Report on a Random Sample Survey of Paddy Yields in the Kandy, Kegalla and Ratnapura Districts

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UP to the time that the survey reported herein was undertaken, a valid estimate by a statistically satisfactory method, of the acre yield in a paddy tract, had not been attempted in this country. Traditional estimates have been extremely low, and the statement that Ceylon yields are among the lowest in the world is common. The low estimate that the peasant usually provides of the yield of his fields, has been blamed on various factors including the share system of tenancy and the belief in the evil eye. The validity of available estimates has often been questioned, and the need for checking on their accuracy by a random sampling method has been frequently urged. At the request of the Director of Census and Statistics, a pilot survey aimed partly at securing yield estimates, and partly at developing sampling methods suitable for subsequent island-wide use, was undertaken in the *yala* season, 1949. The survey covered a total extent of 48,652 acres of cultivated paddy, and included the whole of the Kegalla and Kandy Districts, and 57 per cent. of the paddy acreage in the Ratnapura District.

DESIGN AND METHODS

Multi-stage sampling without weightage for extent was used. First-stage sampling was stratified. It was convenient for purposes of organisation. and equitable from the point of view of division of labour, to treat Agricultural Instructors' ranges as strata. Moreover, as the ranges represent different soil and climatic types, it was expected that stratification would contribute to precision. Each range consists of one or more korales. The stratification and the acreages of cultivated paddy in the *yala* season, 1949, in the area covered by the survey are given in Table 1. Acreage figures were derived by the method of complete enumeration by the Department of Census and Statistics, and possess a high degree of accuracy.

Within each stratum, viz., each Agricultural Instructor's range, nineteen random Village Headmen's Divisions were selected. The 1945-1946 Census list published by the Department of Census and Statistics, formed the frame from which the random Village Headmen's Divisions were drawn. Two random kumburas were selected within each Village Headman's Division. A single random 1/403 acre (18 ft. × 6 ft.) plot was cut from each kumbura.

The plot size in crop-cutting surveys has been the subject of much controversy. In England and the U.S.A., diminutive plots are used. Indian statisticians, except Prof. P. C. Mahalanobis, however, favour the use of plots of considerable size, e.g., 1/10 acre plots for cotton, and 1/20—1/80 acre plots for paddy. In the area under survey, the frequent occurrence on terraced land of narrow liyaddes prevents the use of large, isodiametric plots. It has been agued that the relatively large perimeter of small plots may lead to over-estimation of yields, and it was with much misgiving that I committed myself to a plot size of 1/403 acre in the instance of the present survey. Plots of this size are not recommended for general adoption in an island-wide survey, and their use should be restricted to areas where large plots are not possible.

Appendix 1 reproduces the detailed instructions distributed to all Agricultural Instructors participating in the survey, on the procedure for demarcating and harvesting a random plot in each kumbura. Schedule A mentioned in Appendix 1 is attached. This schedule elicits information

TABLE I

Districts		*Agricultural Instructors' Ranges*		*Korales*	
Name	*Acreage under Paddy*	*Name*	*Acreage under Paddy*	*Name*	*Acreage under Paddy*
Kandy	23,528	Yatinuwara	3,145	Yatinuwara Udunuwara	2,825
				Kandy Gravets	320
		Harispattuwa	5,826	Harispattuwa	3,530
				Tumpane	2,296
		Dumbara	10,421	Pata Dumbara	4,686
				Uda Dumbara	5,735
		Pata Hewaheta	1,772	Pata Hewaheta	1,772
		Uda Bulatgama	2,364	Uda Bulatgama	92
				Uda Palata	2,272
Kegalla	15,420	Galboda-Kinigoda	6,714	Galboda-Kinigoda	6,714
		Paranakuru	4,920	Paranakuru	4,920
		Beligal	1,774	Beligal	1,774
		Lower Bulatgama	2,012	Lower Bulatgama and Dehigampal	1,027
				Atulugam and Panawal	985
Ratnapura	9,704	Kuruwita	4,400	Kuruwita	4,400
		Nawadun	5,304	Nawadun	5,304
Total	48,652		—		—

on prevailing cultural and manurial practices and on varieties grown. Instructions and questionnaires owe much to those issued by Dr. P. V. Sukatme, Statistical Adviser, Indian Council of Agricultural Research, New Delhi. Before the commencement of the survey I held three rehearsals which the Divisional Agricultural Officer, Central, his Senior Assistant and Agricultural Instructors concerned in the survey attended.

Each randomly selected kumbura was inspected by the Agricultural Instructor responsible, on a date well ahead of harvesting. On this occasion, the cultivator's consent to the use of his kumbura in the survey was secured, and the date of harvesting was tentatively agreed on. Any change in the harvesting date was to be communicated by the cultivator to the Instructor. The periods over which harvesting of plots proceeded in the various ranges are given below:

Range	*Period of Harvesting of Plots*
Yatinuwara ..	July 26 —August 31
Harispattuwa ..	August 20 —October 30
Dumbara	August 8 —November 25
Pata Hewaheta ..	July 26 —October 5
Uda Bulatgama ..	July 17 —September 6
Galboda-Kinigoda ..	August 9 —September 14
Paranakuru ..	August 10 —October 5
Beligal	August 1 —September 11
Lower Bulatgama ..	July 17 —September 13
Kuruwita	August 2 —September 22
Nawadun	August 12 —November 3

Yala harvest in the Dumbara range extended into late November.

The samples of stalk paddy received at the Botanist's Station, Katugastota, were threshed, winnowed, cleaned, sun-dried for fourteen days and weighed. The survey provided a rare collection of land races of paddy which were retained by me; equivalent quantities of consumption paddy were returned to cultivators.

The season of the survey showed no striking deviation from normality in the instance of the Kandy District and in the Eastern half of the Ratnapura District. *Yala* 1949 precipitation in the Kegalla District and in the Western half of the Ratnapura District was above normal. A table of deviations from normal rainfall is given in Appendix 2.

RESULTS

Yield per Acre.—The estimation of the mean yield per acre for the area covered was the primary object of the survey. The mean acre yields of paddy for the eleven strata were calculated, and are listed in column three of Table 2. Standard errors providing a measure of the variation between Village Headmen's Divisions within a stratum are given in column four. The figure for total output in the last column of the table is derived from the product of the acreage and the mean acre yield. Stratum yields weighted for acreage and aggregated districtwise and for the whole area surveyed, are also presented.

The weighted mean yield for the whole area covered by the survey was 27 bushels* of paddy per acre. This figure has a standard error of $2\frac{1}{2}$ per cent., and has accordingly high precision. The exact meaning of an acre-yield figure of 27 bushels with a $2\frac{1}{2}$ per cent. standard error should be made clear: this estimate implies a 95 per cent. certainty that the true yield of the area surveyed cannot be less than $25\frac{1}{2}$ bushels per acre, and cannot exceed $28\frac{1}{2}$ bushels per acre.

TABLE 2.—Acre Yields and Total Production of Paddy

District	*Agricultural Instructor's Range*	*Mean Yield of Paddy in Bushels per Acre*	*Standard Error*	*Percentage Standard Error*	*Acreage under Paddy*	*Total Production of Paddy in Bushels*
Kandy	Yatinuwara	27·8	±1·5	±5·4	3,145	87,431
	Harispattuwa	29·3	±1·8	±6·1	5,826	170,702
	Dumbara	30·5	±2·3	±7·5	10,421	317,841
	Pata Hewaheta	41·0	±2·3	±5·6	1,772	72,652
	Uda Bulathgama	26·7	±2·4	±9·0	2,364	63,119
	District Total	30·2	—	—	23,528	710,546
Kegalla	Galboda-Kinigoda	30·6	±1·6	±5·2	6,714	205,448
	Paranakuru	26·7	±1·8	±6·7	4,920	131,364
	Beligal	23·6	±2·0	±8·5	1,774	41,866
	Lower Bulathgama	21·5	±1·5	±7·0	2,012	43,258
	District Total	27·4	—	—	15,420	422,508
Ratnapura	Kuruwita	18·3	±2·2	±12·0	4,400	80,520
	Nawadun	21·5	±1·1	±5·1	5,304	114,036
	District Total	20·1	—	—	9,704	195,050
Total for whole area surveyed		27·3	±0·7	±2·5	48,652	1,328,200

It should be noted that the estimate of 27 bushels per acre is for the early varieties grown in the *yala* season. The long-aged varieties grown in *maha* would give a strikingly higher yield.

The Kandy and Kegalla Districts have mean yields of 30 and 27 bushels per acre respectively. Yields within the Kandy District are uniformly high. The Pata Hewaheta Korale with an acre yield of 41 bushels tops the list of strata composing the survey. All the strata in the Kandy District have yields of over 26 bushels per acre. That fraction of the Ratnapura District included in the survey has an average yield of 20 bushels per acre.

The discrepancy between these objectively derived figures and published ' guesstimates ' is startling. The figures of acre yields, based on harvested acreages, for the Central and Sabaragamuwa Provinces, for *yala* 1948, provided in the ' Statistical Abstract of Ceylon, 1949 ', are 14.0 and 12.3 bushels per acre respectively.

*A bushel weight of 46 lb. paddy is assumed.

Statistical Analyses of Results.—The stratumwise and pooled analyses of variance of yields are given in Table 3. These variance analyses provide data that guide the choice of sampling technique in future surveys. The following equation relates the standard error of the mean yield to the number of Village Headmen's Divisions, the number of kumburas per Village Headman's Division and the number of plots per kumbura:

$$V(\bar{x}) = \frac{V_1}{d} + \frac{V_2}{dk} + \frac{V_3}{dkp}$$

TABLE 3.—Analyses of Variance of Yields

	Between VH Divisions			*Between Kumburas*		
	DF	*SS*	*MS*	*DF*	*SS*	*MS*
Yatinuwara	18	3321615	184534·2	19	2389150	125744·7
Harispattuwa	18	4497973	249887·4	19	2550286	134225·6
Dumbara	18	7812456	434025·3	19	5424257	285487·2
Pata Hawaheta	18	7763515	431306·4	19	4119108	216795·2
Uda Bulatgama	18	8086722	449262·3*	19	3507251	184592·2
Galboda Kinigoda	18	3798750	211041·7	19	3160510	166342·6
Paranakuru	18	4673234	259624·1	19	2956616	155611·4
Beligal	18	5990064	332781·3*	19	2715095	142899·7
Lower Bulatgama	19	3066924	170384·7	19	3737052	196686·9
Kuruwita	18	6898495	383249·7†	19	1490017	78421·9
Nawadun	18	1662815	92378·6	19	3449428	181548·8
Total	198	57572563	290770·5	209	35498770	169850·6

* Significant at five per cent. point.
† Significant at one per cent. point.

where $V(\bar{x})$ is the variance of the mean yield, V_1, V_2 and V_3 are the true variances attributable to Village Headmen's Divisions, kumburas and plots respectively, and d, k and p are the numbers of Village Headmen's Divisions, kumburas and plots respectively. The estimates of numbers of Village Headmen's Divisions needed for securing standard errors of one to five per cent. obtained by solving the above equation with the appropriate values from the pooled variance analyses, are given in Table 4.

Manurial Practices.—Information regarding the use of manures is summarized in Table 5. Forty-six per cent. of the fields in the Kegalla District, and 31 per cent. of the fields in the Kandy District received no manure of any kind. In the Ratnapura District (Kuruwita and Nawadun Korales), on the other hand, the percentage of unmanured fields is only about 4 per cent. The only manure used in the Kuruwita and Nawadun Korales is bonemeal; every sampled kumbura in the Kuruwita Korale, and 89 per cent. of the kumburas in the Nawadun Korale, had received a dressing of bonemeal. The popularity of bonemeal declines as one proceeds to the higher elevations: the percentages of fields that had received bonemeal in the Kegalla and Kandy Districts were 51 and 20 respectively. The extensive use of bonemeal in the Kuruwita, Nawadun and Lower Bulatgama and Dehigampal Korales does not appear to have benefited yields markedly, the yields of these korales are the lowest in the area under survey. The apparently poor response to bonemeal may be due to the fact that it has

invariably been applied alone. Inclusion of bulky organics would have improved the response.

Bonemeal is the only fertilizer used in the area covered by the survey. Cultivators either have been unable to secure or afford supplies of ammonium sulphate and phosphates, or have not heeded Departmental advice.

TABLE 4.—Numbers of V. H. Divisions needed to secure Standard Errors of Various Magnitudes

Number of Kumburas per V. H. Division	*Standard Error of Mean Yield*				
	One per cent.	*Two per cent.*	*Three per cent.*	*Four per cent.*	*Five per cent.*
1	1461	365	163	92	59
2	922	231	103	58	37
3	743	186	83	47	30
4	653	164	73	41	27
5	599	150	67	38	24
6	563	141	63	36	23

The use of farmyard manure and compost is not common in any of the Districts. Green manuring is, however, frequently practised in the Kandy District. The extensive adoption of green manuring may have contributed to the high yield (41 bushels per acre) in the Pata Hewaheta Korale.

Cultural Practices.—Only 3 per cent. of the acreage cultivated in *yala* had been fallow the previous *maha*. This does not necessarily imply that cultivation of the same land in both seasons is general; an appreciable extent of the land planted in long-aged varieties in *maha* is left fallow in *yala*.

Only 2 per cent. of the fields had been transplanted. The short age of the varieties grown in *yala* explains the reluctance to transplant.

Table 6 presents data relating to the practice of weeding. Only 32 per cent. of the fields in the whole area had been weeded. The prevalence of the practice varies markedly between strata. Pata Hewaheta was outstanding in that the percentage of weeded fields was as high as 88 per cent. No weeding appears to have been practised at all in Yatinuwara. Kuruwita with a weeded percentage of eight is almost as bad. The high yield of Pata Hewaheta fields and the poor yield in the Kuruwita Korale may be partly connected with differences in weed infestation.

Table 7 classifies fields on the basis of the implements used in tillage, viz., the plough and the mamoty. Ploughed and mamotied land may or may not be buffalo mudded. The popularity of the plough in the Kandy District, where 92 per cent. of the fields are ploughed, and its infrequent use in the Ratnapura District (Kuruwita and Nawadun Korales) may be indicative of differences in cultivation standards. It is significant that in Pata Hewaheta, the korale that is pre-eminent in the matter of yield, no kumbura is worked with a mamoty. In the Kuruwita and Nawadun Korales, even the peasant who aims at higher cultivation standards may not find the use of the plough possible in some of the deeper swamps in these tracts.

TABLE 5.—Use of Manures in Area under Survey

District	Agricultural Instructor's Range	No Manure		Farmyard Manure or Compost		Green manure		Bonemeal		Farmyard Manure or Compost+ Green Manure		Farmyard Manure or Compost+ Bonemeal		Green manure+ Bonemeal		Farmyard Manure or Compost+ Green Manure+ Bonemeal		Miscellaneous Manures	
		No. of kumburas	Per cent.	No. of kumburas	Per cent.	No. of kumburas	Per cent.	No. of kumburas	Per cent.	No. of kumburas	Per cent.	No. of kumburas	Per cent.	No. of kumburas	Per cent.	No. of kumburas	Per cent.	No. of kumburas	Per cent.
Kandy	Yatinuwara ..	21	55·2	4	10·5	6	15·8	2	5·3	1	2·6	—	—	3	8·0	1	2·6	—	—
	Harispattuwa ..	12	31·6	—	—	9	23·7	16	42·1	—	—	—	—	1	2·6	—	—	—	—
	Dumbara ..	17	44·7	3	7·9	5	13·1	8	21·0	1	2·6	1	2·6	2	5·2	1	2·6	—	—
	Pata Hewaheta ..	1	2·6	3	7·9	24	63·1	1	2·6	5	13·1	—	—	2	5·2	1	2·6	1	2·6
	Uda Bulatgama ..	7	18·4	6	15·8	2	5·2	—	—	3	8·0	—	—	—	—	—	—	20	52·6
	District total ..	58	30·5	16	8·4	46	24·2	27	14.2	10	5·3	1	0·5	8	4·2	3	1·5	21	11·0
Kegalla	Galboda-Kinigoda ..	23	60·5	2	5·2	—	—	11	28·9	—	—	—	—	1	2·6	1	2·6	—	—
	Paranakuru ..	17	44·7	—	—	—	—	19	50·0	—	—	1	2·6	—	—	—	—	1	2·6
	Beligal ..	29	76·3	—	—	—	—	9	23·7	—	—	—	—	—	—	—	—	—	—
	Lower Bulatgama ..	1	2·6	—	—	1	2·6	34	89·4	—	—	2	5·2	—	—	—	—	—	—
	District total ..	70	46·2	2	1·3	1	0·7	73	48·2	—	—	3	2·0	1	0·7	1	0·7	1	0·7
Ratnapura	Kuruwita ..	—	—	—	—	—	—	36	94·7	—	—	2	5·2	—	—	—	—	—	—
	Nawadun ..	3	7·9	—	—	1	2·6	33	86·8	—	—	1	2·6	—	—	—	—	—	—
	District total ..	3	4·0	—	—	1	1·3	69	90·7	—	—	3	4·0	—	—	—	—	—	—
	Total for whole Area surveyed	131	31·4	18	4·3	48	11·5	169	40·5	10	2·4	7	1·6	9	2·1	4	1·0	22	5·3

TABLE 6—Numbers of Weeded and Unweeded Kumburas

District	*Agricultural Instructor's Range*	*Weeded*		*Unweeded*	
		No. of Kumburas	*Per Cent.*	*No. of Kumburas*	*Per Cent.*
Kandy ..	Yatinuwara ..	0	0·0	38	100·0
	Harispattu ..	13	34·3	25	65·7
	Dumbara ..	8	21·1	30	78·9
	Pata Hewaheta ..	28	87·5	4	12·5
	Uda Bulatgama ..	15	39·4	23	60·6
	District Total ..	64	35·2	120	64·8
Kegalla ..	Galboda-Kinigoda ..	10	26·3	28	73·7
	Paranakuru ..	8	21·1	30	78·9
	Beligal ..	16	45·7	19	54·3
	Lower Bulatgama ..	15	39·4	23	60·6
	District Total ..	49	33·0	100	67·0
Ratnapura ..	Kuruwita ..	3	7·9	35	92·1
	Nawadun ..	15	39·4	23	60·6
	District Total ..	18	23·4	58	76·6
Total for whole area surveyed ..		131	32·0	278	68·0

TABLE 7—Numbers of Ploughed and Mamotied Kumburas

District	*Agricultural Instructor's Range*	*Ploughed*		*Mamotied*	
		No. of Kumburas	*Per Cent.*	*No. of Kumburas*	*Per Cent.*
Kandy ..	Yatinuwara ..	28	73·7	10	26·3
	Harispattuwa ..	37	97·4	1	2·6
	Dumbara ..	38	100·0	0	0·0
	Pata Hewaheta ..	38	100·0	0	0·0
	Uda Bulatgama ..	33	86·9	5	13·1
	District Total ..	174	91·5	16	8·5
Kegalla ..	Galboda-Kinigoda ..	37	97·4	1	2·6
	Paranakuru ..	36	94·6	2	5·4
	Beligal ..	36	94·6	2	5·4
	Lower Bulatgama ..	19	50·0	19	50·0
	District Total ..	128	84·5	24	15·5

District	Agricultural Instructor's Range	Ploughed		Mamoted	
		No. of Kumburas	Per Cent.	No. of Kumburas	Per Cent.
Ratnapura ..	Kuruwita ..	6 ..	21·8 ..	32 ..	78·2
	Nawadun ..	8 ..	21·1 ..	30 ..	78·9
	District Total ..	14	18·5	62	81·5
Total for whole area surveyed ..		316	79·0	83	21·0

Fifty-seven per cent. of the fields in the area covered by the survey were completely rain-fed. In the Paranakuru Korale, every kumbura surveyed was rain-fed. The lack of an assured water supply has an important bearing on (*a*) the choice of variety, and (*b*) the allocation of fertilizers. Varieties grown in areas where the water supply is precarious, should possess some measure of drought resistance. Available fertilizer supplies should be concentrated on irrigated tracts, where response is guaranteed, and should be released in quantity to rain-fed areas only when a surplus exists.

Varieties.—Table 8 provides a frequency distribution of the age classes of varieties grown in the area covered by the survey. Sixty-eight per cent. of the varieties had a sowing-to-harvest age of four months; 15 per cent. exceeded this age, and 17 per cent. were shorter aged than four months. Generally speaking, the Ratnapura District grew the longest aged varieties, and the Kegalla District grew the earliest.

Table 9 lists the varieties grown in the area under survey. It should be noted that a number of distinct varieties may be included under one name, and that a single variety may masquerade under numerous names. The Table, however, indicates striking regional preferences. In the Kandy District, *Heenati* predominates. The Kegalla District prefers *Madael*, a variety which, as its name implies, is suitable for ill-drained land; the Beligal Korale grows *Madael* almost to the complete exclusion of all other varieties.

Under 3 per cent. of the fields in the whole area surveyed, carried purelines. Not a single field in the Kegalla District carried a pure line. These depressing facts must be due to one of the following causes: (1) the non-existence of suitable purelines, (2) the failure of extension work to impress the peasant, and (3) the defective functioning of the organisation for seed multiplication and issue. It is admittedly difficult to cover an area like the one under survey, where marked variations in soil and climate occur over relatively short distances with one or two pure lines, but the widely-adaptable *Vellai ilankalayan* should suit the better-drained soils and *Suduheenati* ICPY-15 may be recommended for swamps

TABLE 8.—Age Classes of Varieties

District	*Agricultural Instructor's Range*	*Age Classes of Paddy Varieties*									
		3 Months		*3½ Months*		*4 Months*		*4½ Months*		*5 Months*	
		No. of Kumburas	*Per Cent.*	*No. of Kumburas*	*Per Cent.*	*No. of Kumburas*	*Per Cent.*	*No. of Kumburas*	*Per Cent.*	*No. of Kumburas*	*Per Cent.*
Kandy	Yatinuwara	1	2·6	3	7·9	34	89·5	0	0·0	0	0·0
	Harispattuwa	2	5·3	0	0·0	30	78·9	6	15·8	0	0·0
	Dumbara	8	21·2	10	26·3	15	39·4	5	13·1	0	0·0
	Pata Hewaheta	5	13·1	0	0·0	25	65·9	7	18·4	1	2·6
	Uda Bulatgama	1	2·6	2	5·3	26	68·4	7	18·4	2	5·3
	District Total	17	9·0	15	7·9	130	68·4	25	13·1	3	1·6
Kegalla	Galboda-Kinigoda	10	26·3	7	18·4	21	55·3	0	0·0	0	0·0
	Paranakuru	9	23·7	0	0·0	29	76·3	0	0·0	0	0·0
	Beligal	1	2·6	0	0·0	37	97·4	0	0·0	0	0·0
	Lower Bulatgama	2	5·3	3	7·9	29	76·3	4	10·5	0	0·0
	District Total	22	14·5	10	6·6	116	76·6	4	2·3	0	0·0
Ratnapura	Kuruwita	5	13·1	0	0·0	17	44·5	8	21·2	8	21·2
	Nawadun	1	2·6	1	2·6	22	58·0	9	23·7	5	13·1
	District Total	6	7·9	1	1·3	39	51·5	17	22·4	13	16·9
Total for whole area surveyed		45	10·8	26	6·2	285	68·2	46	11·0	16	3·8

TABLE 9.—Distribution of Varieties in Area under Survey

District	Agricultural Instructor's Range	Names of Varieties Grown																												
		Halleli	Hatiel	Heenati	Hetadawi	Honderawala	Kahamalan	Kaharamana	Kaluheenati	Kaluhunda	Kiriel	Kirinaran	Kottiyaran	Madael	Madatawalu	Mudukiriyal	Murunga	Pachchaiperumal	Podiratawi	Rambutan	Rathkunda	Samba	Suduheenati	Sudunandiran	Suduruwi	Suduwi	Sulai	Tawalu	Vellai Ilankalayan
Kandy	Yatinuwara	—	—	15	—	—	—	—	11	—	—	—	3	4	—	—	—	—	—	—	—	—	5	—	—	—	—	—	—
	Harispattuwa	—	—	24	—	—	—	—	3	—	—	—	1	—	—	8	1	—	—	—	—	—	1	—	—	—	—	—	—
	Dumbara	—	—	20	—	—	—	1	—	—	—	—	4	—	—	—	3	2	—	—	2	—	6	—	—	—	—	—	—
	Pata Hewaheta	—	—	5	—	1	—	—	—	1	—	—	—	—	—	1	—	4	—	—	18	—	3	—	1	1	1	—	2
	Uda Bulatgama	—	—	8	—	—	—	—	7	—	—	—	3	2	—	1	—	—	—	—	—	—	11	—	—	1	—	—	5
	District Total	—	—	72	—	1	1	—	21	1	—	—	11	6	—	10	4	6	—	—	20	—	26	—	1	2	1	—	7
Kegalla	Galboda-Kinigoda	—	—	6	—	—	—	—	3	—	—	—	10	17	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—
	Paranakuru	—	—	1	—	—	—	—	3	—	1	—	9	20	—	1	—	—	—	—	—	—	3	—	—	—	—	—	—
	Beligal	—	—	1	1	—	—	—	—	—	—	—	—	37	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	Lower Bulatgama	—	1	7	1	—	—	—	—	9	—	1	4	6	4	—	—	—	—	—	—	—	—	—	—	—	—	4	—
	District Total	—	1	15	2	—	—	—	6	9	1	1	23	80	4	3	—	—	—	—	—	—	3	—	—	—	—	4	—
Ratnapura	Kuruwita	—	—	—	5	—	—	1	—	1	—	1	—	—	2	—	—	—	1	1	—	1	—	—	—	4	10	10	—
	Nawadun	6	—	—	—	—	—	—	1	3	—	4	—	—	9	—	3	—	—	—	—	—	1	—	4	—	4	2	
	District Total	6	—	—	5	—	—	1	1	4	—	5	1	—	11	—	3	—	1	1	—	1	1	—	8	10	14	2	
	Total for whole Area surveyed	6	1	87	7	1	1	1	27	14	1	6	35	86	15	13	7	6	1	1	20	1	29	1	1	10	11	18	9

Drainage.—Table 10 classifies fields on the basis of the degree of drainage. The proportion of ill-drained fields is particularly high in the Uda-Bulatgama, Lower Bulatgama and Nawadun Ranges.

System of Tenure.—In Table 11, the fields included in the survey are classified according to the system of tenure. Two broad classes are recognized, viz., fields cultivated by owners and by tenants. Temple lands worked by tenants under the system of *rajakariya* are treated as owner-cultivated holdings; tenants under this system enjoy a high degree of permanency and pay no share rental. Under the share system of tenancy, which in its simplest form entitles the landlord to half the produce, an improved agricultural practice becomes unprofitable unless the benefit from the improved practice exceeds twice the cost of this practice.

The numbers of owner and tenant-cultivated fields under *tattu-maru* are given in column 5 of Table 11.

TABLE 10.—Frequencies and Yields of Well-drained and Swampy Kumburas

District	*Agricultural Instructors Range*	*Well-Drained Kumburas*		*Swampy Kumburas*	
		Frequency (per cent)	*Mean Yield (bushels per acre)*	*Frequency (per Cent.)*	*Mean yield (bushels per acre)*
Kandy	Yatinuwara	92	27	8	32
	Harispattuwa	95	29	5	31
	Dumbara	89	30	11	35
	Pata Hewaheta	82	41	18	39
	Uda Bulatgama	47	30	53	25
	District Total	81	31	19	32
Kegalla	Galboda-Kinigoda	89	30	11	35
	Paranakuru	97	26	3	37
	Beligal	97	24	3	12
	Lower Bulatgama	42	20	58	23
	District Total	82	25	18	27
Ratnapura	Kuruwita	76	19	24	17
	Nawadun	45	20	55	22
	District Total	61	20	39	20
	Total for whole area surveyed	77·5	27·0	22·5	28·0

TABLE 11.—Classification of Kumburas according to System of Tenure

District	*Agricultural Instructors Range*	*Numbers of Kumburas*			
		Cultivated by owners	*Cultivated by tenants*	*Under* tattu-maru (*Owner and tenant cultivated*)	*Owner cultivated and not under* tattu-maru
Kandy	Yatinuwara	16	21	1	16
	Harispattuwa	25	13	—	25
	Dumbara	20	18	—	20
	Pata-Hewaheta	17	21	—	17
	Uda Bulatgama	12	26	—	12
Kegalla	Galboda-Kinigoda	21	11	6	21
	Paranakuru	16	11	10	7
	Beligal	10	28	—	10
	Lower Bulatgama	24	9	5	19
Ratnapura	Kuruwita	6	21	11	6
	Nawadun	10	25	3	9

When fragmentation of holdings reaches its physical limit, the system of *tattu-maru*, which involves a rotation of ownership and often of tenancy, comes into operation. The insecurity of tenure implicit in *tattu-maru* discourages the permanent improvement of holdings, the use of fertilisers that leave residual benefits and the ownership of any but the most inexpensive of implements. That both the systems of share tenancy and of the *tattu-maru* seriously obstruct the adoption of improved methods is evident. The numbers of owner-cultivated fields unencumbered by *tattu-maru* are given in column 6 of Table 11. Figures in this column may suggest that yields tend to rise with increase in the percentage of owner-cultivated fields; the coefficient of correlation of stratum yields with numbers of owner-cultivated fields is, however, only + 0.5, and is non-significant.

Visual Estimates of Yield.—The deviations of visual estimates of the yield of the standing crop made by Agricultural Instructors participating in the survey, from the objective figures provided by crop cuts are set out in Table 12. The total unsatisfactoriness of these subjective estimates is evident. The data illustrate a marked bias to under-estimation. Under-estimations of below 50 per cent. occur in the instance of one-fourth of the number of fields. The differences in efficiency between observers are striking and significant. The observer in the Lower Bulatgama range achieved exceptional precision. At the other extreme, under-estimations of below 30 per cent. occurred in 95 per cent. of the visual estimates made in the Pata-Hewaheta Korale.

Suggestions for future Surveys.—Surveys should continue over a series of years if an estimate of normal yield is to be secured. It is not unusual to base estimates of normal yields on quinquennial averages. In Ceylon, with its marked annual variations in rainfall, decennial averages should be preferred. Moving averages correct for progressive trends in cultural and fertilizer practices, but are possible only if crop cutting becomes as established routine.

TABLE 12.—Deviations of Visual Estimates from Survey Estimates

Deviation of Visual Estimate from Survey Estimate	*Numbers of Kumburas in Agricultural Instructors' Ranges*											
	Yatinuwara	*Harispattuwa*	*Dumbara*	*Pata Hewaheta*	*Uda Bulathgama*	*Galboda-Kinigoda*	*Paranakuru*	*Beligal*	*Lower Bulathgama*	*Kuruwita*	*Nawadun*	*Total*
Per cent.												
< 90	—	—	—	—	—	—	—	—	—	—	—	—
— 89 to — 70	—	—	—	14	—	1	3	—	—	2	—	20
— 69 to — 50	2	9	11	17	4	4	22	3	1	8	—	81
— 49 to — 30	15	13	16	5	10	5	3	3	8	11	8	97
— 29 to — 10	15	9	7	—	9	4	5	8	7	6	9	79
— 9 to + 10	4	1	3	—	5	11	3	9	7	6	8	57
+ 11 to + 30	—	2	—	1	3	5	—	7	5	3	6	32
+ 31 to + 50	—	3	1	—	1	1	1	1	8	1	3	20
+ 51 to + 70	—	—	—	1	2	2	—	2	1	—	2	10
+ 71 to + 90	—	1	—	—	2	1	—	2	—	—	1	7
> 90	1	—	—	—	1	4	—	3	1	1	1	12

The product of the normal yield and the condition factor provides an estimate of the mean yield in any season. The condition factor, which may be measured as a percentage, or may, as in India, follow an anna valuation, attempts assessing seasonal effects. The factor is usually determined subjectively, and possesses little precision, but unless crop-cutting experiments are conducted annually, no alternative to its use is possible.

In the islandwide surveys envisaged, at least two modifications in the design adopted in the present pilot survey appear desirable, viz. (*a*) the use of a larger plot—1/80 acre should be a suitable size—and (*b*) the use of a variable sampling fraction. Large plots reduce the bias to overestimation. The use of plots of the magnitude suggested will, however, make changes in technique necessary; it will, for instance, become necessary to thresh, winnow and weigh *in situ*. A variable sampling fraction should contribute to accuracy, particularly in this country where paddy tracts vary so much in structure and size.

SUMMARY

A random-sample survey of paddy yields in the Kandy, Kegalla and Ratnapura Districts, was conducted in the *Yala* season, 1949. The survey covered a total extent of 48,652 acres of cultivated paddy, The mean yield for the whole extent, weighted for acreage, was 27 bushels of paddy per acre. This figure was subject to a standard error of 2½ per cent., *i.e.*, the true acre yield of the area surveyed lay between 25½ bushels and 28½ bushels.

The Kandy and Kegalla Districts had mean yields of 30 and 27 bushels per acre respectively. That fraction of the Ratnapura District included in the survey had a mean yield of 20 bushels per acre.

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