..
1916 ..	79	95	95	16	16	..
1917 ..	91	98	98	7	7	..
1918 ..	66	85	100	19	34	15
1919 ..	62	95	95	33	33	..
1920 ..	85	90	90	5	5	..
1921 ..	57	98	98	41	41	..
1922 ..	88	95	95	7	7	..
1923 ..	86	98	98	12	12	
1924 ..	81	99	99	18	18	..
1925 ..	78	98	98	20	20	..
1926 ..	65	90	90	25	25	..
1927 ..	43	100	100	57	57	..
1928 ..	81	97	97	16	16	..
1929 ..	98	98	98	..	..	..
1930 ..	73	99	99	26	26	..
1931 ..	98	100	100	2	2	..
1932 ..	90	100	100	10	10	..
1933 ..	96	100	100	4	4	..
1934 ..	97	100	100	3	3	..
1935 ..	62	80	99	18	37	19

Appendix II.—Percentage Improvement due to Irrigation : Amta.

1901 ..	94	100	100	6	6	..
1902 ..	74	85	100	11	26	15
1903 ..	97	100 [98]	100	3 [1]	3	0 [2]
1904 ..	66	85	100	19	34	15
1905 ..	89	89	89	..	..	..
1906 ..	*	*	*	*	*	*
1907 ..	70	85	100	15	30	15
1908 ..	56	92	100	36	44	8
1909 ..	94	97	97	3	3	..
1910 ..	95	98	99	3	4	1
1911 ..	62	100	100	38	38	..
1912 ..	62	65	100	3	38	35
1913 ..	91	92	92	1	1	..
1914 ..	..	85	100	85	100	15
1915 ..	90	99 [92]	99	9 [2]	9	0 [7]
1916 ..	87	98	98	11	11	..
1917 ..	82	99	99	17	17	..
1918 ..	66	80	100	14	34	20
1919 ..	60	90	90	30	30	..
1920 ..	86	86	86	..	..	..
1921 ..	74	90	90	16	16	..
1922 ..	86	90	90	4	4	..
1923 ..	85	90	95	5	10	5
1924 ..	97	100	100	3	3	..

* Rainfall records missing.

Year.	Without Irrigation. (w).	Partial Irrigation. (p).	Complete Irrigation. (c).	Improvement due to Irrigation—		
				Partial. (p—w).	Complete. (c—w).	Complete—over partial. (c—p).
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1925 ..	97	99	99	2	2	..
1926 ..	74	80	80	6	6	..
1927 ..	85	100 [96]	100	15 [11]	15	0 [4]
1928 ..	69	95	95	26	26	..
1929 ..	94	98	98	4	4	..
1930 ..	77	98	98	21	21	..
1931 ..	96	100	100	4	4	..
1932 ..	*	*	*	*	*	*
1933 ..	98	98	98	..	..	..
1934 ..	90	99	99	9	9	..
1935 ..	53	80	100	27	47	20

* Rainfall records missing.

Appendix 12.—Estimate of "Full Crop" Yield.

Three factors are involved in estimating crop outturn, namely, (1) area, (2) normal outturn and (3) condition factor.

As regards area, "the general rule is that the return should exhibit the areas actually sown." [*Estimates of Area and Yield of Principal Crops in India, 1931-32.* Appendix I, page 44: Method of Framing Estimates of Crops.]

A "normal crop" is defined as "that crop which past experience has shown to be the most generally recurring crop in a series of years; the typical crop of the local area; the crop which the cultivator has a right (as it were) to expect and with which he is (or should be) content, while if he gets more he has reason to rejoice, and if less, he has reason to complain. Briefly, it is stated to be.....the average yield on average soil in a year of average character. This normal or average yield will not necessarily correspond with the average of a series of years' figures which is indeed an arithmetical average and may possibly never occur." [*Estimates of Area and Yield, 1931-32,* page 44; the wording is the same as in a circular dated 1897.]

The condition factor is described as:—"the fraction representing the relation of the crop reported on to the normal crop per acre is what is known as the 'anna estimate' or 'the percentage estimate'." [*Estimates of Area and Yield, 1931-32,* Appendix I, page 44.]

It follows that "when this average (i.e., normal outturn) is multiplied by the average area sown, the result should give as near an approximation as possible to the outturn of the crop in an average year." [*Agricultural Statistics of India,* Volume I, 1934-35, Appendix A, page 391.] For a particular year, "when these three factors have been determined they are multiplied, with each other to arrive at the required quantitative estimate of outturn." [*Estimates of Area and Yield, 1931-32,* page 45.]

Let M_1 = Official estimate of normal outturn in a district, C_1 = the condition factor, and A_1 = the total area transplanted or sown. Then the total outturn of the district = $M_1 . C_1 . A_1$.

Let A_2 = total cultivable area, and if $f = A_1/A_2$, then f is the fraction of the cultivable area which is actually transplanted. Thus $A_1 = f . A_2$. Then the total production may be written as—

$$M_1 . C_1 . A_1 = M_1 . C_1 . (f . A_2) = M_1 . (C_1 . f) . A_2 = M_1 . C'_1 . A_2$$

where C'_1 = the condition factor on the basis of the normal crop for the total cultivable area.

In Appendix 11 (column 2) of this Note, the estimates of crop condition have been based on (1) "full crop" and (2) total cultivable area. Let C_2 represent these estimates, and let M_2 = "full crop" yield per acre (i.e., the average yield per acre when every unit of area is yielding its own maximum). Then the total outturn = $M_2 . C_2 . A_2$.

Equating the two expressions for the total outturn, we have—

$$M_1 . C_1 . A_1 = M_1 . C'_1 . A_2 = M_2 . C_2 . A_2. \quad \text{Thus } M_2 = \frac{M_1 . C'_1}{C_2} = \frac{M_1 . C_1 . f}{C_2}.$$

We can form some idea about the magnitude of "f" on the basis of the material used for the estimate of crop expectations given in Appendix 11. Since the total cultivable area has remained practically steady during the period under survey, we may use the average value of "f" in estimating the value of M_2 without serious error.

The values of M_1, C_1, f, C'_1, C_2 and M_2 for the three districts of Burdwan, Hooghly and Howrah are shown in Table 12 (1) below:—

Table 12(1).—Estimate of "Full Crop" Yield.

Districts.	Condition Factor.				Yields in maunds per acre.	
	p	C_1	C'_1	C_2	m_1	m_2
Burdwan ..	·934	80·7	75·1	77·6	15·92	15·46
Hooghly ..	·933	80·0	74·8	73·0	14·59	14·92
Howrah ..	·933	83·1	77·5	77·8	13·98	13·93

We can now convert the percentage improvement into maunds. For this purpose we first find the weighted percentage improvement for each district. Let the percentage improvement in the crop be p_1, p_2 and p_3 in Hooghly, Arambagh and Serampore respectively. Multiplying by the corresponding area-weights (0·20, 0·10 and 0·15 respectively) we get the weighted average percentage improvement for the district (or rather for that portion of the district which is included in the present project). Let this weighted average percentage improvement be p. Multiplying by 14·92 maunds per acre (the "full crop" in Hooghly district) we get the average additional yield per acre. Multiplying this by the area under irrigation 351,744 acres), we get the additional yield in maunds. The additional yield in the two other districts were calculated in the same way, and the figures are given in Appendix 14. Two estimates are given in each case corresponding respectively to partial (after allowing for the discharge in the Damodar Canal) and to complete irrigation.

It will be seen from Table 12 (1) that the "full crop" and "normal crop" are practically identical. This shows that the condition factors are in practice estimated by the Department of Agriculture on the basis of the "full crop." This is corroborated by the frequency distribution of the condition factors given below:—

Table 12(2).—Frequency Distribution of "Condition Factor" ("Normal Crop," and area transplanted).

	Burdwan.	Hooghly.	Howrah.	Total.
Below 43	2	1	..	3
43—53	1	0	1	2
—63	0	1	0	1
—73	9	10	6	25
—83	8	10	14	32
—93	6	6	7	19
—103	7	7	6	20
Above 103	2	..	1	3
Total ..	35	35	35	105

From the official definition, it appears that the normal outturn was intended to be the modal value of yields over a series of years. A. L. Bowley and D. H. Robertson also supported this interpretation. (*A Scheme for an Economic Census of India, 1934*, page 38.)

In actual fact however the "mode" of the official condition factor (for at least this region during the period 1901-1936) was far lower than 100 and was found to lie between 73 and 83. Thus the most frequently occurring crop condition is very near to 80 and not 100 as one would expect from the confused wording of the official definition.

Appendix 13—Increase in yield of rice (in hundreds of maunds) due to partial irrigation.

Year.	Burdwan.	Hooghly.	Howrah.	Total.
1901-02 ..	5,602	4,198	1,275	11,074
1902-03 ..	816	577	907	2,300
1903-04 ..	707	1,994	266	2,967
1904-05 ..	1,523	2,204	2,426	6,153
1905-06 ..	2,285	7,413	3,430	13,128
1906-07 ..	1633	1,784	..	1,947
1907-08 ..	871	2,493	1,544	4,906
1908-09 ..	1,577	5,169	3,332	10,078
1909-10 ..	652	2,099	711	3,462
1910-11 ..	2,502	1,522	564	4,587
1911-12 ..	2,774	4,749	5,096	12,619
1912-13 ..	816	2,335	318	3,469
1913-14 ..	653	2,387	681	3,721
1914-15 ..	2,122	5,693	8,502	16,217
1915-16 ..	2,285	7,058	392	9,735
1916-17 ..	3,808	5,798	1,593	11,198
1917-18 ..	1,414	1,837	1,593	4,843
1918-19 ..	436	2,152	1,960	4,547
1919-20 ..	3,046	7,136	3,822	14,005
1920-21 ..	2,883	3,515	246	6,643
1921-22 ..	3,590	6,087	3,185	12,862
1922-23 ..	2,828	4,224	637	7,689
1923-24 ..	1,958	5,772	956	8,686
1924-25 ..	2,720	4,355	1,103	8,177
1925-26 ..	4,079	7,346	1,127	12,553
1926-27 ..	4,514	2,650	1,666	8,830
1927-28 ..	6,581	7,005	3,602	17,188
1928-29 ..	3,808	1,522	2,390	7,720
1929-30 ..	2,883	1,627	294	4,803
1930-31 ..	2,774	5,851	2,818	11,442
1931-32 ..	871	420	392	1,682
1932-33 ..	2,720	4,119	1,225	8,064
1933-34 ..	1,360	604	196	2,159
1934-35 ..	6,473	7,163	809	14,444
1935-36 ..	3,590	8,002	2,867	14,459

Appendix 14.—Increase in yield of rice (in hundreds of manuds) due to complete irrigation.

Year.	Burdwan.	Hooghly	Howrah.	Total.
1901-02 ..	6,962	5,509	1,519	13,991
1902-03 ..	4,133	3,883	3,479	11,496
1903-04 ..	979	2,177	416	3,572
1904-05 ..	5,602	6,716	4,361	16,680
1905-06 ..	4,242	13,643	4,165	22,051
1906-07 ..	2,665	3,778	..	6,443
1907-08 ..	4,405	6,690	3,136	14,232
1908-09 ..	2,665	8,579	4,165	5,409
1909-10 ..	652	2,099	711	3,462
1910-11 ..	2,502	1,627	637	4,766
1911-12 ..	2,774	5,142	5,096	13,013
1912-13 ..	1,630	3,909	3,381	8,922
1913-14 ..	653	2,387	710	3,751
1914-15 ..	3,752	7,005	9,997	20,755
1915-16 ..	2,285	7,844	906	11,036
1916-17 ..	3,808	5,798	1,593	11,198
1917-18 ..	1,414	3,168	1,593	6,175
1918-19 ..	3,372	8,710	4,165	16,238
1919-20 ..	3,046	7,136	3,822	14,005
1920-21 ..	2,883	4,303	246	7,430
1921-22 ..	3,590	6,874	3,185	13,649
1922-23 ..	2,828	4,224	637	7,689
1923-24 ..	1,958	6,296	1,323	9,578
1924-25 ..	2,720	4,355	1,103	8,177
1925-26 ..	4,623	7,346	1,127	13,096
1926-27 ..	4,514	2,860	1,666	9,040
1927-28 ..	6,907	7,215	3,896	18,018
1928-29 ..	3,808	1,522	2,695	8,024
1929-30 ..	2,883	1,627	294	4,803
1930-31 ..	2,774	5,851	2,818	11,442
1931-32 ..	871	420	392	1,682
1932-33 ..	2,720	4,565	1,225	8,509
1933-34 ..	1,360	604	196	2,159
1934-35 ..	6,473	7,163	809	14,435
1935-36 ..	10,116	16,660	5,268	32,045

Appendix 15—Harvesting price of rice in rupees per maund.

A table of harvest prices was introduced into the *Season and Crop Report of Bengal* from the year 1905-06 in which the price for the previous year was also quoted. The harvest prices for the period 1904-05 to 1934-35 were thus obtained directly from these reports. For the first three years 1901-02 to 1903-04, the price quotations in the Weather and Crop Report Section of the *Calcutta Gazette Supplement* were used. Herein the weekly prices of common rice for subdivisional markets of each district are given in terms of *seers* and *chataks* of rice per rupee. The mean of these prices during the harvesting period has been taken to be the harvesting price of the crop in the district. Actual figures are given below:—

Year.	Burdwan.	Hooghly.	Howrah.
	Rs. a.	Rs. a.	Rs. a.
1901-02 ..	3 7	3 13	4 0
1902-03 ..	3 6	3 13	3 8
1903-04 ..	3 2	3 10	3 10
1904-05 ..	2 15	3 0	3 2
1905-06 ..	3 3	3 8	3 9
1906-07 ..	4 10	5 8	4 11
1907-08 ..	5 5	5 15	5 8
1908-09 ..	5 0	5 3	5 0
1909-10 ..	3 3	4 8	4 8
1910-11 ..	3 0	4 0	3 14
1911-12 ..	3 7	4 6	5 0
1912-13 ..	4 2	5 10	4 8
1913-14 ..	4 0	5 8	5 8
1914-15 ..	4 2	5 10	5 11
1915-16 ..	5 3	6 0	6 4
1916-17 ..	3 13	5 0	5 7
1917-18 ..	3 8	3 8	4 6
1918-19 ..	5 8	6 4	5 14
1919-20 ..	6 8	8 0	7 15
1920-21 ..	6 0	7 3	7 8
1921-22 ..	7 12	7 5	7 0
1922-23 ..	5 12	6 4	6 12
1923-24 ..	5 0	5 8	5 12
1924-25 ..	6 8	5 12	5 12
1925-26 ..	7 0	6 6	6 8
1926-27 ..	7 0	6 10	7 0
1927-28 ..	8 0	7 8	7 4
1928-29 ..	7 0	6 8	7 0
1929-30 ..	5 0	5 12	6 0
1930-31 ..	5 0	4 0	4 12
1931-32 ..	4 0	3 6	4 8
1932-33 ..	3 0	3 4	4 0
1933-34 ..	2 13	3 4	4 0
1934-35 ..	3 4	3 8	4 0
1935-36 ..	3 10	4 0	4 0

Appendix 16.—Money value of additional yield of rice (in lakhs of rupees) due to irrigation.

Year.	Partial.				Complete.			
	Burdwan.	Hooghly.	Howrah.	Total.	Burdwan.	Hooghly.	Howrah.	Total.
1901-02 ..	19·3	13·4	5·1	37·8	23·9	17·6	6·1	47·6
1902-03 ..	2·8	4·9	3·2	7·9	14·0	12·4	12·2	38·6
1903-04 ..	2·2	7·2	1·0	10·4	3·1	7·9	1·5	12·5
1904-05 ..	4·5	6·6	7·6	18·7	16·5	20·2	13·6	50·3
1905-06 ..	7·2	25·9	12·2	45·3	13·5	47·8	14·8	76·1
1906-07 ..	0·8	9·8	..	10·6	12·3	20·8	..	33·1
1907-08 ..	4·6	14·8	8·5	27·9	23·4	39·7	17·3	80·4
1908-09 ..	7·9	26·8	16·7	51·4	13·3	44·5	20·8	78·6
1909-10 ..	2·1	9·5	3·2	14·8	2·1	9·5	3·2	14·8
1910-11 ..	7·5	6·1	2·2	15·8	7·5	6·5	2·5	16·5
1911-12 ..	9·5	20·8	25·5	55·8	9·5	22·5	25·5	57·5
1912-13 ..	3·4	13·2	1·5	18·1	6·7	22·0	15·2	43·9
1913-14 ..	2·6	13·2	3·7	19·5	2·6	13·1	3·9	19·6
1914-15 ..	8·8	32·1	48·4	89·3	15·5	39·4	56·9	111·8
1915-16 ..	11·6	42·4	2·5	56·5	11·9	47·1	5·7	64·7
1916-17 ..	14·5	29·0	8·7	52·2	14·5	29·0	8·7	52·2
1917-18 ..	5·0	6·4	7·0	18·4	5·0	11·1	7·0	23·1
1918-19 ..	2·4	13·5	11·5	27·4	18·6	54·4	24·5	97·5
1919-20 ..	19·8	57·1	30·3	107·2	19·8	57·1	30·3	107·2
1920-21 ..	17·3	25·3	1·8	44·4	17·3	30·9	1·8	50·0
1921-22 ..	27·8	44·5	22·3	94·6	27·8	50·3	22·3	100·4
1922-23 ..	16·3	26·4	4·3	47·0	16·3	26·4	4·3	47·0
1923-24 ..	9·8	31·8	5·5	47·1	9·8	34·6	7·6	52·0
1924-25 ..	17·7	25·0	6·3	49·0	17·7	25·0	6·3	49·0
1925-26 ..	28·6	46·8	7·3	82·7	32·4	46·8	7·3	86·5
1926-27 ..	31·6	17·6	11·7	60·9	31·6	18·9	11·7	62·2
1927-28 ..	52·7	52·5	26·1	131·3	55·2	54·1	28·2	137·6
1928-29 ..	26·7	9·9	16·7	53·3	26·7	9·9	18·9	55·5
1929-30 ..	14·4	9·4	1·8	25·6	14·4	9·4	1·8	25·6
1930-31 ..	13·9	23·4	13·4	50·7	13·9	23·4	13·4	50·7
1931-32 ..	3·5	1·4	1·8	6·7	3·5	1·4	1·8	6·7
1932-33 ..	8·2	13·4	4·9	26·5	8·2	14·8	4·9	27·9
1933-34 ..	3·9	1·9	0·8	6·6	3·8	2·0	0·8	6·6
1934-35 ..	21·0	25·1	3·2	49·3	21·0	25·1	3·2	49·3
1935-36 ..	13·0	32·0	11·5	56·5	36·7	66·6	21·1	124·4

Appendix 17.—Note on the shortage of water in October 1912 (Table 8).

It will be noticed that in 1912 although the amount of water required for complete irrigation was small (about 1,213 million c. ft.), the gain in yield and money value (about Rs. 26 lakhs) was large.

The indices of crop estimate in 1912 were as follows:—

Stations.	Without Irrigation.	Partial Irrigation.	Complete Irrigation.	Improvement due to Irrigation. Partial.	Improvement due to Irrigation. Complete—over partial.
	(w)	(p)	(c)	(p—w)	(c—p)
Burdwan ..	90	95	100	5—	5—
Kalna ..	No rainfall records available.				
Hooghly ..	75	85	98	10	13
Serampur ..	91	100	100	9	0
Arambagh ..	85	100	100	15	0
Howrah ..	88	90	100	2	10
Amta ..	62	65	100	3	35

It will be seen that the expectation of crop for Amta was very poor for want of October rain. Partial irrigation was also not possible as the river was low. With complete irrigation, however, the crop could be improved to the extent of 35 per cent.

Thus while the water required was small as the area to be irrigated was small, the percentage improvement was very high, and gave a considerable increase in the total outturn. This is shown below:—

District.	Additional yield of rice in thousands of maunds with— Partial Irrigation.	Complete Irrigation.	Difference.
Burdwan	81·6	163·0	81·4
Hooghly	233·5	390·9	157·4
Howrah	31·8	338·1	306·3

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