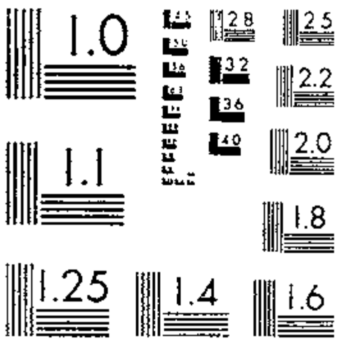
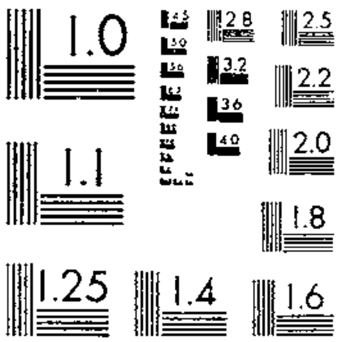
TB 65 (1928) USDA TECHNICAL BULLETINS UPDATA
EXPERIMENTAL TAPPING OF HEVEA RUBBER TREES AT BAYEUX, HAITI, 1924-25
POLHAMUS, L G 1 OF 1

START



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

TECHNICAL BULLETIN No. 65 — APRIL, 1928

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

EXPERIMENTAL TAPPING OF HEVEA RUBBER TREES AT BAYEUX, HAITI, 1924-25

By LOREN G. POLHAMUS

Chief Scientific Aid, Office of Cotton, Rubber, and Other Tropical Plants, Bureau of Plant Industry[1]

CONTENTS

INTRODUCTION

In the summer of 1923 members of the Office of Crop Acclimatization and Adaptation Investigations of the Bureau of Plant Industry, while investigating the sources of crude rubber and the possibility of American crude-rubber production, found a planting of several species of rubber-bearing plants made about 1903 at Bayeux, a sugar and cacao plantation 30 miles west of Cape Haitien, on the northern coast of Haiti.

The plantings consisted of species of Castilla, Hevea, Manihot, Ficus, Mimusops, and Funtumia. With the exception of the Castilla, none of the species had ever been tapped regularly. A few trees of each species, however, showed old scars, indicating that tapping had been attempted, as though from curiosity to see how the latex would flow, but none of the trees had been tapped within 8 or 10 years.

Since the first interest in rubber production had died out, the Castilla and Hevea had been untended and had been utilized as shade for cacao. The Funtumia, grown on waste land between a small stream and a high hill, had been used for firewood and fence posts and allowed to grow wild in competition with the native vegetation. The other trees were present in small numbers and were

[1] The tapping operations on which this report is based were conducted in Haiti by F. C. Baker, technologist, W. H. Jenkins, assistant agronomist, and Laurence Bolte, agent, all of the Office of Cotton, Rubber, and Other Tropical Plants.

81848—28——1

located along ditch banks and in out-of-the-way places where they did not interfere with the main operations of the plantation.

The climate at Bayeux closely resembles that to be found in other parts of the American Tropics where rubber production might be considered. The mountainous topography of Haiti produces a wide variation in climatic conditions. Localities within a short distance of each other are often quite different in regard to temperature and rainfall. This would afford an opportunity to test the cultural requirements of plants which could be grown under these varying conditions during the same period that tapping operations were being conducted at Bayeux.

The ease with which Haiti could be reached from the United States was also an important factor, making possible a close coordination

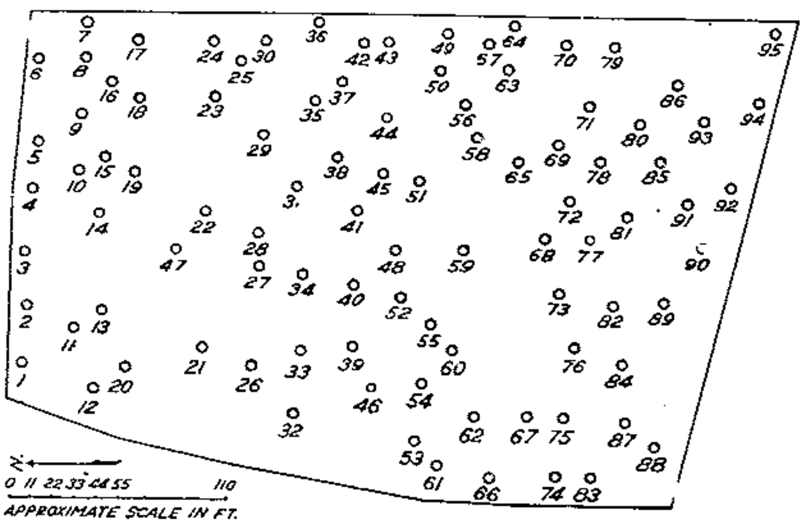


FIG. 1.—Positions of the Hevea trees in plot A

with the investigations in the United States and allowing free movement of equipment and personnel at a minimum of time and expense.

TAPPING OPERATIONS

Through the courtesy of the North Haiti Sugar Co., the owner of the Bayeux estate, members of the Department of Agriculture were allowed to undertake experimental tapping of the rubber trees. Arrangements were also made to permit the department to use the seeds for experimental purposes, in order that plantings might be made at Bayeux and other places for observations on growth rate and cultural requirements under a variety of different conditions.

Tapping operations were started September 1, 1924. For the first experiments 95 trees of *Hevea brasiliensis* were selected. These trees were scattered irregularly over an area of approximately 2 acres and very closely interplanted with cacao. A map of this plot showing the relative position of the Hevea trees is shown in Figure 1.

This plot, which is carried in the records as plot A, has a sticky black alluvial soil about 2½ feet deep, underlain with coarse river gravel.

The ground slopes slightly toward the east and north, part of the east side being actually under water for short periods after heavy rains during the wet season. The water table in dry seasons is about 3 to 4 feet. In wet seasons it rises almost to the surface. The plot is surrounded on all four sides by drainage canals. The canal on the east side, which is approximately 4 feet deep, always carries running water. The canals on the north and west sides are about 1 foot deep, and the canal on the south side is about 2 feet deep.

Before tapping operations were started the trees were numbered and the girth measurements taken at 1 foot and 3 feet from the ground. These measurements are shown in Table 1. The trees were approximately 21 years old when tapping was started. They were well-formed, sturdy trees and appeared to be in a healthy, thriving condition. Considerable variation was noted in the bark and seed characters. The bark varied in color from light to dark gray. The surface of the bark on some trees was quite smooth, while on others it was very rough. The thickness of the bark ranged from 5 to 10 millimeters at a height of 3 feet from the ground. Differences in the texture of the bark were noted in tapping, the bark of some trees having a soft, smooth, cheeselike structure while that of others was hard, dry, and gritty. The seed varied in size, shape, color, and markings.

TABLE 1.—*Girth measurements of Hevea rubber trees at 1 foot and 3 feet from the ground in plot A at Bayeux, Haiti*

Tree No.	Girth measurement (inches)		Tree No.	Girth measurement (inches)		Tree No.	Girth measurement (inches)	
	At 3 feet	At 1 foot		At 3 feet	At 1 foot		At 3 feet	At 1 foot
1	35	39	34	52	57	67	38	42
2	47	50	35	38	45	68	50	55
3	52	59	36	33	41	69	54	61
4	43	50	37	30	40	70	45	46
5	31	37	38	48	54	71	40	45
6	34	44	39	46	57	72	37	45
7	40	40	40	56	63	73	50	57
8	46	54	41	48	61	74	43	60
9	43	50	42	32	36	75	54	58
10	36	42	43	36	44	76	52	56
11	44	52	44	43	49	77	52	58
12	53	61	45	48	53	78	36	41
13	50	58	46	54	59	79	43	47
14	41	45	47	44	48	80	46	49
15	39	46	48	50	58	81	45	56
16	42	48	49	33	39	82	44	50
17	49	56	50	53	57	83	61	71
18	42	48	51	41	47	84	48	53
19	55	61	52	47	56	85	45	47
20	54	63	53	53	57	86	49	60
21	46	53	54	41	46	87	58	63
22	52	56	55	38	41	88	52	59
23	57	64	56	57	62	89	68	80
24	45	50	57	38	45	90	45	51
25	47	47	58	39	45	91	52	54
26	43	49	59	44	50	92	48	54
27	39	44	60	63	68	93	42	50
28	43	52	61	52	55	94	51	58
29	42	49	62	52	56	95	58	63
30	37	43	63	47	54			
31	45	51	64	35	40	Total	4,383	4,965
32	57	68	65	51	57	Mean	46.1 ±.525	52.2 ±.576
33	51	56	66	40	52			

Beginning with the 1st of October a number of trees of Funtumia, Mimusops, Ficus, Manihot, and Castilla were also tapped. Other Hevea trees were later added, so that 298 Hevea trees were finallly included in the tapping experiments. Only the observations for plot A, containing the first 95 trees, are included in this report. Calculations of individual-tree records, except where otherwise noted, have been made from 94 trees, since tree No. A-38 had practically stopped yielding latex before the first individual-tree records were started.

During September the trees were tapped daily with one right cut on one-third of the circumference, the lower end of the cut being approximately 1 foot from the ground. A $\frac{5}{16}$-inch Andrews tapping knife, which is essentially a $\frac{5}{16}$-inch half-round carpenter's gouge, was used. From the 1st of October the trees were tapped only on alternate days.

During September and the early part of October the latex from all trees was bulked together and brought into the coagulating shed in pails. Daily records of the total yield of latex of the 95 trees were kept. It seemed desirable, however, to record the yield by individual trees, and this system was instituted October 21. It was found impracticable to coagulate the latex from the individual trees separately, and so the system of recording the yield in cubic centimeters of latex was continued. In order to be able to measure the yields in the laboratory rather than under the trees, wooden trays were made, each to hold exactly 30 of the porcelain cups used to catch the latex. Numbers were stenciled in the bottom of each tray to show where the cups from the tree having the corresponding number should be placed.

The cups of latex were gathered and carried to the laboratory, where the measuring was done. This made possible not only accuracy in measuring the latex, but also speed in handling it, thus avoiding spontaneous coagulation in the cups as much as possible. Any lumps of rubber which coagulated in the cups were measured with the latex. The measurements were usually taken only to the nearest even-numbered cubic centimeter.

After being gathered and measured the latex was bulked together and strained to get rid of any dirt or lumps of rubber. The latex was next diluted with its own volume of water. Coagulation was then brought about by adding acetic acid in the proportion of 1 part of 0.5 per cent acid to 3 parts of diluted latex. This proportion of acid to diluted latex caused coagulation in approximately 20 hours. After coagulation the rubber was rolled. During the first part of the experimental work this was done by hand, with a small wooden roller. Later a small hand-power sheeting machine was used.

After being rolled into sheets the rubber was rinsed in water, allowed to drain for a short time, and placed in the smokehouse. The sheets were allowed to remain in the smokehouse until they were dry enough to show no cloudy places when held up to the light. The dry weight of the rubber was taken when the sheets were removed from the smokehouse. The cup scrap, or rubber coagulating in the cups, and the tree scrap, or strips of rubber pulled from the old cuts before tapping, were dried and weighed separately.

PLOT YIELDS

The month-by-month plot yields of latex, cup scrap, tree scrap, and smoked sheet for the entire period from September, 1924, to August, 1925, with the exception of July, 1925, during which tapping operations were suspended, are shown in Table 2. The latex measurements given represent the total latex coagulated during each month; that is, the bulked latex from the 94 trees (including a few cubic centimeters yielded by tree A–38) minus spillage and the latex taken out for experimental coagulation. The total yield of dry rubber for the 11 months was 148,240 grams, or 326.9 pounds. This represents a mean yield of 3.4 pounds of dry rubber per tree. Of this mean production, 3.1 pounds represents first-quality smoked sheets The cup scrap and tree scrap together make up the remaining 0.3 pound per tree.

TABLE 2.—*Monthly plot yield of latex, cup scrap, tree scrap, and smoked sheet rubber for the period September, 1924, to August, 1925, inclusive*

Month and year	Latex (cubic centimeters)	Dry weight (grams)			
		Cup scrap	Tree scrap	Sheets	Total yield of rubber
1924					
September	83,478	(1)	2,754	29,564	32,318
October	29,122	(1)	1,278	9,677	10,955
November	30,824	(1)	1,210	10,955	12,165
December	48,122	(1)	1,331	15,779	17,110
1925					
January	71,296	(1)	1,156	21,053	22,209
February	21,430	[2] 248	859	6,347	7,454
March	17,392	356	466	5,524	6,346
April	15,978	407	371	5,291	6,159
May	19,489	313	507	7,254	8,074
June	23,427	162	362	8,671	9,195
July [3]					
August	36,940	417	707	15,131	16,255
Total	397,498	1,903	11,001	135,246	148,240

[1] Included in tree scrap.
[2] After Feb. 12. The cup scrap before Feb. 12 was included in the tree scrap.
[3] Tapping operations were suspended during July, 1925.

Figart (3)[2] gives the average yearly yield for 11 companies in Sumatra at from 284 pounds per acre in 1919 to 330 pounds per acre in 1922. On the basis of about 100 trees per acre, which he shows as the average in the east coast section of Sumatra, the average individual tree yield in Sumatra would seem very similar to the yields at Bayeux. In yield per acre the 95 trees at Bayeux, occupying almost 2 acres, are much below those of Sumatra. However, the wide and irregular spacing of the trees at Bayeux and the possible competition of the cacao trees with which they are closely interplanted precludes comparison on an acre basis.

TREE SELECTION WITH HEVEA BRASILIENSIS

Tree selection is an important detail of plantation development. Variation in individual-tree yield in *Hevea brasiliensis* is so great that in all plantings a small percentage of the trees yield a large percentage of the rubber. Many trees yield too little rubber to repay tapping.

[2] Numbers in parentheses refer to "Literature cited," p. 31.

Tree selection must proceed along two lines: First the selection of high-yielding trees from which to obtain seed or bud wood for propagation. These trees must be selected on the basis of actual yield as they must be compared not only with trees in the same vicinity where conditions are similar but with high-yielding trees from any other locality from which seed or bud wood might be obtained. In this type of selection it will undoubtedly pay to obtain the most accurate data in order to get a definite knowledge of the yielding capacity of the trees and the degree of variation in yield found in the fields in which they occur.

Second, the elimination of poor-yielding trees. This is of more immediate practical importance to estate owners. It is obvious that there are many factors which must be considered. In any thinning operations the relation of tree growth to tree spacing as well as the effect of close spacing on individual tree yields must be taken into account. The best spacing will depend on whether large miscellaneous populations give better returns than small populations of high yielders.

Whatever the decision in regard to spacing and tapping, maximum production by means either of small numbers of high-yielding trees or of large numbers of miscellaneous trees can be obtained only by the elimination of the nonproducers which do not yield sufficient rubber to repay the cost of tapping or which by crowding higher-yielding trees reduce the yield of the latter by a quantity greater than the production of the lower-yielding trees.

All selection or elimination of trees must depend on a knowledge of the yields. In selecting trees for seed or bud wood, as much as possible should be known in regard to the absolute rubber-yielding capacity. In eliminating poor yielders only the relative yielding capacity need be determined. In either case an adequate index of the yielding capacity of the trees is important. Attempts have been made to determine tree characters which are easily measured and which are so closely correlated with yield that they may be used as an index of yielding capacity. In these studies the tree yield has usually been calculated from periods of a year or less and are necessarily only an approximation of the total yield. It would seem desirable to have some measure of the closeness of this approximation.

The most easily measurable tree character obviously connected with ultimate yield is the yield for a single tapping. Any other yield measurement is merely a summation of tappings. Since the useful life of Hevea extends over a period of many years, it is important that one know whether trees which give a high yield for any given number of tappings may reasonably be expected to yield highly throughout their life.

In order to determine the probable standing of any tree in relation to other trees for any given period, it is important that one know the length of time for which the yield of the tree should be recorded. It is probable that the longer the period for which the yield is known the more accurate will be the indication as to future relative yield. While records might be kept on the individual-tree basis for long periods in experimental work, such records are not practicable in estate operations where thousands of trees are being tapped. It is desirable, therefore, to have some measure of the value of short-period measurements of yield in evaluating yielding capacity.

An additional factor is the seasonal fluctuation in yield. In any determination of yield for a period less than a year it is important to know what effect seasonal variations in yield have had on the records obtained, whether all trees are affected alike, and whether high-yielding trees suffer more or less than the low-yielding trees during adverse seasons. It is to be expected that some trees may yield more at first but fall behind later, while others continue to increase. Experience has indicated that the yield of the tree increases from year to year during the first years of tapping, while the daily yields fluctuate from season to season. The question as to when yield tests should be made, so that the individual tapping can be confined to the shortest possible period that will give reliable results, is very important.

COEFFICIENTS OF CORRELATION AND REGRESSION

In attempting to base a system of tree selection according to yield on the yield results from any limited period, it is important to know how closely the relative standing of the trees in any known period is correlated with the relative standing in any subsequent known period. This problem can be approached by the same methods that Harris (*5*) has used i correlating intermonthly and interannual egg production.

The product-moment coefficient of correlation is a measure which can be calculated from known data according to well-known formulas to show the relation between individual-tree yields in any two periods. This measure has been used by Bryce and Gadd (*2*) in correlating interannual yields in Ceylon. It has also been used by these authors and by La Rue (*6*), Gehlsen (*4*), and others to get a measure of the interrelation of other plant characters.

By itself, the correlation coefficient measures only the proportion of the total variation of the two periods that is common to both. To estimate the total yield from the observed yield of a shorter period it is necessary to make use of the regression coefficient. By this coefficient, if the departure of the yield of any particular tree from the mean of all the trees for one period is known, it is possible to estimate the departure of the yield of this tree from the mean of all the trees in a second period.

The regression is derived from the correlation by the formula $b_{xy} = r\frac{\sigma_x}{\sigma_y}$ where b_{xy} is the regression of the tree yields in the x period on the tree yields in the y period, r is the interperiod correlation of tree yield, and σ_x and σ_y are the standard deviations of the tree yields in the two periods.

Since it is possible to estimate the deviation of the yield of any tree from the mean of all of the trees in the second period, it will also be possible to predict the actual yield by taking as the expected mean yield of all of the trees for the second period the mean yield of all the trees for a similar period for which data are available. By multiplying the deviation of the yield of any tree from the mean of all of the trees in the first period by the coefficient of regression, the expected deviation in the second period can be calculated. By adding or subtracting this expected deviation to or from (as the case may be) the expected mean, an estimate of the probable yield in the second period can be obtained.

THE REGRESSION EQUATION

For the prediction of the yields of particular trees from their yields in any given month it is convenient to make use of the regression equation. To illustrate the use of this equation, assume that the yields in November were being used as a basis of estimation of the yields in January, as is done later in this report under the discussion of production control. For this purpose the regression equation may be put in the following form:

$$X=(M-b_{2\cdot1}\bar{n})+b_{2\cdot1}n$$

where X = the desired estimate of the yield of a particular tree for January,
n = the known yield of the same tree in November,
M = the mean yield of all of the trees in January of a previous year,
$\bar{n}$ = the mean yield of all of the trees in November,
$b_{2\cdot1}$ = the regression of January yields on November yields.

In cases where the yields in months other than January are being estimated the same symbols would apply, X always representing the yield of any tree in the month for which the yields are being estimated and M the mean yield of all of the trees in the same month of a previous year. The symbol $b_{2\cdot1}$ would represent the regression of the later period on the earlier. It is assumed, of course, that M and $b_{2\cdot1}$ have already been determined from previous records. As used in this report, the months for which the yield predictions are tested are the same months which were used to obtain the regressions. This was made necessary by the absence of previously calculated regressions with which to illustrate the use of the regression equation in predicting tree yields.

COEFFICIENT OF CORRELATION OF RANK

Another method of comparing the relative yields of the trees in the different months is by means of the coefficient of correlation of rank. This gives a very good idea of how well the trees are maintaining their relative positions in yield and may be used as a quick method of determining which periods show the closest correlation of tree rank. The coefficient of correlation of rank can be calculated by the use of the following formula:

$$\rho=1-\frac{6\Sigma\, d^2}{N\,(N^2-1)}$$

$$PE\rho=0.7063\,\frac{1-\rho^2}{\sqrt{N}}$$

where ρ = coefficient of correlation of rank,
Σ = summation,
d = difference in relative rank in the two periods for each tree,
N = number of trees,
$PE\rho$ = the probable error of the coefficient of correlation of rank.

Where the trees are ranked for each month it is possible by using this formula to get a measure of relative yield in any two periods more quickly than by the use of the product-moment correlation. The coefficient of correlation of rank, however, is not suitable as a means of measuring regression. Its chief utility lies in the fact that it can be calculated quickly, and with data of this type it agrees closely with the product-moment correlation and thus gives a measure of intermonthly correlation that is adequate for many purposes.

The coefficient of correlation of rank disregards the size of the intervals between trees so that those high or low in yield do not influence the correlation more than other trees. On the other hand, in obtaining the coefficient of correlation of rank, all yield intervals between trees of consecutive rank are treated as equal to the mean interval unit for the plot. This tends to increase the effect of the yield classes containing large numbers of trees with small intervals, and when these classes occur at either end of the distribution the closeness of the correlation is overemphasized by the coefficient of correlation of rank.

INTERMONTHLY CORRELATIONS OF YIELD AT BAYEUX

The individual yields of the 94 trees are shown in Table 3 by months for the period from November, 1924, through August, 1925. The record is for only nine months, as the trees were not tapped in July, 1925. The frequency distribution of these yields is shown in Table 4, together with the standard deviation, coefficient of variability, and coefficient of skewness for each month. The trees vary greatly in yield, a small percentage producing a large percentage of the yield in each period. In the high-yielding months the distribution follows closely the normal distribution. In the low-yielding months, however, large numbers of the trees are found in the lowest-yielding group. The standard deviation is large, giving a very high coefficient of variability in every month. The coefficient of variability for the trees at Bayeux is lower than that reported by Whitby (*8*) (76.19) for a miscellaneous population in the Federated Malay States, but is very similar to that for a plot reported on by La Rue (*6*) (60.32) in Sumatra. Bryce and Gadd (*2*) reported a coefficient of variability of 18.2 in the first 12 months' tapping and of 29.2 for the second 12 months' tapping of 155 trees grown from seed from a single high-yielding tree in Ceylon. For these same trees Taylor (*7*) found coefficients of variability of 33.2 and 27.5, respectively, for the next two successive 12-month periods.

The distribution is very skew in every month except December, January, and June. Bryce and Gadd give a coefficient of skewness of 0.095 for the first year and 0.289 for the second year. Whitby gives a coefficient of skewness of 0.575. The distribution for the entire period at Bayeux was found to have a coefficient of skewness of 0.432. In all cases the skewness was toward the lower end of the distribution, emphasizing the fact that a large percentage of Hevea trees are normally relatively low yielders and that there are outstanding high-yielding trees which give a possible source of propagating material.

81848—28——2

TABLE 3.—*Latex yield, in cubic centimeters, of 95 Hevea rubber trees for stated months in 1924 and 1925*

[The totals shown in this table are the summations of daily individual-tree measurements and do not agree with the monthly totals given in Table 2, which are the summations of the daily measurements of the bulked latex from the entire plot and represent the total latex obtained each day minus the latex lost while recording individual-tree yields]

Tree No.	1924		1925							Total
	November	December	January	February	March	April	May	June	August	
1	106	192	188	71	7	9	52	104	250	1,039
2	274	395	630	226	190	190	118	204	276	2,509
3	369	1,301	1,550	376	346	272	218	262	410	5,100
4	140	560	712	242	148	69	91	90	224	2,276
5	154	289	482	80	63	34	95	44	290	1,540
6	300	547	573	303	268	232	214	248	478	3,163
7	436	756	040	337	267	135	74	228	412	3,585
8	118	283	962	289	120	38	25	101	184	2,120
9	120	400	032	100	112	88	70	156	276	1,963
10	218	412	534	105	143	60	150	117	352	2,097
11	66	151	100	73	99	74	60	78	100	900
12	308	526	753	326	255	248	285	352	462	3,515
13	332	769	1,003	343	238	264	366	364	630	4,399
14	570	830	1,375	538	339	342	392	373	664	5,429
15	392	604	1,090	560	363	350	412	495	724	5,008
16	188	409	708	137	89	68	122	258	314	2,383
17	292	754	1,402	480	273	170	140	203	308	4,112
18	204	674	1,262	341	211	140	119	180	288	3,419
19	145	221	265	37	40	76	88	186	272	1,330
20	550	1,070	1,796	628	465	396	526	619	1,100	7,159
21	310	798	1,347	304	136	120	350	539	1,122	5,026
22	308	430	755	339	230	234	242	350	764	3,652
23	544	826	1,208	468	455	370	350	340	512	5,073
24	256	584	1,204	430	310	225	247	348	554	4,158
25	150	207	331	63	90	62	100	141	244	1,388
26	250	287	352	48	85	37	189	232	442	1,922
27	190	274	421	112	183	240	273	260	338	2,297
28	619	569	794	211	197	232	374	508	636	4,140
29	274	448	526	145	117	186	302	462	608	3,178
30	162	283	498	189	154	196	178	216	244	2,120
31	278	352	450	173	80	32	80	199	324	1,968
32	240	453	474	170	100	178	220	304	332	2,470
33	278	345	380	148	126	134	142	150	280	1,983
34	301	596	1,052	242	336	338	418	420	646	4,439
35	322	599	896	206	334	322	315	318	454	3,826
36	338	453	507	172	190	228	274	332	496	3,080
37	74	165	221	21	99	35	65	68	106	854
38	12	4	0						[1] 629	654
39	535	830	1,462	525	376	200	382	496	706	5,611
40	490	624	960	316	312	198	350	382	494	4,126
41	453	711	946	368	190	200	340	360	464	4,032
42	134	220	590	132	54	52	71	112	180	1,545
43	154	242	326	31	91	108	217	236	270	1,675
44	356	523	758	314	268	196	254	314	430	3,419
45	296	458	708	252	254	254	296	312	508	3,338
46	385	500	949	356	334	378	386	336	441	4,125
47	306	486	280	7	0	0	13	0	79	1,177
48	360	599	708	204	216	104	144	238	460	3,053
49	335	611	755	286	224	278	208	276	438	3,471
50	324	564	942	290	334	308	328	327	440	3,863
51	288	623	993	276	153	106	104	124	188	2,855
52	214	370	645	238	320	186	224	220	266	2,683
53	405	648	836	380	312	354	402	368	536	4,241
54	625	823	1,286	427	530	368	564	588	864	6,095
55	280	566	1,068	147	87	124	318	228	283	3,101
56	164	326	418	86	128	132	196	160	280	1,890
57	226	596	722	352	98	166	300	310	410	3,180
58	821	1,285	1,908	614	452	410	528	654	946	7,618
59	467	668	880	105	138	152	206	264	268	3,154
60	204	458	532	161	140	84	160	228	236	2,293

[1] In August a new tapping cut was used on tree No. 38

TABLE 3.—*Latex yield, in cubic centimeters, of 95 Hevea rubber trees for stated months in 1924 and 1925*—Continued

Tree No.	1924		1925							Total
	November	December	January	February	March	April	May	June	August	
61	320	477	870	330	390	324	362	412	415	3,912
62	533	614	972	307	290	250	356	324	390	4,036
63	224	501	714	57	95	84	100	242	210	2,347
64	248	393	484	21	142	188	258	258	228	2,220
65	396	565	706	158	90	146	330	466	512	3,459
66	202	386	602	172	184	220	230	268	514	2,844
67	482	680	832	238	250	252	322	302	358	3,722
68	598	979	1,582	300	484	310	288	366	404	5,413
69	204	157	172	3	0	0	24	99	189	848
70	288	677	825	72	78	52	86	182	234	2,394
71	326	775	774	74	42	36	110	228	224	2,589
72	447	617	608	49	88	144	236	264	322	2,775
73	443	510	690	190	228	122	186	288	244	2,913
74	640	807	1,272	507	514	412	464	548	918	6,082
75	324	476	640	178	132	96	144	174	210	2,374
76	554	1,100	1,628	433	432	564	614	656	556	6,446
77	266	370	558	183	184	212	224	272	378	2,647
78	272	448	600	208	100	114	112	200	244	2,298
79	310	204	658	98	70	108	162	300	358	2,358
80	350	626	875	322	298	280	268	360	548	3,927
81	206	536	699	211	201	210	240	274	270	2,907
82	244	401	470	139	53	49	84	172	178	1,790
83	260	552	823	262	80	128	202	332	186	2,825
84	292	392	583	207	124	114	140	190	252	2,294
85	403	765	925	250	260	374	354	444	604	4,489
86	344	607	778	197	142	152	218	272	364	2,974
87	856	1,504	1,994	812	676	588	730	1,040	1,916	10,122
88	252	364	502	153	151	162	182	200	208	2,173
89	296	523	744	383	271	288	322	364	482	3,674
90	278	280	362	170	53	128	100	238	264	1,942
91	136	268	270	101	58	74	72	110	88	1,173
92	597	701	1,102	245	278	434	398	532	826	5,113
93	280	608	898	270	184	140	194	332	206	3,112
94	222	428	602	174	113	104	178	222	320	2,423
95	176	390	463	107	160	55	170	282	232	2,015
Total	30,707	51,375	74,612	22,652	19,198	17,878	22,517	27,615	30,897	300,449

TABLE 4.—*Frequency distribution and statistical constants for the latex yields of 94 Hevea rubber trees for stated months in 1924 and 1925*

Yield class of latex, cubic centimeters	1924		1925						
	November	December	January	February	March	April	May	June	August
0–100	2	0	0	17	25	24	16	6	2
100–200	15	4	3	26	29	32	25	17	8
200–300	32	12	4	20	19	20	23	30	20
300–400	23	11	5	19	13	13	21	25	13
400–500	9	15	9	5	5	3	4	7	18
500–600	8	21	9	4	2	2	3	5	8
600–700	3	12	11	2	1		1	3	6
700–800	0	8	15	0			1	0	3
800–900	2	5	9	1				0	2
900–1,000		1	9					0	2
1,000–1,100		1	4					1	0
1,100–1,200		1	1						2
1,200–1,300		1	5						0
1,300–1,400		1	2						0
1,400–1,500		0	2						0
1,500–1,600		1	3						0
1,600–1,700			0						0
1,700–1,800			1						0
1,800–1,900			0						0
1,900–2,000			2						1
Mean	326.5	540.5	793.0	241.0	204.2	190.2	239.5	293.8	417.7
Standard deviation	153.6	259.6	382.1	158.7	135.9	121.5	143.3	156.2	270.8
Coefficient of variability	47.04	47.50	48.15	65.85	66.55	63.88	59.83	53.17	64.83
Coefficient of skewness	.420	.010	.128	.599	.461	.306	.562	.216	.585

MONTHLY-ANNUAL CORRELATIONS OF YIELD AT BAYEUX

In the first comparisons of yield periods the yields for each month were correlated with the total yields for the entire period. The coefficients of correlation were found to be as follows:

November	0.842±0.020	February	0.889±0.015	May	0.860±0.018
December	.883± .015	March	.844± .020	June	.882± .016
January	.910± .012	April	.826± .022	August	.863± .018

These coefficients are very high. January, the highest yielding month, has the highest correlation, and April, the lowest yielding month, has the lowest correlation. In general, the closeness of the correlation between the yield for the total period and the yield for any month varies according to the total yield for the month.

An objection to this comparison is that the yield for each month is compared with a total yield of which it is a part. This tends to overemphasize the closeness of the relation. To determine the amount of the increase in the correlation due to the inclusion of the month being compared in the total with which it was compared, each month was correlated with the total of the other eight months. The correlations between each month and the total of the other eight months were found to be as follows:

November	0.820±0.023	February	0.856±0.018	May	0.830±0.022
December	.888± .015	March	.821± .023	June	.863± .018
January	.894± .014	April	.815± .024	August	.809± .024

There was a decrease in the closeness of the correlations in every case except December. These decreases are too small to be considered significant, and it does not appear that any month's correlation has been overemphasized in comparison with that for any other month in making the comparison with the total for the period rather than with the total of the period minus the month being compared.

The coefficients of correlation of rank between each month and the total for the period were also calculated and were found to be as follows:

November	0.841±0.03	February	0.867±0.02	May	0.850±0.03
December	.882± .02	March	.852± .02	June	.875± .02
January	.902± .01	April	.854± .02	August	.817± .03

These coefficients are not significantly different from the product-moment correlation coefficients shown above, indicating that in data of this type a very good idea of intermonthly correlation of yield can be obtained from the coefficient of correlation of rank. In months of low yield where the distribution is very skew the correlation of rank is higher than the product-moment correlation, and in high-yielding months it is slightly lower.

EFFECT OF ELIMINATION ACCORDING TO YIELD

In thinning out rubber plantings according to yield, a necessary effect of the elimination of the poor-yielding trees is to increase the mean tree yield of the plot. This is accomplished regardless of whether the yields of the retained trees are increased due to the increased space per tree. The immediate effect of the elimination is a decrease in the yield per acre but an increase in the mean yield per tree. If the trees have been planted thickly in order to provide for the elimination, a selection of high-yielding trees is accomplished, and the yield per acre is raised over that obtainable by planting only the number of trees actually desired for a permanent stand.

To show the effect of the elimination of trees according to the yields in any month, the trees are shown in Table 5, arranged from 1, high, to 94, low, according to their yields over the entire period. To show the comparative rank of the trees in each of the nine months the trees were assigned numbers corresponding to their rank for the entire period, and these are shown arranged according to yield for each month. Tree No. 87, holding rank No. 1 in total yield for the entire period, was also high tree in every month. At the lower end of the list, tree No. 69 held rank 94 for total yield over the entire period. In two of the nine months it yielded nothing. It was low tree in two of the seven months in which it produced latex. Tree No. 47, ranking eighty-ninth over the entire period, yielded nothing in three months and was low tree in three other months. Tree No. 11, holding rank 92, was low tree in two months. Of the 25 low trees occupying rank numbers 70 to 94 for the total period, 6 were among the lowest 25 in all nine months, 3 in eight months, 1 in seven months, 4 in six months, 6 in five months, 2 in four months, and 3 in three months. Fifty-five out of the 94 trees appeared among the monthly lists of 25 low trees. Of the 30 trees which appeared on the monthly lists of 25 low trees but did not appear among the 25 low trees for the entire period, 19 occupied the 19 ranks immediately above the 25 low trees in the ranking for the total period, and 10 additional were among the next 18 trees. One tree, No. 17, occupying position 70 in May, held rank 23 for the entire period.

TABLE 5.—*Rank of 94 Hevea rubber trees according to yield for the entire period, arranged in accordance with their latex yield in the stated months*

[In column 1 the rank number is followed in parentheses by the field serial number of the tree holding that rank for total yield for the entire period. In columns 2 to 10 the trees are assigned numbers corresponding to their yield rank for the entire period as shown in column 1, and these new numbers are arranged according to yield of latex for each month]

Rank and field serial number	Tree numbers, assigned according to yield rank for the entire period								
	1924		1925						
	November	December	January	February	March	April	May	June	August
1	2	3	4	5	6	7	8	9	10
1 (87)	1	1	1	1	1	1	1	1	1
2 (56)	2	11	2	3	5	4	4	4	13
3 (20)	6	2	3	2	6	10	5	2	3
4 (70)	5	4	9	14	9	6	2	3	2
5 (54)	20	3	11	8	3	2	3	5	6
6 (74)	9	9	4	7	12	3	6	6	5
7 (39)	10	6	7	6	2	5	16	13	10
8 (14)	8	7	23	23	4	22	14	10	32
9 (68)	4	8	8	12	27	15	18	20	14
10 (92)	3	5	13	4	7	12	10	7	7
11 (3)	12	12	5	19	14	18	8	14	8
12 (23)	7	13	6	5	11	14	41	41	16
13 (21)	24	57	36	9	8	8	22	36	20
14 (15)	21	17	12	31	16	16	15	15	17
15 (65)	30	15	19	18	22	27	7	16	41
16 (34)	43	33	10	11	28	29	20	27	15
17 (13)	15	23	14	25	29	9	17	21	4
18 (53)	25	25	17	22	55	28	27	8	19
19 (24)	54	10	45	40	18	7	24	18	26
20 (25)	49	30	16	17	21	31	12	9	18
21 (40)	33	38	51	38	19	26	21	17	52

TABLE 5.—*Rank of 94 Hevea rubber trees according to yield for the entire period, arranged in accordance with their latex yield in the stated months*—Continued

Rank and field serial number	Tree numbers, assigned according to yield rank for the entire period								
	1924		1925						
	November	December	January	February	March	April	May	June	August
1	2	3	4	5	6	7	8	9	10
22 (40)	18	43	24	32	26	35	13	31	36
23 (17)	36	18	74	33	24	11	25	25	12
24 (62)	14	26	21	27	15	17	36	26	39
25 (41)	16	21	22	34	10	39	28	34	40
26 (80)	22	51	25	26	23	30	31	32	21
27 (91)	47	54	28	21	31	24	30	19	31
28 (50)	11	24	33	37	37	34	45	12	42
29 (35)	37	35	15	24	42	67	29	22	25
30 (67)	26	44	44	13	33	32	40	46	34
31 (89)	48	14	29	42	34	42	39	53	47
32 (22)	46	47	43	28	39	20	9	44	29
33 (7)	35	20	26	74	30	46	34	28	28
34 (12)	17	16	27	35	17	19	46	24	81
35 (49)	27	40	18	51	32	52	67	29	22
36 (85)	57	20	30	44	49	56	26	37	35
37 (44)	28	19	61	29	35	50	35	30	37
38 (18)	63	61	53	53	47	25	71	40	11
39 (45)	29	45	36	29	38	21	37	69	27
40 (57)	13	36	20	15	50	37	19	30	33
41 (29)	64	28	48	10	20	73	32	64	40
42 (6)	32	65	57	16	58	53	50	49	9
43 (59)	34	22	37	70	25	71	52	35	23
44 (63)	89	70	35	30	46	55	54	50	24
45 (55)	42	53	32	55	44	41	56	56	56
46 (30)	31	42	34	58	56	59	55	48	48
47 (48)	39	50	31	20	52	23	50	52	30
48 (86)	69	34	40	50	67	40	11	54	64
49 (73)	23	37	65	66	76	60	48	43	75
50 (81)	68	31	70	68	73	72	84	11	67
51 (61)	51	49	47	47	51	48	42	76	59
52 (66)	61	48	62	48	72	43	43	67	78
53 (83)	44	62	39	49	70	36	53	71	54
54 (72)	45	89	60	73	75	54	82	47	60
55 (52)	77	27	49	56	48	38	44	62	62
56 (77)	78	63	64	63	71	44	81	42	86
57 (71)	80	39	55	60	69	33	49	65	38
58 (2)	41	69	63	78	43	77	72	80	45
59 (32)	58	46	79	62	13	82	73	84	82
60 (94)	66	59	58	46	63	63	60	81	77
61 (70)	50	41	54	59	82	80	76	45	58
62 (16)	56	68	60	80	77	45	64	69	79
63 (75)	52	32	52	69	68	49	80	57	88
64 (70)	53	60	66	36	74	13	69	33	50
65 (63)	19	75	46	72	41	68	65	60	84
66 (78)	72	83	85	77	60	66	75	55	43
67 (27)	81	79	68	45	79	84	47	73	55
68 (84)	71	58	42	41	66	64	63	58	80
69 (60)	83	71	56	83	59	51	77	23	68
70 (4)	59	68	75	62	92	47	23	72	91
71 (64)	40	76	60	85	93	63	68	66	49
72 (88)	65	52	41	67	40	70	62	78	73
73 (30)	60	58	72	76	65	69	38	68	86
74 (8)	75	55	73	43	84	65	58	88	87
75 (10)	55	72	71	75	36	88	66	61	69
76 (65)	38	78	86	90	87	92	57	38	61
77 (33)	94	77	59	70	62	90	51	68	76
78 (31)	67	82	83	64	54	70	87	83	71
79 (9)	62	64	76	82	45	62	86	82	57
80 (90)	76	80	78	86	81	75	70	79	70
81 (26)	91	86	67	57	53	87	68	77	65
82 (56)	82	81	82	92	78	76	61	87	63
83 (82)	73	73	77	61	61	61	83	51	72
84 (43)	84	74	80	91	64	85	78	75	44
85 (42)	86	67	81	87	86	83	79	85	94
86 (5)	87	90	87	65	90	74	33	90	51
87 (25)	88	84	84	54	85	81	90	91	53
88 (19)	70	88	89	81	80	57	85	74	74
89 (47)	90	85	90	88	83	93	92	94	86
90 (91)	85	87	88	84	57	86	93	70	88
91 (1)	79	91	93	71	88	78	91	92	93
92 (11)	74	93	92	93	91	91	74	93	92
93 (37)	93	94	91	89	89	80	94	86	90
94 (69)	92	92	94	94	94	94	89	89	89

Tree No. 87 was the only one to maintain its relative rank throughout all periods. Some trees varied widely while others kept to nearly the same relative positions in all periods. On the whole, as shown by the product-moment correlations and by the coefficients of correlation of rank, the trees retained their relative positions to a high degree. Since the coefficients of correlation are high and the differences are not significant, the yields in any month would serve as a satisfactory indication of relative yield.

Had the 25 trees with the lowest yields for the entire period been eliminated, the mean yield of the remaining trees, assuming that their yields were unaffected by the removal of the lowest 25, would have been 3,823.9 cubic centimeters of latex, an increase of 17.5 per cent over the mean tree yield for the entire plot for the period. On the basis of the new spacing and mean yield, 94 trees occupying a 36 per cent larger area would have yielded 17.5 per cent more latex. Eighty trees, occupying a 15 per cent larger area, would have yielded as much as the 94 unselected trees. Had the trees been planted to provide for the elimination of the same proportion of trees and still have a permanent planting of 94 trees in the same area, the area yield as well as the yield per tree would have been increased 17.5 per cent.

This increased yield per tree would have been obtained by elimination according to the knowledge of the relative yielding of the trees obtained from yield tests covering the entire period. Had the 25 trees that were lowest in any month been eliminated at the beginning of the experiment, the mean tree yield for the entire period would have been increased as follows:

By eliminating the lowest 25 trees in—

	Per cent		Per cent		Per cent
November	14.9	February	15.8	May	13.8
December	15.9	March	14.6	June	15.9
January	16.5	April	16.0	August	14.1

The highest month in actual yield and the one that correlated closest with the total yield was January. Elimination according to the yields in that month would have given the largest percentage increase in mean tree yield. April gave the second best basis for elimination as measured by the percentage in mean tree yield. The mean of the percentage increases obtainable on the basis of the different months is 15.3 per cent. The effect of the elimination of 25 trees from a population of 94 trees with a yield distribution similar to that at Bayeux would be an increase in the mean individual tree yield of 17.5 per cent, if based on as exact data as that represented by the yields over this entire period, or from 13.8 to 16.5 per cent, if based on data correlated as closely with the total yield as the monthly yields at Bayeux were correlated with the total yields for the entire period.

Elimination of 25 trees out of 94 (26.6 per cent), or the equivalent of a planting of 136 trees thinned to 100 trees, is a very moderate thinning. The elimination of 50 trees, or 53.2 per cent of the total of trees, on the basis of lowest total yields would have increased the plot mean tree yield 38.4 per cent. This would have been equivalent to 214 trees thinned to 100 trees. Had 75 per cent, or 71 of the 94 trees, been eliminated on the basis of lowest yields, the mean yield of the remaining 23 trees would have been increased 65.1 per cent. This would have been equivalent to a planting of 376 trees thinned to 94.

PRODUCTION CONTROL BASED ON INTERMONTHLY REGRESSIONS

The previous discussion has been based on the elimination of trees by thinning. In some fields the spacing may be such that no advantage can be gained by thinning, and still there are trees which do not yield sufficient latex to repay tapping operations when prices are low yet which might be expected to give a profitable return on the tapping operations under normal or higher prices.

Two questions might be asked in regard to these trees: (1) Will it pay to drop such trees from the tapping operations during periods of low prices? (2) If it would pay to drop such trees, what data would be required to give an adequate basis for predicting whether any tree will yield sufficient rubber to repay tapping?

No attempt will be made to answer the first question, since so much depends on local costs. Data would be needed to show the length of time required to tap a tree and the proportion of a tapper's time used in going from tree to tree. The effect either of thinning operations or of dropping trees from tapping would increase the time spent in walking at the expense of the time used in tapping.

The intermonthly correlations at Bayeux can be used to show the data that would be required as a basis for an estimate of yield. The coefficients of correlation and regression equations for comparisons between November and each of the subsequent months of the period were calculated and are shown in Table 6.

TABLE 6.—*Correlations of November and the subsequent months of the period and regression of the subsequent months on November*

[In the regression equations X is the best estimate of yield in the subsequent month and n is the yield in November]

Month	Coefficient of correlation	Regression equation
December	0.797±0.025	$X = 118.274 + 1.348\,n$
January	.733± .032	$X = 239.712 + 1.824\,n$
February	.706± .035	$X = -5.410 + .720\,n$
March	.726± .033	$X = -24.854 + .041\,n$
April	.746± .031	$X = -20.455 + .590\,n$
May	.752± .030	$X = -3.024 + .701\,n$
June	.778± .027	$X = 30.770 + .791\,n$
July		
August	.721± .033	$X = 22.410 + 1.271\,n$

Having these regression equations, it is possible to predict the probable yield of any tree in any one of the subsequent months by using the November yields as a basis of estimate. In using the regression equation for this purpose the November yield of any tree would be substituted for n in the regression equation and a value found for X, the best guess as to the yield of the tree in the subsequent month.

In production control the desire is not to predict actual yield but to know the minimum yield which any tree must exceed in any month to indicate that it will yield more than any specified quantity in some future month. In this case the process of solving the equation would be reversed and the minimum yield desired in the future month would be substituted for X in the regression equation which would be solved for n.

To show how the regression equation might be used in this way with the data from Bayeux, assume that in any month the minimum individual-tree yield which would repay tapping costs was estimated to be 200 cubic centimeters of latex. By substituting 200 for X in each of the regression equations shown in Table 6 and solving for n, the answer for each month would indicate the yield which any tree must exceed in November to indicate a probable yield of 200 cubic centimeters or better in the month for which the regression equation applies. A smaller yield in November would indicate a yield of less than the desired quantity and would result in the tree being dropped from the tapping operations for the month. Solving the regression equations shown in Table 6 by substituting 200 for X in each case, the value of n was found to be:

December	68.0	March	350.8	June	213.9
January	−21.8	April	373.7	August	139.7
February	281.8	May	289.6		

In other words, a tree yielding 68 cubic centimeters of latex in November would be expected to yield 200 cubic centimeters in December; a tree yielding any latex in November would be expected to yield 200 cubic centimeters in January, etc.

By this method of estimate one would predict that tree 11 would be the only one (other than tree 38) producing 200 cubic centimeters of latex or less in December, whereas there were actually four. The prediction for January would be that every tree would yield more than 200 cubic centimeters. Only two trees did yield less than that quantity, and these two missed it by a very slight margin.

These estimates are inexact and represent only a best guess as to future yield as predicted from known yield. The longer the known period used as a basis of estimate, the greater would be the accuracy of the estimate. Since it would be impracticable to have known yields for considerable periods, regression equations based on monthly or even shorter periods might be adequate for many purposes.

EFFECT OF PROXIMITY ON INTERMONTHLY CORRELATION OF YIELD

The foregoing comparisons have been based on the intermonthly correlations between November and the subsequent months. It was thought that the closeness of the intermonthly relation would be affected by the proximity of the months compared. To determine whether this was a fact in relation to the closeness of the correlation between November and the subsequent months, the correlation between each month and the immediately subsequent month was calculated. The comparison of the correlations between November and the subsequent months and between each month and the immediately subsequent month is shown graphically in Figure 2. With the exception of the November–December comparison, which is of course, identical in both cases, the correlations between November and the subsequent months are distinctly lower. The mean of the comparisons with November is 0.745. The mean of the comparisons of immediately subsequent months is 0.858.

Thus the correlation between a period and a subsequent period is dependent on the proximity of the subsequent period. This dependence is not in a direct ratio and is influenced by the seasonal changes which influence the yield. A measure of the proximity relation, which it is hoped can be obtained from more extensive data, should show for how long the results of any tapping test may be expected to give an adequate knowledge of relative yield in subsequent periods.

INTERPERIOD CORRELATIONS OF YIELD

All correlations between the monthly yields were found to be high, this being especially true when high-yielding months were compared with other months or with the total. This is what might be expected, since the frequency distribution of the low-yielding months tends to become skew owing to the concentration of large numbers of trees in the low-yielding classes.

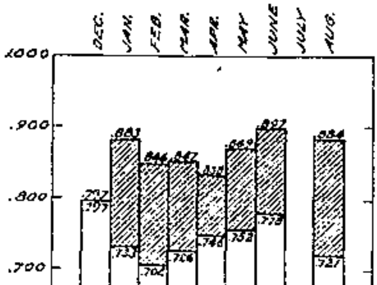


FIG. 2.—Relative magnitude of interperiod correlations of individual-tree yields. The upper figure in each column is the coefficient of correlation of the month with the month preceding, and the lower figure is the coefficient of correlation of the month with November. The shaded area represents the difference between the two coefficients

As indicated by these correlations, the relative yield in any month is a good index of the relative yield in any subsequent month. An estimate of future yield made on the basis of a high-yielding month is of greater accuracy than one made on the basis of a low-yielding month. While the proximity of a subsequent month affects the closeness of the correlation with any given month, a measure of the effect of remoteness on the accuracy of the estimate will require additional data.

Since the monthly yields at Bayeux have shown so high an intermonthly correlation, it is interesting to note that an interannual correlation between the yield in 1921–22 and the yield in 1922–23 reported by Bryce and Gadd (*2*) in Ceylon was 0.83 ± 0.017, indicating that the interperiod correlation of yield at Bayeux is comparable with that for Ceylon, notwithstanding differences in climate and in the age and condition of trees. Taylor (*7*), reporting on the same trees studied by Bryce and Gadd, found a correlation of 0.834 ± 0.016 between the yield in 1922–23 and the yield in 1923–24 and of 0.735 ± 0.025 between the yield in 1923–24 and the yield in 1924–25.

In determining the interperiod relation, the month has been used as the unit period. There is no reason for this other than that the monthly yield is a convenient summation of tappings.

In a first survey of interperiod correlation it was important that the effect of the seasonal variation in yield on the closeness of the correlation be determined. This could be determined most conveniently from intermonthly and monthly-annual correlations. The examination has shown that those correlations are high, and that for any month the correlation with a high-yielding month is higher than with a low-yielding month. The differences, however, are not significant, and the convenience of the operator rather than the time of year should be the determining factor in deciding when to do experimental tapping.

To determine whether the month is the unit best suited for tapping experiments, it is important that other units be tested. These units should be both longer and shorter than a month. If a correlation between length of period and closeness of correlation with total yield (annual, biennial, or longer) can be found, the adequate yield-period unit for estimate of total yield can be determined according to the accuracy of approximation required.

The adequate yield period for approximation of future monthly yields will depend on the closeness of the correlation between the length of period and subsequent monthly yield. This in turn is dependent both on the proximity of the period of test to the period of estimate and on the correlation between length of test period and length of time over which the approximation of monthly yields is adequate.

OTHER TREE CHARACTERS ASSOCIATED WITH YIELD

While recorded yield is the tree character most closely correlated with ultimate yield, there are other tree characters which can be measured and which might be considered as possible indices of yield or of yielding capacity. The character most often considered is tree size as measured by girth. Other characters which have been given attention are the thickness of the bark and the number of rows of latex vessels in a cross section of the bark.

It is obvious that if any stable character could be obtained as a definite index of yielding capacity it would be of great value in tree selection. At the present time, however, no character has been found correlated closely enough with yield to replace tapping tests as a measure for estimating yielding capacity.

Measurements of tree girth and bark thickness were made at Bayeux. The girth measurements were taken with a tape measure and are shown in Table 1. The bark-thickness measurements were taken with a gauge made in the Office of Biophysical Investigations of the Bureau of Plant Industry from plans furnished by C. D. La Rue. In using this gauge the bark was first scraped, as little bark as possible being removed to furnish a smooth surface. The end of the gauge was then placed against the tree and the handle pressed, forcing a blunt point through the soft bark and against the inner wood of the tree. The thickness of the bark was then read to 0.1 millimeter on a vernier on the side of the gauge.

The coefficient of correlation of girth and yield was found to be 0.166 ± 0.068, showing a positive but very small relation. This might be compared with that reported by La Rue (*6*) in Sumatra (0.229 ± 0.019), by Bryce and Gadd (*2*) in Ceylon (0.580 ± 0.035 and 0.560 ± 0.037), and by Whitby (*8*) in the Federated Malay States (0.260 ±

0.020). Taylor (7) giving later measurements from the same trees reported on by Bryce and Gadd, found a correlation of 0.378 ± 0.046 between the yield in 1923–24 and the girth in 1924 and a correlation of 0.408 ± 0.045 between the yield in 1924–25 and the girth in 1925.

In the comparison of bark thickness and yield a zero correlation -0.030 ± 0.070 was found. For this character La Rue reported a correlation of 0.260 ± 0.019, while Bryce and Gadd reported 0.420 ± 0.044. Taylor reported a correlation of 0.483 ± 0.041 between the yield in 1924–25 and the bark thickness in 1925.

The differences between the correlations found at Bayeux and those found in other places are important, indicating that there is no general correlation between yield and either girth or bark thickness. It is probable that the chief utility of girth and bark thickness measurements will be found to be in comparing different populations of Hevea rather than in measuring relative yielding capacity within any one population.

Neither tree size, as measured by girth, nor the thickness of the bark is as good an index of yielding capacity as yield measurements over a period of one month. The highest correlation between girth and yield shown above was that of 0.580 shown by Bryce and Gadd, and the highest correlation shown between bark thickness and yield was that of 0.483 found by Taylor. The lowest intermonthly correlation of yield at Bayeux was 0.706 between November and February.

Since it would entail much more labor to obtain yield measurements for an entire month than to obtain girth measurements, it might be considered that the decreased accuracy of selection based on girth would be offset by the facility with which the girth measurements could be obtained in case the correlation between girth and yield was known to be as high as that shown by Bryce and Gadd. Even in that case it is probable that the yield data from a single tapping, which could be obtained as easily as girth measurements, would give a closer approximation.

While no attempt has been made to determine the exact value of a single tapping, two days, January 5 and February 18, were selected and the correlation of yield between each and the total for the period calculated. For January 5, it was found to be 0.673 ± 0.038, while for February 18 it was found to be 0.744 ± 0.031. These correlations are high and indicate that a close approximation of relative yield can be obtained from a single tapping. If this is found to be the case in a comparison of a larger number of individual tappings, and if ease of measurement is to be the sole criterion, there would be little advantage in using other measurements.

Too much emphasis can easily be placed on using the easiest methods of obtaining data for use in tree selection. The desire is to obtain an adequate index of yielding capacity. Because of chances of error in measurement and chance fluctuations of yield, it is very doubtful whether this adequate measure can be obtained from any single tapping even if found to be of greater value than either bark thickness or girth as an index of yielding capacity.

VARIATION DUE TO PLACE EFFECT

In making the foregoing comparisons no account has been taken of the possibility of variation in the yield due to place. The correlations shown above have been made primarily with the purpose of obtaining information which might be desired in regard to relative yielding capacity for the determination of poor yielders. The variation within the field due to place effect rather than to genetic differences in yielding capacity has not been considered, since with grown trees the location can be changed only by elimination. It is desirable, however, to determine the extent to which observed differences in yield are due to environmental differences or place effects. The smallness of the plot and the uniformity of the soil at Bayeux would tend to give a very uniform place effect. It is desirable, however, that some measure of this uniformity be obtained.

To make a comparison of the different parts of the plot, an arbitrary division was made by drawing a line about midway of the field running approximately north to south. This line was intersected by two lines running from east to west. The attempt was made to divide the field into six sections containing approximately equal numbers of trees. The resulting divisions were unequal in area, the dividing lines being drawn neither at right angles nor at equal distances apart but at such angles and distances as best served the purpose of obtaining six lots with about the same number of trees.

The sections along the west side of the field from north to south were called A, C, and E. Those on the east side of the field, starting from the north, were B, D, and F.

The mean yields of each section of the plot were figured in deciliters of latex per tree for the entire period. They are given in the diagram shown below. For convenience in comparing these figures they are represented in a diagram indicating the relative position of each section to the entire plot. The divisions, however, do not represent the actual shape of the sections.

	East			
North	B 29.088±2.090	D 29.500±2.528	F 28.067±1.920	South
	A 33.667±3.214	C 36.867±2.019	E 38.188±3.694	
	West			

While the means range from 28.067 ± 1.920 deciliters of latex in section F to 38.188 ± 3.694 deciliters of latex in section E, the differences (shown in Table 7) are not significant, since in only 1 comparison out of 15 does the difference equal three times the probable error, and a deviation of this magnitude might be expected once in twenty-two times. A combination of sections A, C, and E gave a mean tree yield of 36.283 ± 1.755, while in sections B, D, and F, combined, the mean tree yield was 28.917 ± 1.228, giving a difference of 7.366 ± 2.142. While this difference is more than three times its probable error, it is of doubtful significance in view of the low significance of the differences between the individual sections. Combining sections A and B, sections C and D, and sections E and F, gives mean yields of 31.355 ± 1.880, 33.065 ± 2.072, and 33.125 ± 2.121, respectively. None of the differences between these means are significant. While a slight difference is indicated between the east and west sides of the field, there is no significant difference in yield between the north and south sides.

Table 7.—*Differences in mean yield between each section and every other section, in deciliters of latex*

Section	Section B	C	D	E	F
A	4.479±3.835	3.200±3.707	4.167±4.000	4.521±4.897	5.600±[illegible].745
B	0	7.679±2.908	.312±3.280	9.000±4.244	1.12[illegible].838
C		0	7.367±3.235	1.321±4.210	8.800±[illegible].786
D			0	8.088±4.543	1.433±3.174
E				0	10.121±4.163

The same sections were compared on the basis of tree girth. The mean tree girths, in inches, for each section of the field are given in the diagram shown below:

East

North				South
	B 42.81±1.189	D 41.29±1.124	F 46.38±1.146	
	A 45.73±0.971	C 50.13±1.124	E 51.00±1.219	

West

Table 8.—*Differences between tree girth means of each section as compared with each other section*

Section	Section B	C	D	E	F
A	2.92±1.535	4.40±1.485	4.44±1.555	5.27±1.559	0.65±1.503
B	0	7.32±1.636	1.52±1.609	8.19±1.703	3.57±1.651
C		0	8.84±1.654	.87±1.658	3.75±1.605
D			0	9.71±1.720	5.09±1.669
E				0	4.62±1.673

Table 9.—*Difference divided by the probable error of the difference in mean tree girth between the six divisions of the field*

Section	Section B	C	D	E	F
A	1.902	2.963	2.855	3.380	0.432
B	0	4.474	.895	4.809	2.162
C		0	5.345	.525	2.336
D			0	5.645	3.050
E				0	2.762

The differences of these means are shown in Table 8, and the differences divided by their probable errors are shown in Table 9. Of the 15 possible comparisons, 6 show differences of more than three times their probable errors. Of the other 9 comparisons, 5 show differences of more than twice their probable errors, and 3 of these show differences of more than two and one-half times their probable errors. On the basis of these differences it seems that there is a place effect within the plot which has manifested itself in a difference in growth.

In a comparison of the east side of the field with the west, sections A, C, and E had a mean girth of 49.000 ± 0.669 inches, while in B, D, and F the mean girth was 43.449 ± 0.679 inches, a difference of 5.551 ± 0.955 inches. This difference, which is 5.81 times its probable error, indicates that in the west side of the field the tree girths are significantly larger than those in the east side.

In comparing the sections from north to south, A–B has a mean tree girth of 44.226 ± 0.778 inches, C–D 45.434 ± 0.977 inches, and E–F 48.688 ± 0.830 inches. Only in the case of a comparison of A–B and E–F is there a difference of three times its probable error. While there is evidence of an increased girth in passing from north to south, it is less definite than the change from east to west.

To make a further test of the uniformity of the field, the trees were compared to determine whether there was any localized effect showing itself in a tendency of trees within a specified distance of one another to yield equal quantities of latex or to have equal girths. This test was made because of the fact that if good or poor spots were of small area their effect might not be apparent in the previous comparisons.

To make these comparisons, each tree was paired with every tree of larger serial number within a distance of approximately 33 feet. In each pair the tree with the lower serial number was treated as a y variable and the tree paired with it as the x variable. By this method of comparison any tendency of the trees within a 33-foot radius to produce equal yields or to have equal girths should reflect itself in positive correlation coefficients. The greater this tendency the higher the correlation coefficient.

One hundred and forty-six pairs of trees were found. Compared on the basis of yield, a negative correlation, -0.045 ± 0.056, was obtained, while on the basis of girth the correlation was 0.221 ± 0.053.

This agrees with the results of the comparison by sections, since a zero correlation is found for the comparison by yield and a slight positive correlation by girth. While this latter is positive, it is too small to be considered significant by itself. The comparison by sections, however, indicates that there is a definite though slight tendency toward spotting in tree size, showing that conditions of growth have not been uniform in all parts of the field.

This lack of uniformity in the field is slight and has not been considered in the other tree comparisons. The possibility of variation in tree characters and yield due to location are great and must be considered in decisions as to the basic relation between tree characters. Especially would this variation be important in correlations of tree characters for large areas or for large numbers of trees where the place effect would necessarily be larger.

LATEX OR DRY RUBBER FOR YIELD MEASUREMENTS

The yields at Bayeux were recorded in cubic centimeters of latex, and all of the interperiod correlations and yield comparisons shown above have been based on these latex volume measurements. The desire, however, in making any type of yield comparisons is to obtain a measure of the capacity of individual trees to yield dry rubber rather than latex.

Whitby (8) found that the rubber content of the latex from individual trees investigated by him was variable, the coefficient of variability being 16.02. This fact Whitby takes as an indication that volume of latex can not be used to measure yield of dry rubber. Whitby found that "the strength of the latex from a given tree was approximately constant on different days, and appeared to be characteristic for the individual tree," but stated that "the figures did not, however, indicate that there was any correlation between yield and latex strength."

Since the measurements of yield at Bayeux were taken by volume, it is important to determine to what degree interperiod correlations based on volume of latex rather than on weight of dry rubber are affected by the variation in rubber content.

In the first place it will be necessary to determine whether high-yielding trees have either relatively low or relatively high rubber content. If the correlation between rubber content of the latex and yield in volume of latex is high, either negative or positive, a large correction would have to be made in the interperiod correlations of volume yield to reduce them to correlations of dry-rubber yield. While this correction could be calculated, it would seriously interfere with the utility of data depending on latex volume measurement.

On the other hand, if there is no correlation between yield and percentage of rubber, no correction would be required in the volume measurements and the adequacy of the latter could be ascertained by calculating the correlation between yield of latex and yield of dry rubber.

There are not sufficient data available from the records taken at Bayeux during the period covered by this report to arrive at any decision as to whether the measurement of volume of latex gives an adequate measure of yielding capacity. For that reason records from a later period must be used to show the degree to which measurements of volume can be relied upon to give an adequate measure of dry-rubber yield.

The latex from each of the trees was weighed and coagulated separately for each of the alternate day tappings from September 11, 1926, through September 29, 1926. The latex was recorded by weight rather than by volume, in order that a more accurate calculation of the rubber content might be obtained and also to prevent the loss of latex in pouring it from the latex cups into the measuring graduate and back into the cups for individual coagulation. Because the tags of many of the rubber samples were lost while the latter were drying, only 598 measurements from 72 different trees were obtained. The percentage of rubber was found to vary greatly, a significant difference being found in the rubber content of the latex from different trees. The percentage of rubber varied from 22.8 ± 0.460 per cent to 41.66 ± 1.301 per cent. The coefficient of variability was 14.977, agreeing very closely with that found by Whitby.

INTERDAILY CORRELATIONS OF RUBBER CONTENT

Owing to the loss of identification tags during drying, only 42 trees were found with measurements for 6 out of the 10 tappings. These six tappings were for September 15, 17, 19, 25, 27, and 29. The correlations for rubber content of the latex from the 42 trees for all possible pairings of the six tappings were calculated and are shown in Table 10. The correlations between the rubber content on September 15 and that on the succeeding days decreases from a correlation of 0.842 ± 0.031 between September 15 and September 17 to one of 0.573 ± 0.070 for the correlation between September 15 and September 29. The correlations between September 17 and the succeeding days show the same tendency except in the case of the correlation between September 17 and September 29, which was higher than that for the correlation between September 17 and either September 21 or September 25.

TABLE 10.—*Interdaily correlations of rubber content of the latex for all possible pairings of the six tappings made September 15, 17, 19, 25, 27, and 29, 1926*

Date	Date (September)				
	17	19	21	25	29
Sept. 15	0.842±0.031	0.771±0.043	0.692±0.055	0.580±0.070	0.573±0.070
Sept. 17		.790± .038	.650± .060	.597± .068	.680± .055
Sept. 19			.624± .064	.589± .069	.558± .073
Sept. 25				.549± .073	.524± .076
Sept. 27					.517± .076

To determine to what degree remoteness has influenced the correlation between rubber content from succeeding tappings, the tapping period (two days) was used as the unit of remoteness, and the correlation between closeness of correlation of rubber content and remoteness of tappings was calculated. A negative correlation, -0.837 ± 0.054, was found. While a population of only 15 correlations covering a period of only 14 days was used in obtaining this figure, it is sufficiently high to be considered significant, since a correlation of this magnitude would be expected to happen by chance less than one time in a hundred. Thus there was a definite effect of remoteness on closeness of correlation in rubber content between different tappings.

The lowest interdaily correlation of rubber content found was that of 0.517 ± 0.076 between September 27 and September 29, two successive tappings. While this correlation is significantly lower than the correlation of 0.842 ± 0.03, between September 15 and September 17, it is high enough to indicate a close relation between the rubber content of the individual trees on different days. In view of this fact, and since significant differences between the mean rubber content for individual trees has been shown, it must be recognized that there is a definite difference in the rubber content from individual trees. While the closeness of interdaily correlations of rubber content decreases with remoteness, the trees maintain their relative rank in regard to rubber content to a high degree.

In order to determine a general correlation between yield of latex and rubber content of the latex, the tree yields for the second year of tapping, from September, 1925, through August, 1926, were taken as the best index of latex yield. The correlation between the mean percentage of rubber in the latex for the tappings from September

11, 1926, through September 29, 1926, and the yield of latex for the entire period from September, 1925, through August, 1926, was found to be 0.199 ± 0.079. This correlation is too small to be considered of significance, and in general it may be assumed that trees with high and low rubber content are scattered indiscriminately among low and high yielders.

CORRELATIONS BETWEEN DAILY YIELDS OF LATEX AND DRY RUBBER

Since the correlation between latex yield and rubber content of the latex is not significant, the next question to determine is whether the quantity of latex can be used to replace the weight of dry rubber in estimating yielding capacity. The value of measurements of latex will depend on whether the variation in rubber content in the latex yield groups is large enough to destroy the grouping when conversion is made to weight of dry rubber. To obtain this information the correlation between the yield of the latex by weight and the weight of dry rubber was calculated for the same six days used in comparing the rubber content.

The 36 possible correlations are shown in Table 11. The mean of the 36 correlations is 0.795. This correlation is high, showing that dry-rubber yields can be predicted with a high degree of accuracy from records of latex yield.

TABLE 11.—*Interdaily correlations between weight of latex and weight of dry rubber for individual trees for all possible pairings of the tappings made September 15, 17, 19, 25, 27, and 29, 1926*

Dates on which latex was weighed	Correlation between weight of latex on specified dates [1] and weight of dry rubber on—					
	Sept. 15	Sept. 17	Sept. 19	Sept. 25	Sept. 27	Sept. 29
Sept. 15	0.890±0.021	0.716±0.051	0.789±0.040	0.784±0.040	0.880±0.024	0.790±0.040
Sept. 17	.722± .050	.705± .053	.667± .058	.632± .063	.706± .053	.655± .060
Sept. 19	.850± .029	.707± .052	.862± .026	.760± .043	.839± .031	.831± .032
Sept. 25	.840± .031	.645± .061	.781± .041	.873± .025	.903± .020	.831± .032
Sept. 27	.838± .031	.616± .065	.822± .034	.841± .031	.927± .015	.876± .024
Sept. 29	.842± .031	.656± .060	.804± .037	.858± .028	.980± .002	.885± .023

[1] See column 1.

To determine whether the yields of dry rubber could be more accurately predicted from measurements of dry-rubber yield than from those of latex yield, the 15 possible interdaily correlations between dry-rubber yields of individual trees were calculated. These are shown in Table 12. These correlations are higher than those between latex and dry rubber, the mean being 0.896.

TABLE 12.—*Interdaily correlations of weight of dry rubber for all possible pairings of the six tappings made September 15, 17, 19, 25, 27, and 29, 1926*

Date	Date				
	Sept. 17	Sept. 19	Sept. 25	Sept. 27	Sept. 29
Sept. 15	0.866±0.026	0.935±0.013	0.911±0.018	0.925±0.016	0.910±0.018
Sept. 17		.866± .026	.783± .041	.820± .034	.807± .037
Sept. 19			.908± .018	.919± .016	.920± .016
Sept. 25				.959± .008	.946± .011
Sept. 27					.972± .006

The difference between the correlations of latex yields and dry-rubber yields and the interdaily correlations of dry-rubber yield is significant, so that there would seem to be an advantage in having tree yields based on dry-rubber measurements rather than on latex measurements. This advantage is offset somewhat by the additional labor involved. The latex from individual trees must be coagulated separately. The rubber "biscuits" obtained from the individual coagulations must be kept and dried separately, the whole process being spread over several days. Measurements must then be made of a mass approximately one-third the size of the original latex. Considering the type of employees available for this work on a plantation, it is probable that there would be less chance of error in recording yield by latex volume than by weight of dry rubber.

It has been shown that remoteness exercises a distinct effect on the closeness of interdaily correlations of rubber content. This effect is not apparent in the correlations between dry rubber and latex. For the 15 interdaily correlations between latex measurements the correlation with remoteness is 0.343 ± 0.159, a correlation which might be expected to occur by chance more often than once in ten times and therefore is not significant.

For the dry-rubber correlations, the correlation with remoteness is -0.328 ± 0.161, which is too small to be considered significant. For the 36 correlations between latex and dry rubber the correlation with remoteness is -0.166 ± 0.082. Of the 15 correlations between dry rubber and latex in which the day for which the latex measurement was taken occurred previous to the day for which the dry-rubber measurement was taken, the correlation for remoteness is -0.340 ± 0.159. For the 15 correlations where the dry-rubber measurement was taken previous to the latex measurement the correlation with remoteness is -0.138 ± 0.146.

In the first of the latter two correlations, in which dry rubber is being predicted from latex, the mean of the 15 correlations is 0.778. In the latter, in which latex is predicted from dry rubber, the mean of the 15 correlations is 0.787. These correlations are high and are not significantly different. In general, therefore, future latex yields can be predicted from dry-rubber yields or future dry-rubber yields from latex yields with equal accuracy.

Latex measurements can be taken much more easily than weight of dry rubber and with much less chance of error, since all measurements can be taken immediately after the latex is gathered. Since approximately three times the volume or weight is being measured when latex measurements are kept, errors of measurement are relatively less. For these reasons it would appear that notwithstanding the difference in correlation, latex volume may be a more practicable means than weight of dry rubber in evaluating the rubber-yielding capacity of Hevea trees. On the other hand, when the utmost precision is desired dry rubber should give the more accurate measure.

BARK CONSUMPTION

In the tapping operations bark consumption was kept to a minimum. The mean width of tapped area for the period from September 1, 1924, to August 31, 1925, inclusive, was 9.3 inches. The trees were tapped daily in September, but were not tapped in July. During the rest of the year the trees were tapped on alternate days. The tapped area thus represents 10 months of alternate day tapping and one month of daily tapping. The trees were tapped 164 times during this period. The mean total consumption of 9.3 inches then represents a mean consumption of 0.057 of an inch per tapping. This would represent a consumption of 0.855 of an inch per month of 15 tappings. Owing to rainy days, the trees were not actually tapped 15 days per month. If September be considered as two months' alternate daily tapping, the bark-consumption record will then represent 12 months' tapping, or only 0.775 of an inch per month. This amount of bark consumption is very conservative. It is probable that greater yields could have been obtained with a greater bark consumption.

BARK RENEWAL

The bark renewal at Bayeux has been satisfactory. On July 31, 1925, bark-renewal measurements were taken for 40 trees by means of a bark-thickness gauge. These measurements were taken at the point where the tapping operations for November, 1924, were started and thus represent nine months' bark renewal. The thickness of the new bark was found to be from 4 to 7 millimeters. The surface of the renewing bark was not scraped in making these measurements, so there is an error due to the bark having become slightly cracked and roughened through the drying out of the outer surface, thus preventing the gauge from fitting snugly against the tree. The measurements were taken as carefully as possible without scraping the slightly roughened surface, and they indicate a satisfactory bark renewal.

Bryce and Gadd (*2*) reported a thickness of renewed bark of from 3.2 to 6.3 millimeters in Ceylon. This covered a renewal period of two years.

Bobilioff (*1*) reported bark thickness of renewing bark in Sumatra at from 2.65 to 5.20 millimeters for a renewal period of nine months.

WEATHER RECORDS

Weather records at Bayeux for the period from September, 1924, to August, 1925, are shown in Table 13. Woodring, Brown, and Burbank (*9*) have published the mean of rainfall records taken at Bayeux over a period of 17 to 18 years. These records, converted from millimeters into inches, are shown in Table 14. The normal mean annual rainfall at Bayeux is shown by these figures to be 83.02 inches. In the 11 months of record during the tapping operations the total precipitation was 82.98 inches, in spite of the fact that this year was considered abnormally dry in this region. While no records were taken at Bayeux for July, it is probable that the rainfall during the month was less than 1 inch, as only 0.2 of an inch was found in the rain gauge on July 29, when arrangements were being made to resume the tapping experiments which had been discontinued during July.

The mean monthly maximum temperature varied from 80.6° F. in February to 89.3° F. in August. The mean monthly minimum temperature varied from 64.8° F. in February to 73.2° F. in August. Woodring, Brown, and Burbank (*9*) give the mean temperature at Bayeux for each month of the year over the period from July, 1909, to December, 1916, with the exception of 1912, the last half of 1914, and the first half of 1915. These records, converted to degrees Fahrenheit, are shown in Table 15. This shows a variation in mean monthly temperature from 72.3° F. in December to 80.4° F. in July and August.

TABLE 13.—*Weather conditions at Bayeux, Haiti, for the period from September 1, 1924, to August 31, 1925, inclusive*

[All records were taken at 6 a. m.]

Month	Mean maximum temperature	Mean minimum temperature	Mean relative humidity	Days of rain	Total precipitation
	°F.	*°F.*	*Per cent*		*Inches*
September			85.1	16	10.82
October			85.5	17	9.52
November	81.7	68.7	90.3	22	21.24
December	81.9	68.8	93.4	13	7.99
January	82.3	64.9	93.8	6	1.24
February	80.6	64.8	93.0	16	5.95
March	81.9	65.6	89.5	16	4.89
April	84.0	67.7	94.0	13	9.71
May	86.4	69.9	91.6	10	8.55
June	85.7	70.6	92.4	5	2.52
July					[1] .20
August	89.3	73.2	86.5	6	.56
Mean	83.7	68.2	90.4	12.7	7.54

[1] Estimated; not figured in the mean precipitation.

TABLE 14.—*Rainfall records at Bayeux, Haiti, for about 17 years, as reported by Woodring, Brown, and Burbank (9), converted from millimeters into inches for easier comparison* [1]

Month	Precipitation (inches)	Month	Precipitation (inches)	Month	Precipitation (inches)
January	6.94	May	8.11	September	5.66
February	4.63	June	4.35	October	8.56
March	4.35	July	1.81	November	15.80
April	7.62	August	3.71	December	11.48

[1] The mean annual precipitation was 83.02 inches.

TABLE 15.—*Mean monthly temperatures at Bayeux, Haiti, for five and one-half years of the period 1909–1916, as reported by Woodring, Brown, and Burbank (9), converted from centigrade into Fahrenheit degrees*

Month	°F.	Month	°F.	Month	°F.	Month	°F.
January	72.5	April	75.6	July	80.4	October	78.4
February	73.8	May	77.2	August	80.4	November	76.5
March	73.2	June	79.2	September	79.9	December	72.3

The mean monthly relative humidities shown in Table 13 were calculated from records taken about 6 a. m. each day and so represent the mean daily maximum humidity at Bayeux. Since the tapping operations were started before 6 a. m., these readings represent the humidity at the time the trees were being tapped.

SUMMARY

Plot and individual-tree yields of 95 *Hevea brasiliensis* trees at Bayeux, Haiti, for the period from September, 1924, through August, 1925, are reported. The mean production of first-quality smoked sheet was 3.1 pounds per tree. Cup scrap and tree scrap amounted to 0.3 of a pound per tree, giving a total yield of 3.4 pounds of dry rubber per tree.

Individual-tree records for nine months are shown. The best tree yielded 10,122 cubic centimeters of latex, or approximately 3,036.6 grams (or 6.7 pounds) of dry rubber in nine months, thus yielding at the rate of 337.40 grams or 0.74 of a pound of dry rubber per month.

The yield distribution shows that a large proportion of the latex is produced by a small proportion of the trees. The selection of high-yielding trees and the elimination of nonproducers are important items in estate development.

It is essential that some definite index of yielding capacity be found. Since any determination of yielding capacity depends primarily on the yields, it is essential that the relationship of the yields in the different seasons and in the different years of the tree's life be studied.

The methods used in studying these relationships were the product-moment correlation and regression methods. The coefficient of correlation of rank can also be used.

The relation between the tree yields in the different months at Bayeux is shown by the use of the product-moment correlation. The coefficient of correlation of rank is shown to be little different from the product-moment correlation.

The intermonthly correlations are high, showing that low-yielding trees in one month are normally low-yielding trees in any other month, and the total yield can be determined with a fair degree of accuracy on the basis of a knowledge of the yields for a month.

The effect of the elimination of trees according to yield is shown from the tree rankings in the different months. By eliminating the lowest 25 trees on the basis of the total yield the mean tree yield would have been increased 17.5 per cent. Elimination according to the yield for any one month would have increased the mean tree yield from 12.1 to 16.5 per cent, according to which month was used as a basis of elimination.

The use of the regression equation is discussed in connection with production control. A method by which the production of any tree can be predicted is given.

The accuracy of a prediction based on a month's yield is in proportion to the closeness of the correlation between the period being estimated and the period used as a basis of estimate.

The closeness of the correlation between any month and a subsequent month is affected by the proximity of the two months, but not in direct ratio, as it is also affected by seasonal influences.

The correlation between yield and tree girth was found to be 0.166 ± 0.068, a correlation which is lower than those reported by La Rue in Sumatra and Whitby in the Federated Malay States, and much lower than that reported by Bryce and Gadd in Ceylon.

The correlation between yield and bark thickness was found to be -0.030 ± 0.070, a correlation very much lower than those reported by La Rue and by Bryce and Gadd.

Girth and bark-thickness measurements have little value as a means of measuring relative yielding capacity. For that purpose they are probably inferior to yield records for even a single day.

An analysis of place effect within the plot showed uniformity in regard to yield and a slight positive tendency toward spotting in girth.

An analysis of rubber-content measurements taken for the same trees in September, 1926, showed that there is only a very slight correlation between latex yield and rubber content. The rubber content is significantly different in different trees and is, to a high degree, constant.

Latex yields may be used to replace dry-rubber yields in measuring yielding capacity. When the most accurate measure of yielding capacity is desired, it should be taken by dry-rubber measurements.

The bark consumption was very conservative, amounting to a mean of 9.3 inches of bark from approximately one-third of the circumference of each tree.

The bark renewal has been good. The bark thickness for 9-months-old bark was from 4 to 7 millimeters.

The weather records covering the period reported on are shown. From comparisons with other weather records taken at the same locality it would appear that the weather conditions for the year were normal.

LITERATURE CITED

(1) Bobilioff, W.
1920. enkele gegevens over de hernieuwing van den bast bij hevea brasiliensis. Arch. Rubbercult. Nederland. Indië 4: 239–247.

(2) Bryce, G., and Gadd, C. H.
1924. yield and growth in hevea brasiliensis. Ceylon Dept. Agr. Bul. 68, 74 p., illus.

(3) Figart, D. M.
1925. the plantation rubber industry in the middle east. U. S. Dept. Com., Bur. Foreign and Dom. Com., Trade Prom. Ser. 2, 317 p., illus.

(4) Gehlsen, C. A.
1921. de waarde van het bastonderzoek voor de plantsoenveredeling. Arch. Rubbercult. Nederland. Indië 5: 453–458.

(5) Harris, J. A., Blakeslee, A. F., and Kirkpatrick, W. F.
1918. the correlation between egg production during various periods of the year in the domestic fowl. Genetics 3: 27–72, illus.

(6) La Rue, C. D.
1921. structure and yield in hevea brasiliensis. Arch. Rubbercult. Nederland. Indië 5: 574–588.

(7) Taylor, R. A.
1926. the interrelationship of yield and the various vegetative characters in hevea brasiliensis. Ceylon Dept. Agr. Bul. 77, 65 p.

(8) Whitby, S.
1919. variation in hevea brasiliensis. Ann. Bot. [London] 33: 313–321.

(9) Woodring, W. P., Brown, J. S., and Burbank, W. S.
1924. geology of the republic of haiti. 631 p., illus. Port-au-Prince.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE

March 14, 1928

Secretary of Agriculture	W. M. JARDINE.
Assistant Secretary	R. W. DUNLAP.
Director of Scientific Work	A. F. WOODS.
Director of Regulatory Work	WALTER G. CAMPBELL.
Director of Extension	C. W. WARBURTON.
Director of Personnel and Business Administration	W. W. STOCKBERGER.
Director of Information	NELSON ANTRIM CRAWFORD.
Solicitor	R. W. WILLIAMS.
Weather Bureau	CHARLES F. MARVIN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Bureau of Dairy Industry	L. A. ROGERS, *Acting Chief.*
Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Forest Service	W. B. GREELEY, *Chief.*
Bureau of Chemistry and Soils	H. G. KNIGHT, *Chief.*
Bureau of Entomology	C. L. MARLATT, *Chief.*
Bureau of Biological Survey	PAUL G. REDINGTON, *Chief.*
Bureau of Public Roads	THOMAS H. MACDONALD, *Chief.*
Bureau of Agricultural Economics	LLOYD S. TENNY, *Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Federal Horticultural Board	C. L. MARLATT, *Chairman.*
Grain Futures Administration	J. W. T. DUVEL, *Chief.*
Food, Drug, and Insecticide Administration	WALTER G. CAMPBELL, *Director of Regulatory Work, in Charge.*
Office of Experiment Stations	E. W. ALLEN, *Chief.*
Office of Cooperative Extension Work	C. B. SMITH, *Chief.*
Library	CLARIBEL R. BARNETT, *Librarian.*

This bulletin is a contribution from

Bureau of Plant Industry	WILLIAM A. TAYLOR, *Chief.*
Office of Cotton, Rubber, and Other Tropical Plants	O. F. COOK, *Senior Botanist, in Charge.*

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
U. S. GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
5 CENTS PER COPY
▽

END