ENUMERATION OF FRUIT TREES IN LAND UTILISATION SURVEYS

By J. M. SENGUPTA

Indian Statistical Institute

SUMMARY. This paper deals with the problem of enumerating the area under fruit trees in orchards not under organised or patterned cultivation. The possibilities of eye-estimating the allocated proportion of net geographical area under a particular species when more than one are grown together, by adopting certain conventions regarding variety-specific coverages commanded by each plant have been discussed. It has been felt that an enumeration of gross geographical area covered by each major combinations or typical mixtures, and then a count of the number of plants in a smaller subsample, may be a more practical approach.

Distribution of individual plants for some of the varieties by their height-levels and girths at foot have been worked out for West Bengal. This may be further developed for estimating the volume of timber in forest areas or for ascertaining the gaps in their age structure and planning for their future replacements.

1. Introduction

Special investigations were carried out in West Bengal during the spring season of 1957-58, for evolving a practical method for the enumeration of area utilised for orchards and miscellaneous fruit trees. It is well known that apart from regular cultivations conducted on a commercial basis, a large number of fruit trees are grown on a domestic scale by many households in an irregular manner, along the banks of a tank, in outlying corners of the home-yard and in all sorts of odd mixtures of a variety of fruit plants. Mango, jack-fruit, guava or black-berry interspersed with one another and with those of the palm family, namely, dates, cocoanuts, arecanuts and palmyras, are a common sight in every village. The spacings are more often than not, irregular, trees of all ages and of all heights crowd together and present a perfectly randomised picture so pleasing to the eyes. In fact, the contribution of irregular 'domestic' cultivations is likely to far exceed the acreage under a patterned commercial cultivation. In commercial exploitations, the spacings are more or less uniform, plants usually occurring in homogenous age-groups. Even here, the usual procedure of eye estimating the proportion of plot area covered by the plants is difficult to apply. For, how should we define the coverage of individual plants? Is it the aggregate over the cross sections of the individual tree-trunk taken at the ground level, or of the spread of the branches around the foot of the tree? In the latter case, the question will arise, is it the present coverage or the future probable coverage which will be reached as the tree will grow in years', a factor which will vary from region to region? Then again, the possibility of utilising the intermediate spaces for other purposes which may or may not have been done at the time of observation, will arise. If we could assume that for a given plant, the intermediate spaces are as a rule, i.e., by tradition, utilised more or less in a given manner, only then, we could impute some arbitrary allocation of the ground area among the component cultivations. In that case, we could at least theoretically estimate the proportion of area for a particular utilisation. But in irregular, i.e., 'domestic' cultivation, we

cannot even imagine the existence of any 'average' sort of tradition. Take for instance, the case of cocoanut plants grown on the bank of a village tank mixed with rows of arecanut plants. The interplant spacings although variable, may retain some semblance of uniformity. But, how one is to allocate the total plot area between water surface, cocoanut plants and other plants growing on the bank, and how the unutilised strip along the banks is to be allocated between water-area and plantation area? Apart from the physical difficulty in making a satisfactory eye-appraisal of the area covered by individual utilisations, the attempt seems to be ineffective so long as some sort of a conventional 'coverage' per plant is not conceived.

The only alternative seems to be in counting up each plant in individual plots. Naturally, the sampling error will be reduced, if we can count separately for each age-class (and other breakdowns). Counting of all plants exhaustively, when the plot is large and specially when the spacings are not uniform, is indeed quite difficult and a laborious operation. Nevertheless, here we have not to face any conceptual difficulty, there being no ambiguity in defining the number of plants, classified or *not* classified into specific groups. And, mechanical contrivances and other tricks can nearly always be devised to overcome operational difficulties. Not so of course, where the object of enumeration cannot be unambiguously defined.

The present experiments were intended to try out how far the counting of individual plants in plots of usual size (leaving out commercial plantations on a large scale) could be performed in practice, laying down certain rules of procedure for ensuring that no plant is counted twice, and none are left out. These counts were taken for a number of selected fruit trees commonly grown in West Bengal and as a side study, height of the plant and its girth at foot, were also recorded for a subsample of trees within each sample plot.

As this enquiry was conducted on a properly designed probability sample, it was possible to obtain valid estimates of the number of fruit-trees living in West Bengal under certain categories or classes. The size of sample was however very small, hardly adequate even for giving the provincial estimates with any reasonable margin of error. Even such dimensional estimates and specially a study of the sampling errors should be of some interest for purposes of future planning. The results have been discussed in subsequent sections.

2. COVERAGE AND SAMPLING DESIGN

2.1. The entire State of reorganised West Bengal constituted the coverage of this special enquiry. A stratified two-stage sampling design with a revenue village as the first stage unit has been adopted for this survey, the second and ultimate sampling units being clusters of 10 plots each. The villages (which form the first stage units) and sample clusters have been chosen with probability proportional to area and with replacement. For collecting particulars of trees, e.g., height, girth etc., a subsample of trees had been selected from sample clusters where ever such trees were observed, following a procedure of systematic sampling. Altogether 624 villages were chosen for this survey, and a total of 52 investigators were employed.

2.2. The total number of sample villages was allocated to the different districts of West Bengal on a joint consideration of area under spring crops in 1954-55 and area under fruit-trees and vegetables in 1948-49. For this purpose, the total number of sample villages was distributed among the different districts proportional to (i) $g\sqrt{p_1q_1}$, where g=geographed area of the district, p_1=proportion of area under 'rabi' crops in 1954-55, $q_1=1-p_1$ and also (ii) $g\sqrt{p_2q_2}$, where p_2=proportion of area under fruit trees and vegetables in 1048-49, $q_2=1-p_2$ and g has the same meaning. A compromise allocation was then adopted by accepting first the larger one of the two allocations and subsequently adjusting the same as a multiple of six. Once the district allocations were made, the subsequent allocation to subdivisions which formed sampling strata, were generally made on the basis of the geographical areas of subdivisions. Altogether, there were 43 sampling strata from each of which, six villages (or a multiple of six) were selected.

2.3. From each stratum, the allocated number of sampling villages have been chosen with probability proportional to geographical area of villages, with replacements. This selection of villages was made in two independent sub-samples one of which was to be allocated to one half of the investigators and the other to the remaining half. These two sub-samples were accordingly termed as two interpenetrating but independent half-samples. Thus a particular village was surveyed by only one of the half-sample teams. This half-sampling was introduced for effecting a joint control over field work as well as in the stages of processing.

2.4. The period of survey from mid-March to mid-June has been divided into three monthly sub rounds and each half sample was accordingly split up into three instalments or lots, one to be surveyed within one month's time in a given order of priority. In each village 6 clusters of 10 plots each were to be enumerated for the determination of area under trees and also for taking a count of their number, along with the enumeration of other utlisations for each individual plot by the method of eye-estimation.

3. Operational procedure

3.1. *Counting of trees.* For counting the number of plants in a plot, the investigator was to start from the south-western corner of the plot and proceed roughly towards east and make a chalk mark at every fifth tree. After counting the trees in any row, he should recommence counting from the southern west extreme of the second row, and thus the entire plot was to be scanned out. This was comparatively easy where there was any tendency towards a row-wise plantation. With haphazardly grown trees, he was to mark out every plant once counted, proceed according to his convenience and put a special mark on every fifth plant. This would ensure that no plant has been overlooked or has been counted twice. In plots of a relatively larger size or with a high density of plantation, there is always some chance of making mistakes, but counting conducted in the above procedure is likely to be satisfactory and by and large reasonably accurate. Besides, the chalk marks left by the investigator

gator can later be followed up for inspection purposes. Apart from the direct advantages in adopting this procedure for the counting of trees, there is also an indirect benefit, namely, a psychological effect on the investigator, who with detailed instructions pin-pointing each step of the counting procedure is less liable to pass over the enumeration work in a slipshod manner. Besides, the very process of marking the plants systematically and the measurement of heights and girths adds to his interest in the work. For good results, it is always worthwhile to make the primary operations a little varied and interesting and thereby lessen the monotony and dullness of work.

3.2. *Height and girth of selected plants* After counting the trees, the investigator was required to estimate the height and girth at the foot of a number of plants. For mango, jack fruit, lichis, and black berry plants, height and girth was to be measured for every fifth plant and for date, palmyra, cocoanut and arecanuts which were usually more densely sown, for every tenth. It may be recalled, that in counting, every fifth plant was to be chalk-marked progressively. Thus, trees numbering 1, 6, 11, 16 etc. in sequence were selected in case of the first group, while numbers 1, 11, 21, 31 etc. were selected for the second group i.e., the palm family.

The height of a plant above the ground level was determined approximately by an eye estimation. As accurate measurement was not required, the investigator was merely asked to record the height in six broad classes, namely :

code	height class
1	less than 2 ft.
3	2 ft. or more but less than 5 ft.
3	5 ft. or more but less than 10 ft.
4	10 ft. or more but less than 15 ft.
5	15 ft. or more but less than 20 ft.
6	20 ft. and above

The girth of the plants nearest to the ground level was measured in inches and recorded in the appropriate columns of the crop-schedule. Each investigator was given a small metal tape which measures up to 5 ft. and is graduated to the tenth of an inch. This tape was also of some use in measuring the two lower height levels up to 5 ft.

4. BASIC RESULTS OF ENQUIRY

4.1. *Estimated number of plants in individual districts.* Table 1 gives the estimated number of plants for the different kinds of fruit trees by districts for the two half samples combined. The number of sample villages in each district has been shown in column (3). It may be noted here that the size of sample was very small on which reasonably precise estimates cannot be obtained at the district level, being hardly adequate for estimating even at the State level. Yet, this may give

a dimensional picture, bringing out the relative importance of the individual districts in respect of the different fruit crops. It will be seen that 24 Parganas tops the list in the cultivation of mango, cocoanut, arecanut, date, jackfruit and lichis, while Midnapore is a close second except in arecanut, where Jalpaiguri steps in and in cocoanut, where Howrah scores the second position. Midnapore takes the lead in blackberries and Nadia in jackfruits. For banana, largest contribution is form 24 Parganas, while Nadia, Midnapore and Hooghly follow in order of importance. Midnapore has the largest cultivation of guava, 24 Parganas coming next.

TABLE 1. ESTIMATED NUMBER OF PLANTS IN (000) BY INDIVIDUAL DISTRICTS ON THE TWO HALF-SAMPLES COMBINED

districts	geogra-phical area in sq. mile	number of sample villages	estimated number of trees in (000)									
			mango	jack-fruit	black berry	lichis	guava	date	pal-myra	coco-nut	areca nut	bana-na
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1. Bankura	2617	5	147	10	1	—	—	1295	651	—	—	—
2. Birbhum	1752	48	347	31	142	4	13	641	696	7	—	630
3. Burdwan	4098	48	405	41	15	1	3	986	713	189	—	613
4. Cooch Behar	1318	22	298	151	—	—	5	—	29	1	562	3695
5. Darjeeling	331	2	24	12	—	2	3	—	—	1	4	78
6. Hooghly	1174	27	367	122	13	6	35	365	632	224	—	7248
7. Howrah	543	17	376	160	2	25	22	328	655	852	172	1516
8. Jalpaiguri	2373	9	125	118	—	2	9	1	1	17	1371	2184
9. Malda	1380	76	839	66	11	2	10	78	406	2	1	671
10. Midnapore	5093	94	3156	194	375	32	231	3051	2469	646	197	7954
11. Murshidabad	2020	47	322	178	17	9	—	61	205	101	—	846
12. Nadia	1474	44	537	617	53	19	109	2387	260	97	318	8078
13. Purulia	2386	36	103	14	1	—	10	35	20	—	—	2
14. 24-Parganas	3539	41	1377	228	41	96	102	3691	1365	3216	1962	10354
15. West Dinajpur	2073	21	631	162	150	5	10	50	86	2	58	723
total	32180	537	9114	2094	821	173	622	12968	8179	5355	4555	44502

4.2. *Per acre cultivation of different species in individual districts.* It may be noted however that the geographical area of the individual districts has a wide variation, 24 Parganas and Midnapore being many times larger than Howrah, Hooghly, Nadia, Purulia or West Dinajpur. It will be interesting therefore to examine the per square mile densities of fruit cultivation in the different districts. Table 2 gives the estimated number of plants per square mile of geographical area. The position now undergoes a radical change.

TABLE 2. ESTIMATED NUMBER OF PLANTS PER SQUARE MILE BY INDIVIDUAL DISTRICTS ON THE TWO HALF-SAMPLES COMBINED

districts	geogra-phical area in sq. mile	number of sample villages	estimated number of trees per square mile									
			mango	jack fruit	black berry	lichis	guava	date	pal-myra	cocoa-nut	areca nut	banana
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1. Bankura	2617	5	56	4	0	—	—	495	249	—	—	—
2. Birbhum	1752	48	198	18	81	2	7	366	397	4	—	300
3. Burdwan	4098	48	113	10	4	0	1	241	174	46	0	150
4. Cooch Behar	1318	22	226	115	—	—	4	—	15	1	426	2735
5. Darjeeling	331	2	73	36	—	6	9	—	—	3	12	236
6. Hooghly	1174	27	313	104	11	5	30	302	538	191	—	6172
7. Howrah	543	17	692	276	4	46	41	604	1206	1568	317	2791
8. Jalpaiguri	2373	9	53	50	—	1	4	0	0	7	578	920
9. Malda	1380	76	608	48	8	1	7	57	294	1	1	486
10. Midnapore	5093	94	620	38	74	0	45	590	485	127	21	1562
11. Murshidabad	2029	47	159	88	8	4	—	30	101	50	—	417
12. Nadia	1474	44	364	419	36	13	74	1619	176	66	216	5480
13. Purulia	2386	36	43	6	0	—	4	15	8	—	—	1
14. 24-Parganas	3539	41	389	64	12	27	40	1043	386	909	554	2926
15. West Dinajpur	2073	21	304	78	72	2	5	28	41	1	28	340
total	32180	537	283	65	26	5	19	403	254	166	142	1383

4.3. *Provincial estimates.* Table 3 gives the estimated number of plants of each kind for the State of West Bengal as a whole, separately by half samples and for the combined. Standard errors and percentage variabilities of the combined estimates have also been given side by side. The sampling errors have been built up on the half-sample variations with one degree of freedom at the level of individual districts, instead of more properly building up from the stratum level, there being altogether 43 strata over the fourteen districts for which the data was collected. The percentage variabilities of the estimated number of plants are rather high. Nevertheless, it gives an indication regarding the size of sample necessary for estimating within a given margin of error.

The number of mango trees has been estimated with a percentage variability of 7.5, dates and cocoanuts are close around, having 7.6 and 9.1 respectively. The highest variability is obtained in black berries, areca nuts, bananas and lichis following

in order. A sample size several times as large seems to be necessary for estimating with a reasonable precision in the latter cases.

TABLE 3. PROVINCIAL ESTIMATES OF THE NUMBER OF TOTAL PLANTS BY HALF SAMPLES ALONG WITH THEIR STANDARD ERRORS

plant	estimated number of plants (000)			percentage variabilities
	h.s.1	h.s.2	combined	
(1)	(2)	(3)	(4)	(5)
1. mango	8680	9695	9114± 680	7.5
2. jack-fruit	2164	2062	2094± 275	13.1
3. black berry	759	915	821± 312	38.0
4. lichis	159	210	173± 34	19.7
5. guava	574	678	622± 111	17.9
6. date	12782	13346	12968± 983	7.6
7. palmyra	9374	7335	8170± 854	10.4
8. cocoanut	5423	5756	5555± 486	9.1
9. arecanut	3308	5919	4555± 987	21.7
10. banana	31083	62006	44502±9093	20.4

4.4. *Distribution of plants by height levels in individual districts.* It may be recalled that height as well as girth was recorded for a sub-sample of plants from within each plot, the sub-sampling fraction being 1 in 5 for mango, blackberry, jack fruit and lichis and 1 in 10 for those of the palm family. For guava and banana, height and girth measurements were not taken. The frequencies of plants under a two-way distribution by height and girth levels were weighted by the estimated number of plants at the stratum level, and the same were totalled up over strata to give the estimated number of plants in each class cell.

Table A.1 gives the distribution of the total number of plants into the six height levels for individual districts obtained by combining the two half samples. Although the estimates at the district level further detailed under height classes are liable to very high margins of error, a dimensional picture of the pattern of height-wise distribution in individual districts would be revealing. It would show, for instance, the need of supplementing the particular height levels, if we want to maintain a continuous succession of the adult population of fruit trees. Height as we understand, broadly describes the age of a plant. If therefore we find a shortage of plants at a particular age-level, continuity of propagation is affected. The mortality rate in plants must be made up by a fresh income of the crop and new plantations must be planned accordingly. This one study would be far from adequate for that purpose. Repeated observations would not only give us an indication of the mortality in fully

adult plants, but also the incidence of plant mortality at intermediate ages. A batch of seedlings newly planted should show up with a corresponding increase in the appropriate age group, i.e., height level, when reviewed at given intervals. Such a study would give us the age-specific mortality rates and would also furnish us with data for the true calibration of the height scales against age-increments.

A close review of Table A.1 would disclose a lot of local peculiarities in fruit culture. But the task is quite laborious and the present material is too scanty for the purpose. The object of the present study was merely to draw particular attention to the importance of bringing out the local growth patterns for a ready reckoning of the actual situation.

TABLE 4. DISTRIBUTION OF TOTAL PLANTS ACCORDING TO THEIR HEIGHT LEVELS FOR THE PROVINCE OF WEST BENGAL SEPARATELY BY HALF-SAMPLES

height levels	mango			jackfruit			blackberry			lichis		
	h.s.-1	h.s.-2	total	h.s.-1	h.s.-2	total	h.s.-1	h.s.-2	total	h.s.-1	h.s.-2	total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(a) trees with hard timber												
less than 2′	46	47	41	10	36	34	—	4	2	2	2	3
2′ — 5′	310	577	482	106	109	144	55	59	57	1	5	5
5′ — 10′	644	967	855	193	252	235	132	199	164	17	12	15
10′ — 15′	1639	1269	1449	369	240	305	188	176	180	6	13	9
15′ — 20′	2041	1690	1848	504	391	412	126	198	163	79	17	30
20′ and above	4000	5125	4409	982	1034	964	258	279	255	54	161	111
total	8680	9695	9114	2164	2062	2094	759	915	821	159	210	173
(b) palm family												
height levels	date			palmyra			cocoanut			arecanut		
	h.s.-1	h.s.-2	total	h.s.-1	h.s.-2	total	h.s.-1	h.s.-2	total	h.s.-1	h.s.-2	total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
less than 2′	829	1535	1426	429	296	359	—	48	20	349	808	541
2′ — 5′	1955	2491	2189	989	672	841	69	45	60	316	1349	801
5′ — 10′	2210	1807	1982	996	527	753	130	254	176	31	272	147
10′ — 15′	2160	1625	1927	824	724	760	455	253	361	570	143	324
15′ — 20′	1785	2122	1846	1018	739	962	645	467	531	722	644	727
20′ and above	3843	3766	3598	5118	4377	4474	4124	4689	4207	1380	2703	2015
total	12782	13346	12968	9374	7335	8170	5423	5756	5355	3368	5919	4555

4.5. *Provincial distribution of plants according to their height levels, separately by the two half-samples.* Table A.1 gives the distribution of the different kinds of fruit trees under different height levels for the State as a whole by half-samples and combined. It may be said that the agreement between the two half-sample estimates is not unsatisfactory, considering the size of sample.

4.6. *Distribution of mango plants according to their girth levels.* Height of plants seems to have a greater importance as an indicator of plant age. Girth of these plants had also been measured along with their heights except for guava and bananas. A distribution of the mango trees only by their girth levels in individual districts is being given in Table 5.

TABLE 5. DISTRIBUTION OF THE MANGO TREES ACCORDING TO THEIR GIRTH MEASUREMENTS, TAKEN AT THE GROUND LEVEL IN INDIVIDUAL DISTRICTS, ON TWO HALF-SAMPLES COMBINED

district	number of plants (000) according to girth in inches						
	0—10	11—20	21—40	41—80	81—120	121 above	total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Bankura	29.4	—	42.0	66.0	4.4	4.4	146.8
2. Birbhum	14.4	3.1	92.8	153.2	55.3	28.1	346.9
3. Burdwan	21.9	17.6	37.9	243.9	128.8	14.5	464.6
4. Cooch Bihar	6.5	10.4	89.1	152.7	31.2	8.4	298.3
5. Darjeeling	0.7	3.9	2.2	17.6	—	—	24.4
6. Hooghly	25.8	33.7	43.8	148.1	115.8	—	367.2
7. Howrah	19.7	33.8	111.4	205.3	2.2	3.1	375.5
8. Jalpaiguri	7.3	7.3	21.1	69.9	9.9	9.6	125.1
9. Maldah	67.2	67.2	92.3	495.2	100.7	16.8	839.4
10. Midnapore	280.7	587.0	1232.5	1014.4	31.0	3.8	3155.4
11. Murshidabad	—	1.6	27.8	98.4	182.2	13.8	321.8
12. Nadia	191.8	54.2	133.9	135.4	19.5	2.2	537.0
12. Purulia	2.6	1.5	18.5	40.1	31.4	8.5	102.6
14. 24 Parganas	202.4	147.7	387.3	504.1	122.6	13.2	1377.3
15. West Dinajpur	47.1	76.4	124.1	239.0	122.4	22.4	631.4
total	923.5	1045.4	2457.3	3581.3	957.4	148.8	9113.7

The maximum crowding of plants is observed at the level 41"—80" except in Midnapore, where the peak number is in the group 21"–40" in Nadia, where it occurs in the lowest group below 10" and in Murshidabad between 81"—120". This is in contrast with the picture shown in Table A.1 i.e., the distribution of plants according to their height levels. This shows that height may not be very strongly correlated with girth, although one would expect a larger girth associated with taller

plants. Thus, in Nadia, it appears there are a lot of mango trees which are quite tall and yet with a small girth.

4.7. *Distribution of mango trees under a joint classification by height and girth levels.* Table 6 gives a distribution of mango trees in the whole of West Bengal under a two-way classification of height and girth. It appears that when all West Bengal is pooled up supressing the regional peculiarities of individual districts, the correlation between height and girth is small. For a detailed distribution under height or girth, mango trees were chosen solely with the idea of studying a plant whose timber has some value in the market. It is possible in fact to estimate the volume of timber for all plants above a certain girth, or above a certain height or for all heights and girths taken together if heights and girths are measured at sufficiently close intervals. And to measure volume, it will be much better to have two or three girth measurements at different heights from the ground level instead of only one as has been done in the present experiment. The present study could not of course tackle this problem, and its object being merely in developing an operational procedure for enumerating the area utilised under orchards.

TABLE 6. DISTRIBUTION OF MANGO TREES JOINTLY UNDER HEIGHT AND GIRTH LEVEL FOR THE PROVINCE OF WEST BENGAL AS A WHOLE FOR THE TWO HALF-SAMPLES COMBINED

height level	number of plants (000) according to girth in inches						
	0—10	11—20	21—40	41—80	81—120	121 and above	total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. less than 2′	38.9	—	—	2.1	—	—	41.0
2. 2′— 5′	414.8	60.9	6.5	—	—	—	482.2
3. 5′—10′	302.3	378.5	113.6	24.7	1.7	4.4	885.2
4. 10′—15′	84.1	374.6	738.0	252.0	—	—	1448.7
5. 15′—20′	9.5	129.1	787.6	865.5	60.9	5.7	1848.3
6. 20′ and above	13.9	102.3	811.6	2447.0	894.8	138.7	4408.3
total	923.5	1045.4	2457.3	3581.3	957.4	148.8	9113.7

5. THE PROBLEM OF MIXED CULTIVATION IN ORCHARDS 24 PARGANAS, 1957-58

5.1. *Conventional acreage under fruit trees cultivated in mixture versus the number of plants.* It is possible to work out the average density of plants of different species per unit of area under orchards. This can be done on the basis of a total plant count and the gross or net acreage under orchards. Table 7 gives the density of coconut plants per acre of gross orchard area against the percentage utilisation intervals. In computing the percentage of utilisation, the conventional net acreage allocated to coconuts when cultivated in mixture with others had to be considered for each utilisation in an orchard i.e. that portion of the cadastral plot which is cultivated under fruits. The so-called allocation of area to the component crops

by the method of eye-estimation is however of a doubtful value and hence a state-wide analysis of the material was not considered worthwhile. The analysis has therefore been confined to cocoanuts in 24 Parganas, an important district of the State, for purposes of a detailed investigation. The correlation co-efficient between the two variates, namely, between density per acre and percentage area under cocoanut plants is small and has been obtained as 0.3327. This shows that the usual eye-estimation of area 'covered' by different types of plants to total area over all types of plants fails to correctly represent the relative stand of plants. In the events of a close association between absolute density and relative coverage in terms of area, we could have concluded that, eye-estimation can be accepted for all practical purposes, as a reasonably workable method in forecasting the number of plants. The average percentage of area at each density level and the average densities per acre of gross orchard area at each percentage level have also been given in the margins of Table 7.

TABLE 7. TWO-WAY DISTRIBUTION OF ORCHARDS BY DENSITY OF COCOANUT PLANTS PER ACRE AND PERCENTAGE AREA UNDER COCOANUT PLANTS OBTAINED THROUGH EYE-ESTIMATION, 24-PARGANAS, 1957-58

number of cocoanut plants per acre of area as per complete count	percent of net area under cocoanuts to total orchard area as reported by eye-estimation												
	-5%	-10%	-20%	-30%	-40%	-50%	-60%	-70%	-80%	-90%	100%	total	average percentage
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
less than 5	6	–	–	–	–	–	–	–	–	–	–	6	2.2
— 20	7	1	3	–	–	–	–	–	–	–	–	11	6.3
— 25	5	8	7	1	–	–	–	–	–	–	–	21	9.8
— 50	7	10	17	7	2	1	–	–	–	–	1	45	16.5
— 100	4	9	18	11	6	4	1	–	1	–	1	55	22.9
— 200	1	7	18	21	12	9	3	2	–	–	2	75	29.2
— 300	4	–	5	3	6	9	3	2	–	–	3	35	39.1
— 400	1	1	2	1	3	4	–	2	1	1	4	20	50.4
— 500	–	1	1	2	1	2	2	1	–	1	2	13	51.4
— 600	–	1	2	–	2	2	–	–	–	2	–	9	41.3
— 700	–	–	–	–	2	–	–	2	1	1	1	7	65.5
— 800	–	–	–	–	1	–	–	–	–	–	–	1	35.5
— 900	–	–	–	–	–	–	–	1	–	1	2	4	85.4
— 1000	–	–	–	–	–	–	–	–	–	–	–	–	—
1000 and above	11	–	1	–	4	5	–	2	–	1	10	34	46.4
total	46	38	74	46	39	30	9	12	3	7	26	336	30.6
average density	529	95	140	136	423	481	242	675	368	771	993	359	

The overall density of plants per acre will also be of some interest. This gives us an overall plant specific density of cultivation per acre of gross orchard area and if this density is found to be reasonably stable for a particular region, a district say, the usual eye-estimation of net area under a particular plant combined with its characteristic density as a technological factor, may give us dimensional estimates of the number of plants.

5.2. *Plant-specific density of fruit trees per acre of net cultivated area.* Table 8 gives the over all estimates of average density for a few fruit trees in the district of 24 Parganas. Separate estimates by the two half-samples, each in turn split up into three sub-samples representing the three sub-rounds, have been worked out. It will be seen that the number of plants per acre is fairly stable for palmyra, 'other fruit trees' and cocoanut, percentage variabilities being 6.1%, 12.4% and 15.1% respectively. Total net acreage under cocoa nuts was built up by contributions from plots having cocoanuts cultivated singly or in combination with others. In the former case, whole area, and in the latter case an allocated proportion of area was credited, to constitute the effective or net area under cocoanut cultivation. The percentage variability of the over all densities based on the six sub-sample means with five degrees of freedom have been computed and shown at the foot of Table 8. A comparative stability in the over all density for some of the plants indicates that with a reasonable size of sample, fairly stable technological ratios may be evolved.

TABLE 8. DENSITY OF FRUIT TREES PER ACRE OF NET AREA UNDER CULTIVATION, 24-PARGANAS, 1967-68

half-sample sub-rounds	density of plants per acre of net area					
	date	palmyra	cocoanut	arecanut	banana	other fruit trees
(1)	(2)	(3)	(4)	(5)	(6)	(7)
11	873	979	343	778	1110	124
12	612	653	368	1956	1095	94
13	558	998	589	3199	5879	106
21	950	760	256	446	1250	62
22	1064	808	576	2469	1954	154
23	2177	839	698	—	1356	121
total	816	810	428	2137	1437	93
percentage variability	27.0	6.1	15.1	21.0	48.8	12.4

5.3. *Percentage number of cocoanut plants to all plants versus the percentage of area under cocoanut in 24 Parganas.* In Tables 7 and 8, we have made use of percentage areas under cocoa nut plantation to the total orchard area as eye estimated by the investigator in the field. It may be noted here, that no fixed procedure was formulated in advance for the guidance of the investigator in making such eye estimates. For instance, 'standard' or specific coverages, i.e. 'spreads' could have been ascribed to each type of plant, the proportionate geographical area commanded by each could then be arrived at by weighting the number of plants of different types in the orchard by their respective 'coverage' specifics. As a matter of fact, it is little known as to how the investigator enumerates the percentage of area under a particular fruit tree when more than one type of fruit is cultivated in an orchard. He is asked to get his crop-records duly filled in, and this he does, presumably on the dictates of his own common sense and judgement. Eventually, some data is collected and we are in a position to tabulate them for whatever they are worth. It may frankly be stated, that this aspect has so far been ignored and did not receive the attention it deserves. A two way distribution of cocoanut orchards in 24 Parganas by percentage number of cocoanut plants to all fruit plants in the orchard against percentages of area under cocoanuts obtained by an eye-estimation, have been presented in Table 9.

TABLE 9. TWO-WAY DISTRIBUTION OF ORCHARDS BY PERCENTAGE OF THE NUMBER OF COCOANUT PLANT TO TOTAL PLANTS AGAINST THE PERCENTAGE AREAS UNDER THE COCOANUT PLANT TO TOTAL ORCHARD AREAS, 24-PARGANAS 1957-58

percentage of cocoanut plants to total fruit plants as per complete count	percentage area under cocoanut to total orchard area as reported by eye-estimation												
	–5%	–10%	–20%	–30%	–40%	–50%	–60%	–70%	–80%	–90%	–100%	total	average percentage
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
— 3%	8	3	1	1	–	1	–	–	–	–	–	14	9
— 5%	11	8	8	–	–	–	–	–	–	–	–	27	8
— 10%	6	9	26	10	1	–	–	–	–	–	–	51	15
— 20%	9	9	19	13	3	3	1	–	–	–	–	57	17
— 30%	5	3	12	8	9	4	–	–	–	–	–	41	22
— 40%	4	3	3	6	9	4	–	1	–	1	1	32	30
— 50%	1	3	4	4	6	13	4	2	1	–	2	40	40
— 60%	–	–	1	2	2	4	1	2	–	1	3	16	55
— 70%	–	–	–	1	4	3	–	1	1	1	–	11	48
— 80%	1	–	1	1	3	2	3	4	1	2	1	19	53
— 90%	–	–	–	–	1	1	–	–	–	2	1	5	69
— 100%	1	–	–	–	1	1	–	2	–	–	18	23	84
total	46	38	74	46	39	36	9	12	3	7	26	336	31

The chart reveals a strong correlation between these two characters and the coefficient of correlation works out to be 0.7675. This brings out that whatever be the guiding rules on principle, the returns are by and large made on the basis of their relative 'stands' rather than by relative 'coverages'. Thus the investigators virtually enter the percentages by an over-all visual review of the garden. It seems there is some prospect for a subsequent weighting of these 'proportionate numbers' by suitable technical 'specifics' for improvement. The marginal averages of the percentage figures obtained through eye-estimation given in the table indicate that there is a slight tendency of over estimation at the lower levels balanced by an under-estimation at the higher ones, compared to the relative proportions of cocoanut plants to the number of all plants.

5.4. *Patterns of fruit cultivation in orchards* (24 *Parganas*) *with a mixed cultivation.* The varieties of combinations in which fruit trees occur in domestic orchards are numerous, but only a few of them may be considered as important. A distribution of 624 sample orchards for 24 Parganas in 1958-59 according to all the possible combinations among (1) palmyra, (2) cocoanut, (3) mango, (4) arecanut and (5) other fruits, is shown below in Table 11. It will be observed that the first four are rarely cultivated singly by themselves except 'other fruits' which alone represents 28.2% of cases.

TABLE 10. PERCENTAGE OF ORCHARDS UNDER DIFFERENT COMBINATIONS OF FIVE IMPORTANT FRUITS IN 24-PARGANAS

combinations		percentage of orchards
	(1)	(2)
1.	palmyra	2.1
2.	cocoanut	3.7
3.	mango	2.4
4.	arecanut	0.3
5.	other fruits	28.2
6.	cocoanut, mango	4.5
7.	cocoanut, other fruit	5.1
8.	cocoanut, mango, other fruits	11.1
9.	cocoanut, palmyra, other fruits	5.6
10.	cocoanut, mango, palmyra, other fruits	6.7
11.	mango, other fruits	6.4
12.	palmyra, other fruits	7.2
13–31.	remaining 10 combinations	16.7
	total	100.0

It is expected, that the relative acreages under the different combinations will also be more or less similar to the relative frequencies of occurrence. If we have to sample for the estimation of acreage and yield for two crops, cocoanut and mango say, we shall have the following combinations to deal with :

TABLE 11. PERCENTAGE OF ORCHARDS UNDER DIFFERENT COMBINATIONS OF COCOANUT, MANGO AND OTHERS

combinations	number of orchards	percentage to total orchards with cocoanut and mango
(1)	(2)	(3)
1. cocoanut (singly)	23	6.0
2. mango (singly)	15	3.9
3. cocoanut with others *not* mango	89	23.2
4. mango with others *not* cocoanut	52	13.5
5. cocoanut and mango	28	7.3
6. cocoanut, mango and others	177	46.1
sub-total	384	100.0
7. others *not* cocoanut *nor* mango	240	
total	624	

The 28 orchards in category (5), growing cocoanut and mango plants only, were further examined and their distribution according to the proportion of cocoanut plants: mango plants is being given below. On an average, there are 3 cocoanuts to 2 mango trees in such orchards.

TABLE 12. DISTRIBUTION OF ORCHARDS WITH COCOANUT AND/OR MANGO, WITH VARYING PROPORTIONS OF COCOANUT PLANTS TO MANGO PLANTS

proportion of cocoanut plants to mango plants	number of orchards with cocoanut and mango
(1)	(2)
upto 0.50	6
— 1.00	8
— 2.00	8
— 3.00	2
— 4.00	2
— 5.00	1
— 7.50	1
total	28

This is rather of an academic interest, for it is neither practicable nor worthwhile to subdivide the individual combinations according to the relative intensities of their components. For production estimates, it is enough, if the acreages under a few important combinations are separately estimated along with their specific yield rates.

5.5. *Density of cocoanut plantation on size of orchards.* Table 13 gives the two way distribution of the orchards (parcels of cadastral plots under fruit cultivation) according to their size in acres and the density of cocoanut plants per acre of orchard area obtained by a complete counting of plants. As expected, the smaller orchards are more intensely utilised for cocoanuts and it is likely that the same will hold for other fruits also. This is of incidental interest and have no direct bearing on our main objective in finding out a suitable method for the enumeration of fruit acreage and outturn.

TABLE 13. TWO-WAY DISTRIBUTION OF ORCHARDS BY SIZE AGAINST DENSITY OF COCOANUT PLANTS PER ACRE OF GROSS ORCHARD AREA, 24-PARGANAS 1957-58

orchard size in acres	number of cocoanut trees per acre of orchard area (by actual count)												
	less than 10 or below 10	-25	-50	-100	-200	-300	-400	-500	-600	700	-700 & above	total	aver-age
(2)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
less than 0.03	—	—	—	5	29	19	12	6	8	7	36	122	760
— .05	—	1	11	13	22	12	4	4	1	—	3	71	228
— .10	—	6	9	15	21	3	3	2	—	—	—	59	126
— .15	4	3	6	8	1	1	—	—	—	—	—	23	57
— .20	—	4	6	5	1	—	—	—	—	—	—	16	51
— .25	—	—	4	1	1	—	—	—	—	—	—	6	62
— .30	4	3	1	1	—	—	1	—	—	—	—	10	54
— .35	1	1	2	2	—	—	—	—	—	—	—	6	42
— .40	1	2	—	—	—	—	—	—	—	—	—	3	14
— .45	—	—	1	2	—	—	—	—	—	—	—	3	62
— .50	2	—	2	—	—	—	—	—	—	—	—	4	20
— .60	1	1	1	1	—	—	—	—	—	—	—	4	34
— .70	—	—	3	—	—	—	—	—	—	—	—	3	38
— .80	—	—	—	—	—	—	—	—	—	—	—	—	—
— .90	—	—	—	—	—	—	—	—	—	—	—	—	—
— 1.00	—	—	—	1	—	—	—	—	—	—	—	1	75
— 1.50	—	—	—	—	—	—	—	—	—	—	—	—	—
1.50 & above	4	—	—	1	—	—	—	—	—	—	—	5	19
total	17	21	46	55	75	35	20	12	9	7	39	336	358

6. A REVIEW OF THE ACREAGE AND TOTAL NUMBER OF COCOANUT PLANTS IN WEST BENGAL, AS AVAILABLE FROM DIFFERENT SOURCES

6.1. *West Bengal statistics on acreage and production of fruit trees.* Very little work is known to have been done in this state on the statistics of fruit cultivation, either relating to acreage or regarding the number of plants and yield. In the year 1944-45, the Government of Bengal (undivided) conducted a plot to plot enumeration for the entire State and on this, acreage under certain fruits were compiled. The results were published in June 1946 as "Agricultural statistics by plot to plot enumeration in Bengal, year 1944-45" known as Ishaque's Report. This is the only published source which has an objective basis of enumeration. Although Ishaque's survey was conducted some 18 years ago and the reorganised districts of West Bengal have

undergone considerable changes during this time, this is still the best and in fact the only source regarding the extent of fruit cultivation in this State. The acreages under different crop and other utilisations were enumerated by the traditional method, namely by an eye-estimation of the proportionate area under a particular utilisation in individual plots. But this report does not account for the total acreage under a particular fruit tree, as will be evident from the following comments made in para 10(d) of pp 154 of the Report:

> "*Special notes for 'bagan' and fruit trees :* In case of bagan or other high lands, we may find a lot of them entirely covered with mango trees as in Maldah, Rajshahi, Bogra, Nadia and Murshidabad and such areas shall be noted under col. (6) with proper description (AAM). The areas covered by Supari (betelnut) or Narikel (cocoanut) in the districts of Barisal, Khulna, Noakhali and 24 Parganas will be treated in the same manner. Date trees are important for the production of sugar. The area of any land entirely covered by date trees will be recorded with proper description (Khejur) under column 6.
>
> It must be remembered that no estimate of area should be made for stray patches covered with mango, cocoanut, betelnut or date trees which are parts and parcels of homestead or of land which mainly grow other crops or vegetables and the trees stand here and there. In such a case, the entire area will be recorded either under homestead or any other crops or vegetables as the case may be."

It will be seen that the acreage under a fruit cultivation is not taken into account, when it is adjoining to a homestead or is exploited mainly for other crops or vegetables. It is not known if cocoanut cultivated in mixture with other fruit trees has been included or excluded by Ishaque. Cocoanuts grown about a homestead or on the banks of a pond have been definitely left out, while cocoanuts along with mango or other trees in mixture may have gone under the heading other fruit trees, other crops, or vegetables. The instruction given to the enumerator is rather vague leaving a good deal to the judgement and discretion of the investigator. From Table 8, we have seen that only 26 out of 336 cocoanut growing orchards (crop-plots) belonged to an "all cocoanut" (91%—100%) category, the rest representing stray plants or a sprinkling of cocoanuts in orchards with a mixed cultivation. Ishaque's acreages therefore give only a partial return of total cocoanut area. In fact, "domestic" cultivation is known to be commonly of mixed crops and rarely of single crop orchards.

6.2. *The Indian Central Cocoanut Committee.* In an article "Improvement of cocoanut statistics in India", in the *Cocoanut Bulletin* (Vol. 15, No. 8, November 1961, pp 284-286) published by the Indian Central Cocoanut Committee, Ministry of Food and Agriculture, Govt. of India, Dr. P. J. Gregory and M. S. Venkataraman have given an account of the current official methods of collecting data in the different States. The following comments regarding Assam, Orissa and West Bengal are being reproduced below:

> "no regular estimates of area under cocoanuts are prepared for Assam, Orissa or West Bengal and accurate village records of land use do not exist. Consequently, the figures of area under cocoanuts for Assam and Orissa are purely conjectural. In West Bengal also, the position was same upto 1944-45, where a plot to plot enumeration of agricultural crops was made. In 55-56, the Statistical Bureau of West Bengal Government conducted a sample survey to ascertain the number of cocoanut

palms and production of cocoanuts in the State. The figures of area under cocoanuts as estimated from this sample survey area about 3 times the figures from the plot to plot enumeration conducted in 44-45. Results of this survey have not been published and the precision of the estimate is not known. The yield data too appears to have been estimated by the enquiry method and not by crop-cutting experiments. In view of these, the results of this survey have not so far been included in the publications of the Government of India on Agricultural Situation."

An account of the recent improvements made in the different States have also been given in this article. Under the second five year plan (56-57 to 60-61), the Government of India provided necessary funds for sample surveys for the correct estimation of area and yield in all important cocoanut growing States. West Bengal however did not participate in these surveys during the second plan period.

Table 14 gives the acreage under cocoanuts for the reorganised districts of West Bengal, as built up on the basis of Ishaque's report, along with the corresponding acreages and production in (000) nuts for 1955-56 published by the cocoanut committee in their Cocoanut Atlas. The number of cocoanut trees estimated on the basis of the present experiments have also been shown. This review will not be of much help as it is, but the data is being reproduced here for convenience of future references.

TABLE 14. ACREAGE AND PRODUCTION OF COCOANUTS IN WEST BENGAL

district	Ishaque's area in acres, (1944-45)	cocoanut atlas		ISI; number of plants in (000) (1957-58)
		area in acres (54-55)	production in (000) nuts	
(1)	(2)	(3)	(4)	(5)
1. Bankura	1	1	1	—
2. Birbhum	20	20	27	7
3. Burdwan	322	322	435	189
4. Cooch Behar	—	—	—	1
5. Darjeeling(a)	0	—	—	1
6. Hooghly	1696	1696	2290	224
7. Howrah	5859	5059	7640	852
8. Jalpaiguri	36	36	49	17
9. Maldah	2	2	3	2
10. Midnapore	669	669	890	646
11. Murshidabad	229	229	309	101
12. Nadia	326	330	445	97
13. Purulia	—	—	—	—
14. 24-Parganas	7487	7487	10107	3216
15. West Dinajpore(b)	7	7	9	2
West Bengal(c)	16644	16448	22205	5355

(a) Siliguri Sub-division only, (b) excluding police stations transferred from Bihar,
(c) excluding Cooch Behar and Purulia.

6.3. *Net acreage under fruit trees in the district of 24 Parganas.* Table 15 below gives the estimates of net acreage under a few fruit trees in 24 Parganas based on Ishaque's and the corresponding estimates based on the present survey.

TABLE 15. ACREAGE UNDER FRUIT TREES IN 24 PARGANAS (INCLUDING MERGED POLICE STATIONS OF JESSORE)

fruit trees	area in acres Ishaque (1944-45) ISI (1957-58)	
(1)	(2)	(3)
1. cocoanut	7487	7520
2. arecanut	362	918
3. date	6787	4523
4. mango	22784	29413
5. other fruit trees	19348	
total : 24-Parganas	56768	42374

The two estimates of acreage for cocoanut in 24 Parganas, i.e., that of 1944-45 by Ishaque's and the present one, both based on the eye-estimation procedure are surprisingly close, and in fact one would feel uneasy at such coincidence, when one considers that in eye-estimation, the investigators had in either case no firm guiding principle for enumeration. But as has already been discussed, Ishaque's acreage and our acreage do not actually correspond. For, stray plants and those cultivated with other crops were not included by Ishaque, and such areas were merged under different heads.

6.4. *Production of cocoanuts in the district of 24 Parganas.* The yield rate computed on the basis of acreage and production published in the cocoanut atlas works out to be 1350 nuts per year per acre. A total production of 10107 (000) nuts against our estimate of the number of cocoanut plants as 3216 (000); gives an yield rate of 3.1 nuts per plant of all ages per year. Leaving out the younger plants below the height of 20' (which represents 15.5% of total plants according to Table 4 the yield rate works out to be 3.7 nuts per adult plant. This seems to be unusually low, total production being likely to be much higher in West Bengal.

Some results based on the first round of sample surveys started in 1958-59 in some of the States under the second five-year plan, have been given in the Cocoanut Bulletin, Vol. 15, No. 8 (november-61) referred to earlier. It is seen that Assam has an yield rate of 37 nuts per 'bearing' plant per year against 48 for Mysore. The proportion of 'bearing' palms to 'all' palms for these two states were obtained as 47% and 65% respectively (Table II). The gross yield rate per palm of all ages thus comes to 17.4 and 31.2 nuts respectively. Obviously, either the number of plants have been grossly overestimated in our present sample or the official productive figures given in the Cocoanut Atlas for West Bengal are absurdly low.

7. General observations

It is evident that a complete counting of plants, so far as it is operationally feasible, is the best and a direct propedure for purposes of estimating production. Allocated acreages under individual crops is an abstraction and further, is not an essential stage in the process of yield estimation. It's only importance may be felt for a formal accounting of the total land surface given under different uses. Such allocations made under any arbitrary set of conventions, if at all necessary, might also be done at the level of district aggregates. For instance, we may enumerate and estimate the gross acreage under orchards, crediting the entire area of an individual orchard to each of its components, same as is done in case of mixed crops in the National Sample Surveys. The sum total of gross acreages over different types of fruit plants would thus far exceed the geographical area under orchards. If the tabulation is done separately for each important combination of plants, i.e., mango alone, mango with cocoanut etc., the acreages from each of these combination classes may be subjected to any system of allocation and distributed among the component crops.

For yield estimating purposes, crop cutting may be done separately for a number of important combinations or combination groups. For each group, within each first stage unit, a village say, plots may be selected in the second stage with a probability proportionate to gross orchard area under particular cultivation for the estimation of gross acreage. In a second phase, the number of plants of each type may be completely counted up, in a number of selected orchards, within which a number of plants may be ultimately selected at random for crop cutting experiments. Thus, complete counting may be reduced and confined to the sample orchards selected for crop cutting. Even for estimating the total number of plants in a particular category, we may have a larger sample for which the gross areas under orchards will be enumerated, and then a smaller sub sample may be taken up for which all plants will be completely counted. A double sampling technique for estimatind gross acreage and the number of plants per acre of gross area may thus be adopted. For cocoanut, we have to classify the orchards into combination, cocoanut singly, cocoanut with arecanut, cocoanut with mango etc., including cocoanut with others and estimate the acreage under each and the corresponding, i.e., specific yield rates.

Apart from the geographical stratifications which would be essential, further sub-stratifications by combination classes, although desirable, cannot obviously be carried too far. A practical compromise shall have to be struck up, between gains in efficienoy by reducing the variability by stratification and the operational costs and complexities involved therein.

Acknowledgement

Analysis of the data was conducted under the able guidance of Sri J. N. Taluqdar and Sri P. Dey Sarkar. Sri Paul Jacob made considerable contribution by collecting relevant data on the subject from all available outside sources and in writing up Section 6.

Appendix

TABLE A.1. ESTIMATED NUMBER OF PLANTS BY THEIR HEIGHT LEVELS IN INDIVIDUAL DISTRICTS FOR THE TWO HALF-SAMPLES COMBINED

districts	number of plants (000) according to height levels						
	less than 2'	2'—5'	5'—10'	10'—15'	15'—20'	20' & above	total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			1. mango plants				
1. Bankura	—	14.7	19.1	4.4	19.1	89.5	146.8
2. Birbhum	—	3.1	22.5	55.0	97.7	168.6	346.0
3. Burdwan	2.2	—	28.5	43.0	162.6	228.3	464.6
4. Cooch Bihar	—	5.4	8.0	39.6	120.8	124.5	298.3
5. Darjeeling	—	—	2.0	4.1	6.1	12.2	24.4
6. Hooghly	—	9.5	5.1	28.1	34.5	290.0	367.2
7. Howrah	—	6.6	13.1	20.3	7.9	327.6	375.5
8. Jalpaiguri	—	—	8.9	11.1	29.4	75.7	125.1
9. Maldah	—	33.6	100.7	75.6	92.3	537.2	839.4
10. Midnapore	—	207.8	352.5	718.9	790.5	1085.7	3155.4
11. Murshidabad	2.2	—	—	9.7	15.0	294.9	321.8
12. Nadia	24.6	92.7	98.9	45.9	87.0	187.9	537.0
13. Purulia	—	—	—	14.1	12.6	75.9	102.6
14. 24 Parganas	2.6	81.7	151.6	214.0	192.2	735.2	1377.3
15. West Dinajpur	9.4	27.1	74.3	164.9	180.6	175.1	631.4
total	41.0	482.2	885.2	1448.7	1848.3	4408.3	9113.7
			2. jack-fruit plants				
1. Bankura	—	—	2.5	—	—	7.4	9.9
2. Birbhum	—	—	0.6	6.9	8.0	15.8	31.3
3. Burdwan	—	—	10.5	7.8	18.7	4.3	41.3
4. Cooch Bihar	—	—	4.3	36.1	71.4	39.3	151.1
5. Darjeeling	—	—	—	1.1	4.8	5.8	11.7
6. Hooghly	—	—	3.1	3.1	11.5	103.9	121.6
7. Howrah	—	—	—	5.5	32.5	112.2	150.2
8. Jalpaiguri	—	—	—	22.6	26.1	69.4	118.1
9. Maldah	0.6	4.0	7.3	4.6	13.2	36.3	66.0
10. Midnapore	—	10.3	42.8	38.8	43.0	59.6	194.5
11. Murshidabad	—	8.1	9.8	21.3	4.0	135.1	178.3
12. Nadia	33.2	98.6	90.8	84.4	126.6	185.6	617.2
13. Purulia	—	—	—	0.1	3.4	10.4	13.9
14. 24-Parganas	—	8.1	19.4	39.6	34.5	125.9	227.5
15. West Dinajpur	—	16.9	44.1	32.8	14.7	53.3	161.8
total	33.8	144.0	235.2	304.7	412.4	984.3	2094.4

TABLE A.1 (*Contd.*). ESTIMATED NUMBER OF PLANTS BY THEIR HEIGHT LEVELS IN INDIVIDUAL DISTRICTS FOR THE TWO HALF-SAMPLES COMBINED

districts	number of plants (000) according to height level						
	less than 2′	2′—5′	5′—10′	10′—15′	15′—20′	20′ & above	total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			3. black-berry plants				
1. Bankura	—	—	0.5	—	—	—	0.5
2. Birbhum	—	—	46.5	39.8	30.1	25.8	142.2
3. Burdwan	1.5	—	1.2	1.2	6.3	4.8	15.0
4. Cooch Bihar	—	—	—	—	—	—	—
5. Darjeeling	—	—	—	—	—	—	—
6. Hooghly	—	—	—	—	—	13.9	13.9
7. Howrah	—	—	—	—	—	2.4	2.4
8. Jalpaiguri	—	—	—	—	—	—	—
9. Maldah	—	—	1.1	2.3	0.5	7.4	11.3
10. Midnapore	—	23.9	68.2	46.5	88.9	146.8	374.3
11. Murshidabad	—	—	—	—	—	17.3	17.3
12. Nadia	0.4	7.9	4.9	21.3	6.4	11.8	52.7
13. Purulia	—	—	—	—	—	1.2	1.2
14. 24 Parganas	—	—	1.0	8.3	16.5	15.5	41.3
15. West Dinajpur	—	24.9	40.6	60.2	14.7	9.4	149.8
total	1.9	56.7	164.0	179.6	163.4	256.3	820.9
			4. litchi plants				
1. Bankura	—	—	—	—	—	—	—
2. Birbhum	—	—	—	—	3.9	—	3.9
3. Burdwan	—	—	—	—	—	0.9	0.9
4. Cooch Bihar	—	—	—	—	—	—	—
5. Darjeeling	—	—	—	2.1	—	—	2.1
6. Hooghly	—	1.9	3.7	—	—	—	5.6
7. Howrah	—	—	—	—	—	24.5	24.5
8. Jalpaiguri	—	—	—	—	0.6	1.2	1.8
9. Maldah	1.4	0.3	—	—	—	—	1.7
10. Midnapore	—	—	1.9	—	—	0.6	2.5
11. Murshidabad	—	—	—	—	—	8.8	8.8
12. Nadia	1.2	3.1	6.3	2.3	3.0	3.3	19.2
13. Purulia	—	—	—	—	—	—	—
14. 24 Parganas	—	—	2.9	4.3	22.4	66.9	96.5
15. West Dinajpur	—	—	—	—	—	5.1	5.1
total	2.6	5.3	14.8	8.7	29 9	111.3	172.6

TABLE A.1 (*Contd.*): ESTIMATED NUMBER OF PLANTS BY THEIR HEIGHT LEVELS IN INDIVIDUAL DISTRICTS FOR THE TWO HALF-SAMPLES COMBINED

districts	number of plants (000) according to height level						
	less than 2'	2'—5'	5'—10'	10'—15'	15'—20'	20' & above	total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			6. date plants				
1. Bankura	531.2	129.5	181.4	181.4	64.8	207.3	1296.0
2. Birbhum	141.0	97.0	83.6	65.3	94.3	158.6	640.7
3. Burdwan	37.0	209.2	282.7	177.4	125.2	154.5	986.0
4. Cooch Bihar	—	—	—	—	—	—	—
5. Darjeeling	—	—	—	—	—	—	—
6. Hooghly	2.8	62.3	91.3	50.2	49.0	99.7	355.3
7. Howrah	—	—	5.7	11.1	46.2	265.4	328.4
8. Jalpaiguri	—	—	—	—	—	0.7	0.7
9. Maldah	0.8	15.6	28.1	4.7	7.0	21.8	79.0
10. Midnapore	486.5	587.1	473.4	421.0	436.7	646.0	3050.7
11. Murshidabad	—	—	—	—	16.5	44.2	60.7
12. Nadia	180.0	562.5	321.8	333.7	310.2	679.4	2387.6
13. Purulia	—	25.6	—	—	4.4	4.6	34.6
14. 24 Parganas	46.1	500.3	513.6	882.4	633.1	1315.6	3891.0
15. West Dinajpur	—	—	—	—	58.8	—	58.8
total	1426.3	2189.1	1981.5	1927.2	1843.2	3597.8	12968.1
			7. palmyra plants				
1. Bankura	—	91.1	91.1	91.1	65.1	312.4	650.8
2. Birbhum	102.3	62.7	62.3	40.3	74.0	354.7	696.3
3. Burdwan	7.4	51.3	11.1	22.0	114.7	506.6	713.1
4. Cooch Bihar	—	—	—	—	—	20.4	20.4
5. Darjeeling	—	—	—	—	—	—	—
6. Hooghly	—	—	71.6	124.6	111.0	324.3	631.5
7. Howrah	—	—	—	25.1	15.0	614.4	654.5
8. Jalpaiguri	—	—	—	—	—	0.7	0.7
9. Maldah	97.5	69.1	40.6	12.2	12.2	174.8	408.4
10. Midnapore	118.2	331.1	299.0	354.0	404.7	962.2	2469.2
11. Murshidabad	—	—	2.0	—	9.8	193.1	204.9
12. Nadia	15.8	46.7	26.5	8.7	40.0	123.5	266.2
13. Purulia	—	—	—	1.6	5.0	13.4	20.0
14. 24 Parganas	17.7	131.8	149.6	111.0	110.7	844.4	1365.2
15. West Dinajpur	—	50.8	—	—	—	29.1	85.9
total	358.9	840.6	762.8	790.6	962.2	4474.0	8179.1

TABLE A.1 (*Contd.*). ESTIMATED NUMBER OF PLANTS BY THEIR HEIGHT LEVELS IN INDIVIDUAL DISTRICTS FOR THE TWO HALF-SAMPLES COMBINED

districts	number of plants (000) according to height level						
	less than 2'	2'—5'	5'—10'	10'—15'	15'—20'	20 & above	total
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			8. cocoanut plants				
1. Bankura	—	—	—	—	—	—	—
2. Birbhum	—	—	—	—	—	7.0	7.0
3. Burdwan	—	11.1	31.5	33.3	66.9	46.6	189.4
4. Cooch Bihar	—	—	—	—	1.2	—	1.2
5. Darjeeling	—	—	—	—	—	0.8	0.8
6. Hooghly	—	17.4	17.4	9.0	9.9	170.1	223.8
7. Howrah	—	—	—	15.4	34.2	802.7	852.3
8. Jalpaiguri	—	—	—	—	11.0	6.0	17.0
9. Maldah	—	—	—	—	—	1.8	1.8
10. Midnapore	14.9	—	70.7	89.8	109.3	361.6	646.3
11. Murshidabad	—	—	—	8.2	46.1	46.7	101.0
12. Nadia	4.8	12.9	14.8	11.6	8.0	45.2	97.3
13. Purulia	—	—	—	—	—	—	—
14. 24 Parganas	—	18.8	41.6	193.7	244.4	2717.3	3215.8
15. West Dinajpur	—	—	—	—	0.5	1.1	1.6
total	19.7	60.2	176.0	361.0	531.5	4206.9	5355.3
			9. arecanut plants				
1. Bankura	—	—	—	—	—	—	—
2. Birbhum	—	—	—	—	—	—	—
3. Burdwan	0.0	—	—	—	—	—	0.0
4. Cooch Bihar	—	20.0	14.4	78.3	189.4	260.0	562.1
5. Darjeeling	—	—	—	3.7	—	—	3.7
6. Hooghly	—	—	—	—	—	—	—
7. Howrah	—	—	—	—	12.8	159.3	172.1
8. Jalpaiguri	—	151.1	47.5	123.6	289.2	760.1	1371.5
9. Maldah	1.3	—	—	—	—	—	1.3
10. Midnapore	—	10.9	32.0	21.1	28.8	14.2	107.0
11. Murshidabad	—	—	—	—	—	—	—
12. Nadia	164.4	140.5	23.0	—	—	—	317.9
13. Purulia	—	—	—	—	—	—	—
14. 24 Parganas	386.1	478.9	30.3	39.2	206.4	821.7	1961.6
15. West Dinajpur	—	—	—	57.7	—	—	57.7
total	540.8	801.4	147.2	323.6	726.6	2015.3	4554.9

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