Effect of Planting Systems on Times of Tapping and Collection

COLIN BARLOW, LIM SOW CHING and P. O. THOMAS

Two experiments comparing tapping and collection times for 500-tree tasks on the 20 and 30 ft conventional and 60 ft hedge planting systems have shown that the latter involved 7–8 minutes less in tapping and 20–25 minutes less in collection than the other two row widths. The saving in time was due to the shorter walking distance on the 60 ft avenues. In both experiments, the speed of tapping increased as the number of trees on which tapping had been completed increased within each full-sized task. Assuming that tapping had to be carried out within a given time, budgeting with figures obtained from the experiments indicated that the reduction in tapping and collection times on the hedge system had a relatively small effect on the total cost of tapping and collection per acre.

DE JONGE AND WESTGARTH (1962) studied the influence of the size of tapping task on the times of tapping and collection, but the relative effect of hedge and conventional planting systems on these times had not been investigated previously. This was mainly because the hedge system was thought to result in delays in trees reaching maturity and also in lower yields per acre; its study, therefore, was not considered to be economically significant.

Recently, however, some results obtained at the R.R.I.M. Experiment Station at Sungei Buloh question the assumption of lower yields from hedge-planted trees. These results, from an experiment comparing yields from 20, 30, 50, 65 and 80 ft planting systems over a 4–5 year period of tapping, are presented in *Table 1*. They show that cumulative yields from 80 ft plantings are definitely low but those from the more closely spaced 50 ft plantings are slightly higher than yields from both 20 and 30 ft plantings, although the differences are not significant at the 5% level. Cumulative yields from the 65 ft plantings are also slightly higher (but not significantly) than those from the 20 ft planting. In addition, the 50 and 65 ft plantings have had a higher rate of yield than both the 20 and 30 ft plantings in each year from July 1962 to June 1965. For the last two years, however, the superiority in yield of the 50 ft plantings has been easily significant at the 5% level.

Following these results, the possibility of the hedge systems reducing tapping and collection times and, therefore, lowering labour costs, became much more significant; the two experiments to compare these times on hedge and conventional planting systems were hence conducted. Although it was originally intended that these experiments should be carried out in Field 53, preliminary work on timing studies indicated that the plots in the field were not large enough—meaningful comparison of times could only be made where the tappers concerned were working on full-sized tasks.

EXPERIMENTAL DETAILS

Experiment I. This experiment, involving comparison of overall tapping and collection times between the 20 ft conventional and 60 ft hedge planting systems was carried out at Sungei Buloh in March 1965. Recordings of distances walked, lengths of tapping cuts, tapping and walking times per tree and task yields of latex, tree lace, and cuplump were also made. At the time of the experiment, the actual dimensions of the two systems were respectively 20×19 ft and 60×9 ft. The former, planted between 1949 and 1950, and the latter, planted between 1948 and 1950, both had

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TABLE 1. YIELDS FROM DIFFERENT PLANTING SYSTEMS IN FIELD 53 EXPERIMENT AT THE R.R.I.M. EXPERIMENT STATION

Original planting distances in feet[a]	Current trees in tapping per acre[b]	Yields in lb/acre			
		July '62–June '63	July '63–June '64	July '64–June '65	Cumulative June '65
20×12	140	1,012	1,220	1,186	5,531
30× 8	131	1,089	1,289	1,343	5,901
50× 6	118	1,051	1,409	1,447	5,268
50× 4½	123	1,055	1,356	1,456	5,160
50× 3½	140	1,223	1,630	1,704	6,076
65× 4½	108	998	1,403	1,375	5,060
65× 3½	113	1,070	1,411	1,347	5,267
65× 2¾	118	1,167	1,584	1,460	5,660
80× 3½	95	756	1,023	1,127	3,157
80× 2⅝	111	884	1,172	1,291	3,651
80× 2¼	110	726	973	1,121	3,057
s.e. of system means		±55.7	±59.5	±58.9	±259.7
l.s.d. between system means (5%)		158	170	168	735

[a] The 20 and 30 ft systems were opened in July 1959, the 50 and 65 ft systems in July 1960 and the 80 ft system in June 1962.
[b] In June 1965. Figures are averages for each treatment.

mixed high yielding materials. This was not considered important to the comparison, however, since the experiment reported in *Table 1* had shown little interaction between clones and planting systems in effects on yield. Again, the tapping panel on the 20 ft system was relatively lower—about 30 inches from the ground as compared to 48 inches on the 60 ft system—but it was considered that the speed of tapping and collection would not have been affected by the difference in height. The average girth of the trees was very similar and both areas were flat. Although there were a few drains crossing tasks on the 20 ft system, they were adequately bridged so that no detours were necessary. In both fields the previous tapping system, S/2, d/2, 100%, was adopted.

Experiment II. This experiment, carried out in June 1965 on the Klabang Estate near Ipoh, comprised comparison of tapping and collection times for the 30 and 60 ft systems. Recording of distances walked, lengths of tapping cuts, tapping and walking times per tree and yields of latex, cuplump and tree lace were also made. At the time of the experiment, the actual dimensions of the two systems were 30×10 ft and 60×6 ft. The fields concerned were adjacent to each other, both flat and planted in 1949 with PR 107. The tapping panels were about 30 inches from the ground at the time of the experiment and the mean girth of the trees was similar. The previous tapping system, S/2, d/2, 100%, was again used.

Tapping and Collection Times

Both experiments involved the recording of tapping and collection times for a total of four full-sized tasks of 500 trees in each of the two planting systems selected. Times of tapping and collection here refer to the duration of time required for tapping and collecting from the first tree to the last tree of each task, and include walking time between trees and between rows, but *not* waiting time between tapping and collection and time spent carrying latex to a central point during the collection.

The method used was the same in both experiments, and involved 8-day tapping 'cycles.' The procedure is illustrated in *Table 2*, where the first subscript against each *T* denotes the identification number of each of the four tappers, and the second subscript represents the

TABLE 2. ILLUSTRATION OF TAPPING PROCEDURE IN EACH SYSTEM IN AN 8 TAPPING-DAY CYCLE

TASK 1	TASK 2	TASK 3	TASK 4
$T_{1.1}$	$T_{3.1}$	$T_{2.1}$	$T_{4.1}$
$T_{4.3}$	$T_{2.3}$	$T_{1.3}$	$T_{3.3}$
$T_{3.5}$	$T_{1.5}$	$T_{4.5}$	$T_{2.5}$
$T_{2.7}$	$T_{4.7}$	$T_{3.7}$	$T_{1.7}$

day on which he taps. Thus $T_{1.1}$, for example, refers to the first tapper working on the first day of a cycle. The arrangement in these experiments was that the four tappers tapped the first system together on one day, and the second system the following day. On the third day, the tappers returned to the first system, each tapping a task different from the one previously tapped. After 8 tapping days, when each of the four tappers had tapped four tasks each on the two systems, another 8 tapping-day cycle, using the same procedure, was repeated.

In both experiments, four male tappers chosen for their similar skill and speed of tapping and collection, were employed. In the first experiment, the tappers, who had been tapping smaller tasks previously, were paid a dollar more per day for the additional effort involved. Each tapper was accompanied by an enumerator throughout the period of the experiment. Both tappers and enumerators spent the first four days trying out the systems chosen; whenever it was felt that the times were distorted, by lengthy conversation between tappers or by the intrusion of the kepala, the results were ignored. This occurred on one day in the first experiment, and on two days in the second experiment. In addition, there was no tapping on five Sundays and one public holiday during the second experiment.

Two 8-day tapping cycles were recorded in the first experiment which took 21 days to complete, including 'running in' time. In the second experiment, three 8-day cycles were recorded and the work lasted 36 days to obtain greater accuracy of comparison.

Tapping and Walking Time per Tree

Recordings of tapping and walking time per tree enables the study of the relative speed of work at different stages of tapping. The tapping procedure used, which was the same in each experiment, was as follows: the tapper collected the tree lace and cuplump and put them in his bag. He then picked up the dirty cup from the tree, cleaned it and put it back in the cup hanger in a slanting position, to prevent bark shavings from falling in. He tapped the tree, adjusted the cup and shook anticoagulant from a bottle he carried into the cup. Finally, he walked to the next tree in the row. In Experiment I, total tapping and walking time per tree was recorded for 40 trees at the beginning of the task, 40 trees in the middle of the task, and 40 trees at the end. In Experiment II, an attempt was made to record the times of tapping and walking for each tree separately for the three stages. Because the stop-watches could not be operated quickly enough, it was found impossible to record on the same day the times for both tapping and walking; they were hence recorded separately on alternate days.

The figure of 40 trees was taken as a result of statistical analysis of variations in tapping times per tree obtained from preliminary work. This work had shown that estimates of average time per tree could be considered reliable within 95 per cent confidence limits if based on 25 trees. Recordings of 40 trees were made to allow for possible extra variations of a different site.

Yield

Yield was recorded for each task on each tapping day, in order to check whether yield differences were likely to have any effect on relative tapping and collection times. The kepala carried out d.r.c. determinations on total latex collected, using the 'Chee' method, 60 per cent of the wet weight of tree lace and cuplump being taken as the dry rubber content.

RESULTS AND DISCUSSION

Tapping and Collection Times

The mean times of tapping and collection in Experiment I are recorded in *Table 3*, from which it can be seen that tappers working on the 20 ft system required more time than those working on the 60 ft system. The differences

TABLE 3. MEAN TIMES OF TAPPING AND COLLECTION IN EXPERIMENT I

Planting distances[a] ft	Task size trees	Area covered[b] acres/task	Tapping, min/task	Collection min/task	Total min/task
20×19	500	5.10	191.5	53.5	245.0
60× 9	500	4.84	184.6	28.3	212.9
Means		4.97	188.1	40.9	229.0
Difference between systems			6.9	25.2	32.1
s.e. of system means			±3.288	± 0.384	± 3.410
l.s.d. between system means (5%)			9.4	1·1	9.7

[a] Original planting distances were 60×4½ ft and 20×12 ft.
[b] Mean of 4 task areas on each system.

of 25.2 min between collection times, and 32.1 min between total tapping and collection times, are significant at the 0.1% level. The difference of 6.9 min between tapping times however is not even significant at the 5% level.

The mean times of tapping in Experiment II are recorded in *Table 4* which shows that tappers working on the 30 ft system took an average of 7.8 min longer to tap the 500-tree task than those working on the 60 ft system, although this difference was not significant at the 5% level. Collection times were also recorded in Experiment II, but the results could

TABLE 4. MEAN TIMES OF TAPPING IN EXPERIMENT II

Planting distances[a] ft	Task size trees	Area covered[b] acres/task	Tapping, min/task
30×10	500	3.80	246.1
60× 6	500	4.05	238.3
Means		3.93	242.2
Differences between systems			7.8
s.e. of system means			±4.10
l.s.d. between system means (5%)			11.6

[a] Original planting distances were 60×4 ft and 30×8 ft.
[b] Mean of the 4 task areas on each system.

not be used due to an error in the instructions given to the enumerators. It was nevertheless apparent that the tasks on the 30 ft system took about 20–25 minutes longer to collect than those on the 60 ft system. The total collection time on the 30 ft system was similar to that on the 20 ft system in Experiment I.

Although the results in both experiments showed that the variation in times between tappers was considerable, statistical analysis has indicated that there is no interaction between tappers and systems in effects on tapping and collection times per task.

Differences within experiments. The major factor causing the above variations in time within each experiment was the differences in distance walked by the tappers. The mean distances walked per task are presented in *Table 5*. In Experiment I the 20 ft system involved covering over twice the distance on the 60 ft system, and in Experiment II the 30 ft system involved just under twice the distance on the 60 ft system.

TABLE 5. MEAN DISTANCES WALKED PER TASK ON EXPERIMENTS I AND II

EXPERIMENT I		EXPERIMENT II	
Planting distances, ft	Distance walked per task[a] in chains	Planting distances, ft	Distance walked per task[a] in chains
20×19	143	30×10	78
60× 9	66	60× 6	43

[a] Estimated, using measurements for 3 sets of 40 trees within each task of 500 trees.

The much smaller differences in tapping than in collection times in both experiments are

thought to be due to the relatively slower rate of travel between trees during tapping on the 60 ft system as compared to the others. This might also be due to the workers' need for some 'rest' between tappings, regardless of the distance between trees. The actual time spent at each tree 'tapping' or 'collecting'—as opposed to time spent 'walking' between trees,—is not likely to differ much between systems within each experiment.

Testing the validity of the last mentioned proposition would have involved recording separately the times for 'tapping', 'collection' and 'walking' per tree during the operations, but it was not possible to obtain all this information with the few enumerators available. Though an attempt was made in Experiment II to record separate 'tapping' and 'walking' times per tree, the tapping times obtained cannot be considered reliable. The 'walking' times recorded for each system are presented in *Table 9*, and can be used to indicate whether a difference exists, between the two systems compared in Experiment II, in the time actually spent 'tapping' each tree. Multiplying these 'walking' times by 500 to obtain the estimated total 'walking' time per task during tapping gives total 'walking' times of 22.7 min on the 30 ft system, and 17.2 min on the 60 ft system. The estimated difference of 5.5 min compares well with the actual Experiment II difference of 7.8 min in total tapping times including 'walking' (*Table 4*). This shows that at least the majority of the actual differences between systems can be attributed to the difference in walking time.

Scrutiny of *Table 6*, giving details of the estimated mean lengths of tapping cut per tree, indicates that since these lengths were similar within each experiment, this factor is unlikely to have had any influence on tapping time. Again, *Table 10* shows that yield per task in Experiment II was somewhat lower on the 30 ft than on the 60 ft system, but this could not have had any influence on relative times, especially as time spent on carrying latex to a central point was not included in the recorded collection period.

Differences between experiments. Comparison of mean tapping times per task between the two experiments shows that tappers in Experiment I took an average of 54.1 min less than those in Experiment II to complete their tasks, even though the mean area per task was larger (4.97 as opposed to 3.93 acres). This time difference seems to have been due primarily to the more cautious work of Experiment II tappers, whose earnings were based partly on the amounts of latex, tree lace and cuplump collected.

TABLE 6. MEAN LENGTHS OF TAPPING CUT PER TREE IN EXPERIMENTS I AND II

EXPERIMENT I		EXPERIMENT II	
Planting distances, ft	Length of tapping cut/tree[a], in.	Planting distances, ft	Length of tapping cut/tree[a], in.
20×19	16.2	30×10	17.6
60× 9	17.2	60× 6	17.1

[a] Estimated, using measurements from a sample of 100 trees within each task of 500 trees.

It is interesting to compare the times recorded in Experiments I and II with those reported by DE JONGE AND WESTGARTH (1962) for a 500 tree task on a 30×9 ft planting system, with 140 trees per acre. The latter times were 174.6 min for tapping, which is considerably less than the 191.5 min achieved on the 20 ft system in Experiment I, and 53.2 min for collection, a figure similar to the 53.5 min recorded on the 20 ft system in Experiment I (*Table 3*).

Influence of tapping procedure. It should be borne in mind that the tapping procedure used in these timing experiments is not the one always employed commercially. On many estates, the tapper starts with a clean cup in hand and he replaces the dirty cup on the first tree with it. The dirty cup is cleaned during his walk between trees and used as replacement for the cup on the second tree. This procedure is repeated throughout, so that no cleaning of cup is done during the actual tapping operation itself. If this method had been used in the experiments, it would certainly have increased the saving in tapping time recorded for the 60 ft systems.

TABLE 7. MEAN TIMES OF TAPPING AND WALKING PER TREE IN EXPERIMENT I

Planting distances, ft	Tapping stages[a], min/tree			Mean min/tree
	Beginning	Middle	End	
20×19	0.398	0.373	0.357	0.376
60× 9	0.389	0.362	0.340	0.364
Means	0.393	0.367	0.348	0.370

Statistical measures	*s.e.*	*l.s.d.* (5%)
Planting system, means of	±0.0028	0.013
Tapping stage, means of	±0.0059	0.020
Difference between tapping stage times within each system	±0.0110	0.022
Difference between system times within each tapping stage	±0.0093	0.018

[a] Means of times on 40 trees for four tasks on 8 separate days.

Tapping and Walking Time per Tree

The mean tapping and walking times per tree, recorded for three successive groups of 40 trees in each task in Experiment I, are presented in *Table 7* which shows that on both planting systems the mean time per tree decreased as more trees were tapped within each task. All differences between mean times in the successive stages were significant at the 5% level. The speed of tapping and walking per tree also increased relatively faster on the 60 ft than on the 20 ft system, a difference between systems of 0.009 min in mean time per tree at the 'beginning' stage comparing with a difference of 0.017 min at the 'end' stage. The reason for this may have been the lower height of tapping cut on the 20 ft system.

The overall mean tapping times per tree, recorded for three successive groups in Experiment II, are given in *Table 8*. These figures cannot be considered reliable, but the overall experimental averages are presented because they illustrate a very definite trend for the speed of tapping to increase. The only apparent reason for this speeding up is that nearer the end of the task, tappers become increasingly keen to finish and return home early.

The mean walking times per tree in Experiment II are presented in *Table 9*, and the difference shown between the two systems, which is

TABLE 8. MEAN TIMES OF TAPPING PER TREE IN EXPERIMENT II

Planting distances, ft	Tapping stages[a], min/tree			Mean[a] min/tree
	Beginning	Middle	End	
Means[b]	0.471	0.380	0.345	0.398

[a] Means of times on 40 trees for 4 tasks on 8 separate days.
[b] Since the figures are not considered very reliable, no statistical measures are quoted.

significant at the 1% level, has already been mentioned. These figures give no indication of any speeding up in walking time between trees as tapping progresses.

Yield

Details of the yields of latex, tree lace and cuplump secured in the two experiments are given in *Table 10* which shows that although the total yield per task differed very little between planting systems in Experiment I, the 60 ft system yielded 4.6 lb more per task per tapping than the 30 ft system in Experiment II. The influence of this yield difference on collection times has already been discussed.

Statistical analysis of the yield data within each experiment shows that while the difference in mean yield per tapper in Experiment I is not significant, the difference observed in Experiment II is significant at the 1% level. In both cases, however, there is no interaction between tappers and systems in effects on yield.

ECONOMIC ASSESSMENT

Using some of the experimental data obtained, an attempt is now made to assess the economic significance of savings in time achieved on the 60 ft system. In this assessment, the following assumptions are made:

TABLE 9. MEAN TIMES OF WALKING PER TREE IN EXPERIMENT II

Planting distances, ft	Tapping stage, min/tree[a]			Mean
	Beginning	Middle	End	
30×10	0.0459	0.0468	0.0438	0.0455
60× 6	0.0330	0.0366	0.0336	0.0344
Means	0.0395	0.0417	0.0387	0.0399

Statistical measures	*s.e.*	*l.s.d.*(5%)
Planting system, means of	±0.0014	0.0051
Tapping stage, means of	±0.0076	0.0263
Difference between tapping stage times within each system	±0.0026	0.0075
Difference between system times within each tapping stage	±0.0032	0.0091

[a] Means of times on 40 trees for 4 tasks on 8 separate days.

TABLE 10. MEAN YIELDS IN EXPERIMENTS I AND II

Planting distances, ft	Latex[a] lb/task	Lace and cuplump[a] lb/task	Total lb/task	Total lb/acre[b]
Experiment I				
20×19 (98)	36.7	5.4	42.1	1,288
60× 9(103)	37.7	4.9	42.6	1,373
Experiment II				
30×10(132)	38.3	2.8	41.1	1,697
60× 6(123)	43.0	2.7	45.7	1,760

[a] As dry rubber.
[b] Estimated, assuming 156 tapping days a year (S/2 d/2 100%).

(a) the planting systems compared are either the 20 or 30 ft conventional with the 60 ft hedge; the planting density on all systems is 100 trees per acre, this stand being very close to the density of the systems compared in Experiment I.

(b) the total yield per acre from all systems is 1500 lb, the approximate mean of all experimental yields in *Table 10*, and the proportion of lower grades is 12% in all cases. In so far as the results from the experiment reported in *Table 1* indicate the 20 ft system to give inferior yields, this system will, of course, lead to lower profits.

(c) it takes 245 min to tap and collect from a 500-tree task on the 20 or 30 ft sytems, and 220 min to tap and collect from the same task on the 60 ft system. The difference of 25 min, based on the results of the experiments described here, is assumed to be mainly savings in collection time. As already explained, the saving in tapping time on many commercial estates is likely to be less than that demonstrated in the experiments.

(d) if the above tapping and collection time of 245 min on the 20 ft or 30 ft system is taken to be the total time within which these operations have to be completed, then 557 trees can be tapped in this time on the 60 ft system.

The costs of tapping a 500 tree task on the 20 or 30 ft system, and a 557 tree task on the 60 ft system, are compared in *Table 11*, using the current Malayan Planting Industries Employers Association and Lee Plantation wage scales. The estimated savings on these scales amount respectively to $10 and $13 per acre per year, or 0.67c and 0.87c per lb. If a stand of 120 trees per acre and appropriately higher yields are assumed, the savings are very similar. On the other hand, if it is assumed that a higher task size of 600 trees can be tapped on the 20 or 30 ft system in 245 min and that the above relationship still prevails so that 667 trees can be tapped on the 60 ft system in this time, the savings on the scales both drop by about $3 per acre. For other scales similar to the two quoted the savings are likely to be of the same order, but for estates entirely on piece-rate scales there will of course be no saving, apart from the minor one achieved through a greater 'spreading' of labour benefits.

CONCLUSION

Comparison of tapping and collection times for 500 tree tasks on the 20 or 30 ft conventional and the 60 ft hedge planting systems shows that the saving obtained on the latter system is relatively small. This saving is probably not worth taking into account especially in view of other disadvantages on hedge systems such as greater susceptibility to wind damage and root diseases. There is also the additional expenditure on cover crop maintenance because of

TABLE 11. COMPARISON OF ESTIMATED ANNUAL COSTS OF TAPPING AND COLLECTION PER ACRE[a]

Wage scales	Avenue with		Saving on 60 ft system	
	20/30 ft	60 ft		
	$/acre	*$/acre*	*$/acre*	*c/lb*
M.P.I.E.A.[b]	214	204	10	0.67
Lee Plantation[c]	193	180	13	0.87

[a] S/2 d/2, 156 days tapping a year, with a total yield of 1320 lb latex and 180 lb tree lace and cuplump.

[b] $2.55 basic wage per day *plus* 8 cents per lb incentive on latex for every lb over 14 lb and 4c per lb on scrap (wet) Fringe benefits vary, but are assumed to cost $1.65 per tapping.

[c] $3.20 basic wage per day *plus* 4.25c per lb on latex for every lb over 20 lb (in price range 60—70c lb) and 4c per lb on scrap (wet). Fringe benefits vary, but are assumed to cost $1.65 per tapping.

the wider 'open' period and delayed maturity.

The method of comparison used in this study may have somewhat over-emphasised the saving in that limited extra working time on collecting latex may often be acceptable to tappers in estates. A big saving in tapping time, as opposed to collection time, could be important from the view point of making better use of the higher pressure during the early hours of the morning, but this of course was not achieved.

On smallholdings using family labour, the saving on tapping and collection inputs is not so important, but hedge systems may have definite advantages to smallholders growing catch crops during the immaturity of rubber. Recent observations have shown that even on holdings with conventional planting systems the supplementary gross income from such crops usually ranges from $500 to $1500 per acre per year.

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