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EXTRACTION OF RUBBER THROUGH PUNCTURE AND SHORT CUT TAPPING TECHNIQUE AND RESEARCH ON ITS PHYSIOLOGY

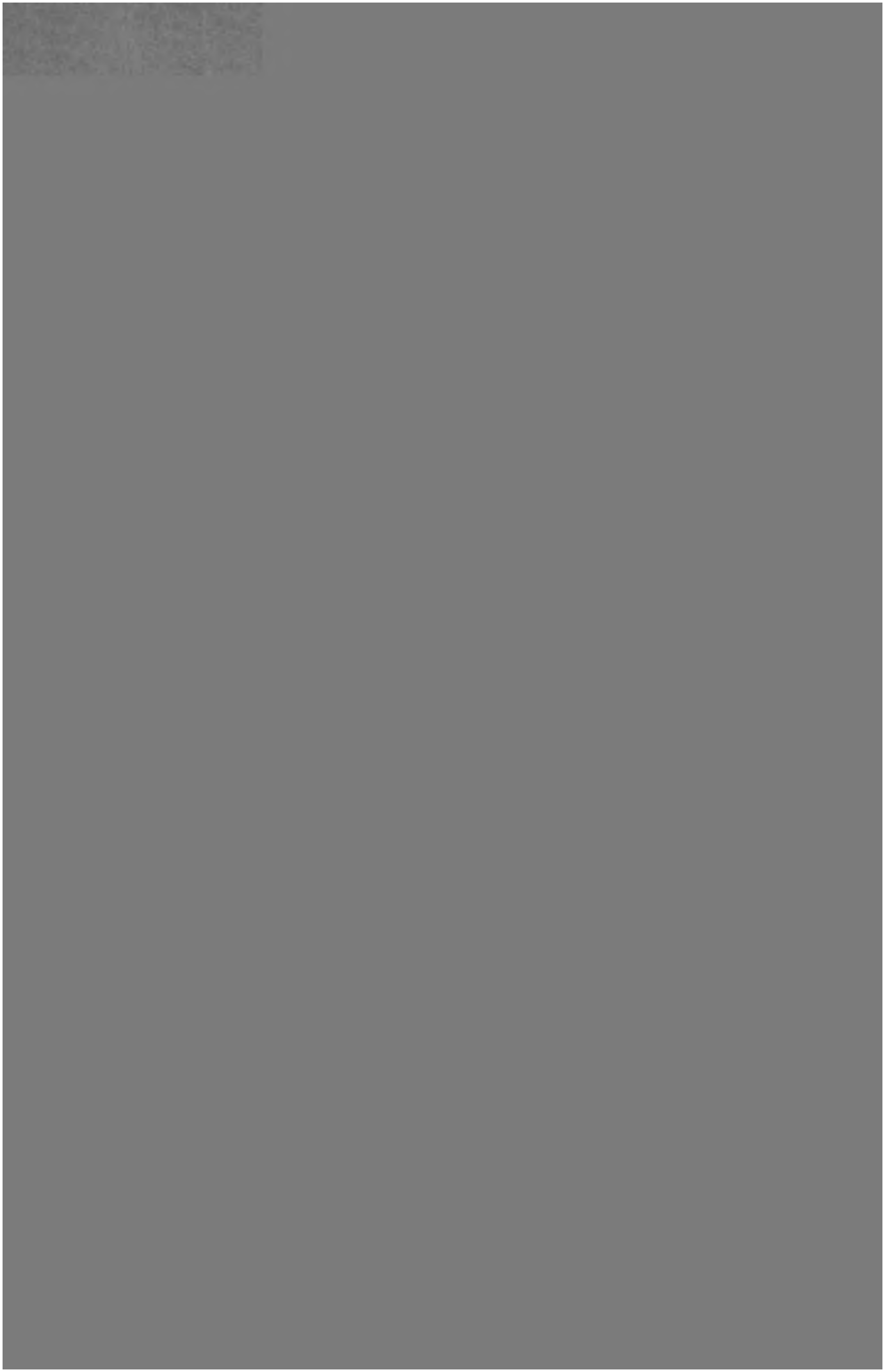
IV. IMMATURE PERIOD OF CLONING OF RRIM 600 AND THE SPECIAL CHARACTERISTICS FEATURES OF THE DIFFERENT CATEGORIES OF COMMODITIES IN EXPLOITATION OF RUBBER BY PUNCTURE TAPPING

BY

Xu Wen Xian

Wei ~~Xiao Ti~~ Xiaodi, Li ~~Han Hua~~ Hanhuai*

Research Centre on Cultivation of Rubber
of Research Institute on Tropical Crops
in South China.



Exploitation of Rubber through Puncture and Short Cut Tapping Technique and Research work on its Physiology

IV. Immature period of cloning of PRIM 600 and the Special characteristic features of the different categories of commodities in extraction of rubber by puncture tapping method.

Important Extracts.

The results of the experiments carried out during the period 1978 to 1981 manifestly showed that PRIM 600 is a comparatively more suitable for going into production before it is due in the usual course by puncture tapping method and cloning process from an original seedling or stock. When the girth of the trunk of the plant is 42.2 milli-metre on the average, the parameters of the puncture tapping rubber extraction technique is resorted to for extraction of rubber. During the first four years of harvesting the total amount of production of dry rubber out of a single stump of plant was 15 kilograms. The highest yield per acre was 450 kilograms. At the time when the average girth of the trunk of a plant became more than fifty milli-metre in circumference during the third or the fourth year of extraction the production of dry rubber from a single stump reached the level of 4.65 to 5.04 kilograms per year which when compared to the process

of controlled reaping with sickle of plants with similar girth is an increse in production of between 70.6 to 146.0 per cent. The number of times of extraction of rubber in this case is also comparatively less than in reaping with sickle, and the content of dry rubber is higher than reaping with sickle by about 2.8 per cent. The quantum of output is basically identical when compared to that of cutting with sickle. The secondary effects are still not very significant. In the light of this background, at the very outset we consider that for convenient extraction of rubber the specified standard for the girth of the trunks of rubber plants, 50 per cent of which are ~~located~~ at a ~~distance~~ height of 1.2 meters from ~~each~~ the ground level ~~other~~ in the selected segment of the plantation forest land are ~~will be proper~~ in the region of 40 millimetre in circumference or in case of immature plants of PRIM 600 obtained by cloning from an original seedling in the cultivated fields in Hainan (South Sea) areas of our country (China). When the girth of rubber plants in the particular segment of the plantation is more than 35 milli-metre at the time of starting of extraction of rubber, we should also go into production by using entirely the puncture and short cut tapping technique.

The statistical data collected after thorough analysis of the reports obtained on this process clearly established that during a particular year of extraction of rubber, there is extraordinarily significant interdependence to each other

between the dissimilar girth of rubber plant trunks and both of the other two factors i.e. quantum of production and the content of dry rubber (n = 6, r = 0.983 and r = 0.993) But just at the time of starting of extraction of rubber, the influence of the dissimilarity in the dimension of the girth of the trunks to the quantum of production after three years of extraction of rubber is less when it is compared to the influence of the dissimilarity of girths of plant trunks to the quantum production in respect of extraction of rubber in those years (n = 5, r = 0.830, and it cannot attain a significant level).

In this scientific document, we have also introduced the methods of useful application of Calcium Carbide (Tourmaline) as a catalytic agent to promote the quantity of production.

Preliminary results of experimental activities carried out by our Scientific Institute in the year 1973 in respect of extraction of rubber using Puncture tapping technique (Scientific Literature under Reference No.1) has already been established that the reaction of dissimilar cloning in respect of extraction of rubber by puncture tapping method is identical to that of the reaction due to extraction by cutting with a sickle and there is conspicuous difference in the grade of commodities. During 1974 we came to know a step further during carrying out experiments on early extraction of rubber by puncture tapping method from the tender immature plants of

PRIM 600 seedlings that this type of commodity is comparatively more resistant to artificial stimulations and it can withstand puncture tapping and, therefore, this type of plants are quite suitable for going into production at a comparatively earlier stage. By use of this type of indulgent puncture and short cut tapping method (namely 5 P 1 (50 Centimeters), the quantum of yield from immature tender plants with girth of plant trunks ranging between 30 to 50 centimeters can attain upto the level of about 80 per cent of the normal output obtained by extraction of rubber out of harvesting by routine cutting with sickle (when the girth of plant trunks is more than 50 centimeters). In this case when the girth of the plant trunk is more than 50 centimtey, it can even surpass the level of the amount of output by normal sickle cutting technique of harvesting. However, the amount of output from plant trunks having dissimilar girths has close resemblance to each other. After this Mr. M. Tonnelier and other research scholars of Rubber Research Institute of Africa (Scientific Literature under Reference No.5) carried out experiments on puncture tapping technique of rubber exploitation from the immature tender plants of PRIM 600 and GT 1. According to the results of these experiments done in 1978, it is considered that tender plants of dissimilar properties has different magnitude of growth in the circumference of its trunk girth after rubber has been extracted by puncture tapping technique. In this respect PRIM 600

has been found to be much superior when compared to GT 1. During 1981, Mrs. S. Waidyanatha of Si Li Lan Qia (Scientific Literature under Reference No.6) also carried out experiments on exploitation of rubber by puncture tapping method with tender immature plants of PB 86 with the purpose of obtaining rubber earlier than the normal time of production and secured preliminary results showing higher quantum of yield and content of latex emulsion and saechaarose as compared to the routine exploitation by sickle cutting harvest (S/2. d/2) Looking from this point of view, profound research has been carried out on the effectiveness of different classes of vegetation for extraction of rubber by puncture tapping of various types of dissimilar plants produced vegetatively by cloning.

Precise determination of the correct specification of the girth of the trunk of the immature tender plants for going into production and the proper technique for exploitation of rubber from various grades of plants with varying properties has very remarkable and important practical significance.

In view of the above facts, sooner or later we have carried out extensive research work during the years 1976 and 1978 on a continuous basis for many years on the puncture tapping technique of exploiting rubber as well as its physiological parameters in respect of the tender immature plants

of GT 1 and PRIM 600. Out of these the results of experiments with GT 1 has already been reported (Scientific Literature under reference Nos. 2,3 and 4). This Scientific document is mainly concerned with research on the quantum of production and efficiency of PRIM 600 plants vegetatively produced by cloning in respect of going into production ahead of time by puncture tapping method as well as the magnitude of growth of the girth of plant trunks after the puncture tapping operation and the content of dry rubber in it. It also includes the changes in the parameters of content of nutriments in the leaf vanes and content of diastase grains in the bark of the plant trunks so as to trace the nature of the allowable early extraction and going into production of this type of commodity by using puncture tapping technique.

Material and Methods of Experimentation

PRIM 600 vegetatively grown by cloning process having thirty stumps planted per acre which were transplanted permanently by No. 4 Production Unit of the experimental agricultural farm of our Research Institute in 1970 in the 2-2 segment of plantation forest provided the material for our preliminary trials. For extraction of rubber, puncture tapping was done in 250 stumps in the first year. Before the experiments were started (during the early part of 1978), the average girth of the trunks of plants ~~located~~ at a

~~distance~~ height of 1.2 meters from ~~each other~~ from the ground surface level was 42.2 centimetres (and the standard variation was only 4,33 centimeters), the coefficient of displacement of the stumps was 10.26 per cent). Out of these nine stumps having girth of plant trunk between 30.1 to 35.0 centimeters constituted 3.6 per cent, 36 stumps having plant trunk girth between35.1 to 40 centimeters constituted 34.4 per cent,98 stumps having girth of plant trunks between 40,1 to 45.0 centimeters constituted 39.2 per cent, 52 stumps having girth of plant trunks between 45.1 to 50.0 centimeters constituted 20.8 per cent and five stumps having girth of plant trunks between 50.1 to 55 centimeters constituted two per cent. It can be seen that the 98 per cent of the rubber plants did not readily attain the normally expected standard of exploitation of rubber by means of sickle cutting extraction method.

In this experiment investigation were repeated twice all over again on two separate days extracting rubber from two different plants located at different positions making use of the discoidal puncture tapping technique of exploitations of rubber. During the entire process the same strength of stimulants and identical intensity of exploitation were uniformly used. During the period 1978 and 1979, 6P. 2C/2. d/3 + 10 to 15 grams of Calcium Carbide (Tourmaline) was selected for use and on application it was observed that immediately two semi discs (half discs) were formed up and

down. Needle perforated pin holes were oriented laterally in a linear arrangement, each semi-disc having three pin holes and in each stump of plant six pin holes were punched each time the stream of rubber flowed through the channel. For one or two days, before starting of puncture tapping, 10 to 15 grams of Calcium Carbide (Tourmaline) was applied to each of the stumps of rubber plants. The method adopted for this purpose is: check and ensure that the alignment of the position is correct for extraction of rubber by puncture tapping. A hole is dug of depth 40 to 50 centimeters and of diameter of the hole three centimeters in a position located at a distance of approximately 15 centimeters from the stump of the rubber plant. After inserting Calcium Carbide (Tourmaline) inside the pit, the mouth of the hole is immediately sealed up closely to make it air tight. After a lapse of about 24 hours, we are in a position to readily extract rubber. From 1980 onwards it was considered that for rubber plants with average girth of stems of plants having already reached more than fifty centimeters, it is more suitable to change over to use of 9P. (C + C/2). d/3 + 10 to 15 grams of Calcium Carbide (Tourmaline) to increase the intensity of stimulants and promoting agents and also enhance the extraction of rubber. Each time at once nine pin holes are punched on each stump in the lower portion of the upper half portion of the entire disc formation. At the same time

during the season covering the month of May as well as the period July to September when the potential capacity to produce rubber is comparatively the highest, we increasingly apply five percent acqueous Ethylene agent in the upper half of the disc for about five times during each year. During the entire experiment we maintained ~~the~~ half a month as the periodic cycle throughout for artificial stimulation and rubber was extracted on four occasions during each periodic cycle. The quantum of production of latex from each individual rubber plant location was recorded during each time of extraction of rubber. The content of dry rubber was determined four times during each periodic cycle of extraction (Data in respect of two rubber plants positions were determined by turns alternatively).
At the time of starting of the experimental research as well as after stoppage of exploitation of rubber, the girths of the trunks in fixed location of the rubber plants were measured once during each year in order to determine the extent of growth of the circumference of the plant girth as well as its distribution. During 1978 and 1979 comparative study was carried out on the growth of the trunk girths of the rubber plants which have provided no rubber exploitation out of the group experimental plant positions in sharp contrast to the above. On the contrary another comparative review was made in 1980 between the selected segment of plantation forest in which experimental plants were located and one particular plant position having growth of stump girth

identical to that of the experimental rubber plants being used for extraction of rubber by sickle cutting. In July 1981 the quantum of yield from one single stump in one periodic cycle of half a month was measured. The plants being subjected to puncture tapping were divided into six marginal groups according to extent of growth in the size (bigness or smallness) of the plant girth during that particular year and their quantum of yield was measured. Moreover statistical data was also prepared on their content of dry rubber as well as content of latex and total saccharose content. At the same time the rubber plants were divided into five marginal groups according to the size of the circumference of the plant girth at the time of extraction of rubber. The statistical data so prepared on the quantum of latex produced by each of these groups was further analysed. During 1981 samples were picked up according to the dissimilarity of plant girths in various groups and the content of starch sugar (diastase) in the bark of the plants and the quantum of nutriment in the leaf sheets were determined, carrying out each experiment twice.

Results of Experimental Research.

(1) Quantum of output.

At the time when the circumference of the trunk girth is 42.2 centimetres of the PRIM 600 plants obtained by cloning from an original seedling vegetatively at location at a

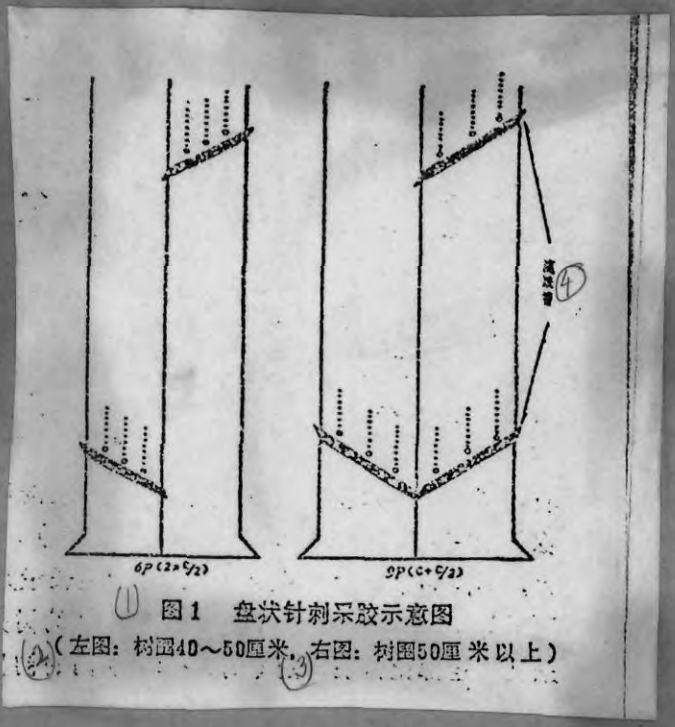


图1 盘状针刺采胶示意图
(左图: 树围40～50厘米, 右图: 树围50厘米以上)

Key: (1) Diagram No. 1 - Drawing revealing discoidal puncture tapping technique for extraction of rubber.

(2) Left part of the Diagram - girth of plant trunks between 40 to 50 centimeters.

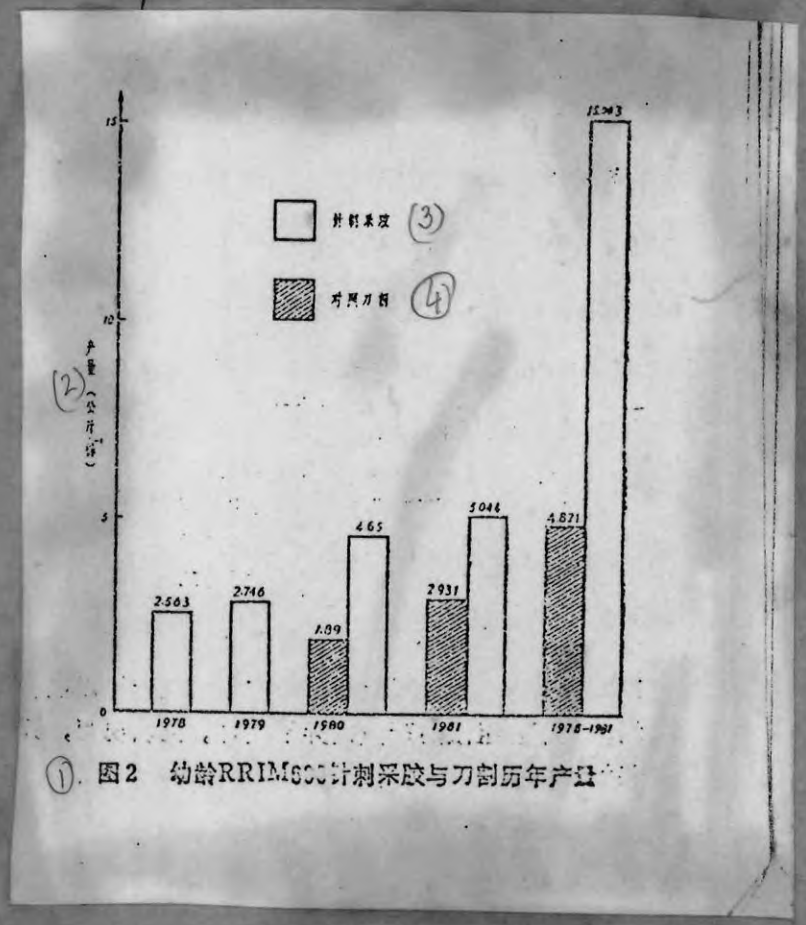
(3) Right part of the Diagram - girth of plant trunks more than 50 centimeters.

(4) Channels of flow of rubber.

distance of 1.2 meters from the ground level, it is proper to carry out puncture tapping for exploitation of rubber. The total amount of dry rubber yield obtained from single trunk during the initial period of four years was 15.003 kilograms and the output per acre was 450.09 kilograms. During each time of

extraction, high quantity of secondary yield of 67.7 grams ~~of~~ per stump of plant was produced. ~~When the average girth of the stem reached more than 50 centimeters.~~ When the average girth of the stems of rubber plants reach more than 50 centimeters in circumference on the very third or the fourth year of extraction, rubber was extracted for about 52 to 56 times in a year. The quantum of yield from each trunk of plant was between 4.650 and 5.044 grams and secondary products were separately 83.00 grams and 97.00 grams per trunk. Along with this, at the same time in sharp contrast to harvesting by sickle cutting of rubber plants, under the conditions of 74 to 89 times of exploitation of rubber per year, yield of dry rubber per year was only 1.890 and 2.391 kilograms respectively and during two years of extraction, the average quantum of output by puncture tapping technique was higher by one hundred per cent when the production is compared to that of sickle cutting extraction. If the quantum of yield by premature exploitation of rubber during the two harvesting years is added to it, then the output of dry rubber from each plant trunk by puncture tapping technique is on the contrary more than the output of sickle cutting extraction by 10.82 kilograms and the excess yield of dry rubber per acre is 305.460 kilograms. Moreover the output of the rubber plants by puncture tapping technique is increased every year though the extent of increase is not similar and uniform in each year. The increase in the quantum

of yield of rubber in the fourth year when compared to that of the previous three years is separately found to be to the extent of 96.8 per cent, 83.7 per cent and 8.5 per cent (For details please refer to Table No. 1 and Diagram No.2).



(1) 图2 幼龄RRIM600针刺采胶与刀割历年产量

Key (1) Diagram No.2 - Extraction of rubber by puncture tapping of immature plants of PRIM 600 and by sickle cutting and the quantum of production year by year.

(2) Quantum of output (Kilogram per stump)

(3) Puncture tapping technique of exploitation of rubber.

(4) In contrast, harvesting by sickle cutting.

Table No. 1 - Exploitation of rubber by puncture tapping of the immature plants of PRIM 600 obtained by cloning and quantity of its yield year after year.

Method of Extraction of rubber.	Year	No. of stumps	No. of times drugs used in a year.	No. of times of Extraction	Total amount of dry rubber (Kg)	Output per stump (gm)	Secondary product of stumps (gm)	For Comparison with sickle cutting (%) *	Yiel per acre (Kg)
Puncture Tapping for Exploitation of rubber.	1978	250	13	58	640.679	2.563	44.2	-	76.89
	1979	250	14	55.5	686.515	2.746	49.5	-	82.38
	1980	223	14	56	1038.700	4.650	83.0	246.0	139.5
	1981	222	13	52	1119.670	5.044	97.0	170.7	151.3
	Total of 4 years		54	221.5	3485.564	15.003	57.7	-	450.0
In Contrast (Sickle cutting extraction)	1980				320.720	1.890	25.5	100.0	56.70
	1981				685.960	2.931	32.9	100.0	87.93
	Total of 2 years				2006.660	4.821	29.6	-	144.6

* For Comparison between puncture tapping technique and the method of sickle cutting for extraction of rubber, the percentage has been worked out taking into account the quantum of production of rubber per stump.

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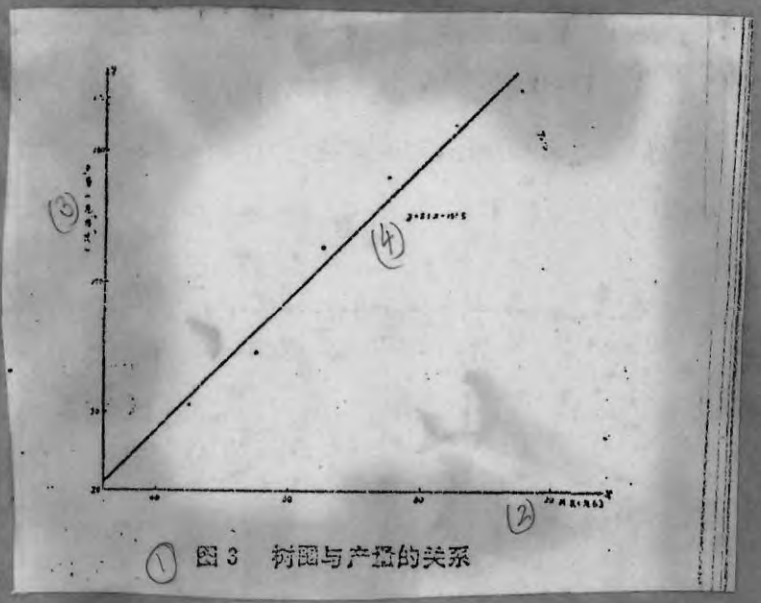
* For Comparison between puncture tapping technique and the method of sickle cutting for extraction of rubber, the percentage has been worked out taking into account the quantum of production of rubber per stump.

Table No. 2 clearly manifests that there is very great variance in the quantum of production from rubber plants having circumference of trunk girth different from each other. During the period covering this experimental research it was found that there is positive interdependent relationship of remarkable significance between the growth of the girth of the rubber plant trunks and the quantity of output extracted from it ($n = 6$, $r = 0.988$). The straight line recurrent equation between the quantum of yield (y) which is dependent on the girth of the rubber plants (x) is:

$$y = 5.1x - 161.3$$

(the unit of the plant girth (x) is centimeter, and the unit of production (y) is grams of dry rubber. Stump times. For details please refer to Diagram No.3).



Key (1) Diagram No. 3 - Relationship between girth of plant trunk and the quantum of yield.

(2) Girth of plants (centimeters)

(3) Quantum of output of dry rubber (grams) per stump.

t experiment clearly shows that, the quantum of production from marginal group of plants having various sizes of plants girths ranging above fifty centimeters is uniformly or excessively higher to a remarkable extent than the amount of output from plants of rubber, having trunk girth between 40.1 to 45.0 centimeter. The group of rubber plants having varying plant girths of above 55.0 centimeters evidently has uniformly or excessively higher quantum of yield as compared to the group of rubber plants having trunk girth of less than fifty centimeters. However, the variation in the quantum of production is not very much conspicuous in case of group of rubber plants having trunk girths of above 50 centimeters.

At the time of extraction of rubber, the various conditions of production after extraction which has been continued for three years from rubber plants with dissimilar stump girths have been somewhat summed up in Table No.3. By a comparative study of Table No. 3 and Table No. 2 we can observe that the influence of the size of the stump girth at the time of extraction at the present moment in respect of the quantum of output to be obtained after three years is relatively less than the influence of the size of the stump girth on the same year of extraction after three years in respect of the

quantum of yield. The coefficient of corelation between the girth of plant stumps and the quantum of production n=5, r=0.830, cannot attain very significantly conspicuous level. t experiment clearly establishes that at the time of extraction the quantity of latex produced by rubber plants having plant girths more than fifty centimeters is exceedingly and remarkably higher than the yield from groups of rubber plants having plant girth of various specifications below fifty centimeters. However, the variation in quantum of production for groups of rubber plants having different stump girths below fifty centimeter is not very remarkably significant. But it must be clarified that at the time of extraction, rubber plants having plant girth of more than fifty centimeters has only five stems. Moreover, each of the stems has very high quantity of yield and there is no tree with lower output and therefore, the average quantum of production is comparatively high.

Table No.2 - Condition of production of rubber from rubber plants with dissimilar trunk girths by puncture tapping technique.

Girth of plant trunks(Centimeters)	No. of trunks.	Total Production of dry rubber (Kg)	Dry rubber yield from each trunk(Kg)	Dry rubber output per trunk time(gm)	Percent from pl nts of girth to 55.(cm(%)
40.1 to 45.0	6	1.274	0.212	53.0	46.6
45.1 to 50.0	36	10.520	0.292	73.0	64.2
50.1 to 55.0	66	30.0520	0.455	114.0	100
55.1 to 60.0	76	42.420	0.558	140.0	122.6
60.1 to 65.0	22	14.110	0.641	160.0	140.9
65.1 to 70.0	7	4.873	0.696	174.0	153.0

Note: Determined on the basis of four times of extraction.

Table No.3 - Conditions of production when extraction is done after three years for rubber plants which had dissimilar plant girth at the time of initial extraction.

Plant girth at the start of extraction.	No.of trunks	Total production of latex(Kg)	Yield of latex per trunk(kg)	Output per trunk time (millilitre)	Percentage from plants of girth 50 to 55.0 (%).
30.1 to 35.0	6	6.691	1.149	287.1	48.0
35.1 to 40.0	55	75.668	1.376	343.9	57.5
40.1 to 45.0	75	110.355	1.471	367.9	61.5
45.1 to 50.0	39	52.120	1.336	334.1	55.8
50.1 to 55.0	5	11.970	2.394	598.5	100

Note: Determined on the basis of four times of extraction.

In order to fully comprehend the conditions of production by each of the various needle pricks during the periodic cycle, we prepared statistical data separately in respect of the quantum of the output due to the various needle pricks individually during each of the periodic cycle for the period

between 1979 to 1981. The results demonstrated that for the first, second, third and fourth time of the puncture tapping, the average quantity of yield of latex per needle prick was separately 64.8 kilograms, 59.8 kilograms, 53.9 kilograms and 44.9 kilograms respectively, on the average and these separately constituted 29.0 per cent, 26.8 per cent, 24.1 per cent and 20.1 per cent respectively of the sum total of latex yield during the period cycle of half a month. The experience gained after t experiment clearly showed that after administering the stimulating agents of drugs and chemicals, the quantum of yield from each separate puncture tapping had remarkably significant variations, The output from each of the first, second and the third needle pricks significantly or exceedingly significantly exceeded the output from the fourth needle prick. The output from the first puncture tapping also exceedingly significantly surpassed the output from the third needle prick. However, the variation in output from the other pricks was not very remarkable.

(2) Content of dry rubber.

Because of the reason that the relative frequency of exploitation of rubber by puncture tapping technique is comparatively low, the extraction of rubber is normally restricted to only about eight times per month and the total period of extraction of rubber in a year is comparatively of a short duration (it is within seven months (in a period of four uniformly in all cases

years). The number of times of extraction of rubber during one year is comparatively less (52 to 58 puncutre tappings a year). The content of dry rubber is uniformly maintained at a comparatively higher level throughout and it is separately 30.4 per cnt, 34.9 per cent, 29.6 per cent and 31.5 per cent during the four successive years of exploitation of rubber and the average content of dry rubber is 31.6 per cent. In sharp contrast, the content of dry rubber in sickle cutting exploitation of rubber plants, was 25.0 per cent and 30.5 per cent respectively during 1980 and 1981 which is separately lower than the dry rubber content in case of puncture tapping process of exploiting rubber plants during the same years by 4.6 per cent and one per cent respectively (for details please refer to Table No.4).

During 1981 the content of dry rubber was measured in respect of group of rubber plants having dissimilar trunk girths. The results clearly demonstrated that more the girth of the plant trunks, the content of dry rubber is correspondingly higher and, therefore, there is positively utmost interdependent relationship between the girths of rubber plant trunks and the quantum of dry rubber contained in it ($n = 6$, $r = 0.933$, for details please see table No.5).

It can be still seen from Table No.5 that the group of plants having varied trunk girths manifests very great variation in the quantum of dry rubber contained in it. The highest variation is upto 15.4 per cent but the variation is

not so large in case of various groups of plants which have the trunk girths of above 50.1 centimeters and here the largest variation is only 3.9 per cent. However, in case of the plants having trunk girth between 45.1 to 50.0 centimeters, the dry rubber content is less by eight per cent as compared to the dry rubber content in plants having girth of trunks in the region between 50.1 to 55.0 centimeters. This tantamount to saying that, girth of rubber plant trunks of approximately fifty centimeters, as if, constitute a delimiting boundary line for abrupt change.

(3) Growth of girth of plant trunks.

The circumference of the girth of plant trunks from which rubber was exploited by puncture tapping technique, roughly increased by 2.5 centimeters during the eight months of the first year of extraction (1978) and during the second year of extraction the growth was roughly 6.4 centimeters. During these two years, the plants from which no extraction of rubber was carried out, in sharp contrast to the above plants, had separately rough growth of 5.7 and 7.1 centimeters respectively in the girth of the plant trunks. In other words the rubbers plants which were subjected to exploitation of rubber by puncture tapping technique when compared to the rubber plants from which no rubber was extracted, in contrast, had lower growth of girth by thirty per cent. Afterall the reason may be that by puncture tapping and exploitation of the rubber plants, the original balance in the matabolic

Table No. 4 - Content of dry rubber year by year in PRIM 600 while exploiting rubber by puncture tapping technique (during 1978 to 1981, %).

Method of Extraction of rubber	1978		1979		1980		1981		Average content of dry rubber.
	Content of dry rubber	Standard Variation	Content of dry rubber	Standard Variation	Content of dry rubber	Standard variation	Content of dry rubber	Standard variation	
Puncture Tapping	30.4	3.0	34.9	4.8	29.6	5.9	31.5	4.7	31.6
In Contrast Sickle Cutting Exploitation	-	-	-	-	25.0	-	30.5	4.0	27.8

Table No. 5 - Content of dry rubber in rubber plants with dissimilar girths, while extracting rubber by puncture tapping technique.

Girth of Plant Trunks	Date of Measurement				Average	Standard Variation
	21 July	24 July	27 July	30 July		
40.0 - 45.0	24.5	24.0	22.5	22.5	23.4	1.03
45.1 - 50.0	27.5	27.0	27.0	26.0	26.9	0.63
50.1 - 55.0	36.0	33.0	36.0	34.5	34.9	1.44
55.1 - 60.0	35.5	38.0	37.0	35.5	36.5	1.22
60.1 - 65.0	45.0	37.0	35.0	33.5	38.1	5.30
65.1 - 70.0	36.5	37.0	40.5	41.0	38.8	2.33

properties of material has been shattered. This is as a consequence of the contradiction brought forth in the distribution of the nutriment, between the growth of the girth and the production of rubber. During the third and the fourth year of extraction of rubber of puncture tapping technique, the girth of plants of rubber separately increased roughly by 3.9 and 4.5 centimeters. During these two years in case of sickle cutting method of exploitation of rubber, the growth of girth of plant trunks was increased roughly by 3.9 and 4,7 centimeters respectively in sharp contrast to the above. The average comparative difference between the growth of girth between puncture tapping of rubber plants and sickle cutting method of exploitation during these two years was 0.1 centimeter. The overall total growth of trunk girth of rubber plants during four years of puncture tapping technique of extraction of rubber was roughly 17.4 centimeters which amounts to an average growth of 4.35 centimeters per year. In contrast to the above, in case of sickle dutting method of exploitation of rubber plants, the average growth of trunk girth per year was roughly 4.3 centimeters. Thus the variation in growth between the two methods enumerated above was very negligibly small. From this it can be obviously seen that the growth rate of the girth of the plant trunks undergoing puncture tapping technique and the plants subjected to rubber extraction by sickle cutting method are

basically identical. This magnitude of growth level is high when compared to normal sickle cutting of rubber plants in the local cultivated fields in general (The average increase in growth of the girth per year in plants being exploited for rubber extraction by sickle cutting method in the normal cultivated fields during the initial four years of extractio was roughly about 2.5 centimetre).

Table No. 7 shows the year to year growth of the girth of the plant trunks while exploiting rubber plants of dissimilar girths by puncture tapping technique. The rubber plants have been grouped under five categories of plant girth i.e. 30.1 to 35.0 centimeters, 35.1 to 40.0 centimeters, 40.1 - 45.0 centimeters, 45.1 to 50.0 centimeters and 50.1 to 55.0 centimeters. The average growth of girth was separately 4.9, 4.0 , 4.5, 4.2 and 4.7 centimeters roughly. While comparing the magnitude of growth in different cases, it was observed that under conditions of identical intensity of stimulation and extent of exploitation, the difference between the amount of growth of the girth of trunk of large plants and small plants were not large. Moreover there was no intimate relationship between the size of the girth of plant trunks and the magnitude of growth of the plant girth ($r = 0.08$).

Table No. 6 - Amount of growth in the girth of plant trunk in PRIM 600 rubber plants using puncture tapping technique (1978 to 1981, centimeters).

Item Method of handling	1978			1979		1980		1981		*
	Girth of stem at beginning of year.	Girth of stem at end of year.	Growth during the yr.	Girth of stem at end of year.	Growth during the yr.	Girth of stem at end of year.	Growth during the year.	Girth of stem at end of year.	Growth during the year.	
Exploitation of rubber by puncture tapping.	42.2	44.7	2.5	57.2	6.5	55.1	3.9	59.6	4.5	
In Contrast non-extraction of rubber	39.1	44.8	5.7	51.9	7.1					
In Contrast sickle cutting ext-raction				49.4		53.3	3.9	58.0	4.7	

ued.

Average growth in a year	Percentage of puncture tapping in contrast to non-extraction	Percentage of puncture tapping in contrast to sickle cutting extraction.
4.35	68.0	101.2
6.4	100	
4.3		100

Table No. 7 - Influence of puncture tapping technique of extraction of extraction of rubber on the amount of growth of PRIM 600 rubber plants having varied girth of plant trunks (Centimeters)

Girth of plants	1978			1979		1980		₤₤ 1981		1978 to 1981	
	Girth of stem at beginning of year.	Girth of stem at end of year.	Growth during the year.	Girth of stem at end of year.	Growth of stem at end of year	Girth of stem at end of year	Growth of during the yr.	Girth of stem at end of year.	Growth during the year.	Growth during the 4 years	Average growth during the yr.
1-35.0	34.8	37.1	2.3	43.1	6.0	49.0	5.9	54.3	5.3	19.5	4.9
1 - 40.0	38.7	41.6	2.9	47.8	6.2	50.8	3.0	54.6	3.8	15.9	4.0
1-45.0	42.9	45.1	2.2	52.9	7.8	56.5	3.6	60.7	4.2	17.8	4.5
1-50.0	47.3	49.6	2.3	56.2	6.6	60.0	3.8	64.1	4.1	16.8	4.2
1-55.0	51.4	54.0	2.6	61.5	7.5	65.7	4.2	70.2	4.5	18.8	4.7

Note: Demarcation of groups of plants according to the girth of plant trunks was marked at the time of starting of the experimental research during the early part of 1978.

(4) Rate of distribution of dry matter.

The rate of distribution of the dry matter in puncture tapping of rubber plants during the four years was separately 30.4 per cent, 13.2 per cent, 25.6 per cent and 22.1 per cent respectively and the average rate per year was 21.3 per cent. In sharp contrast to the above the rate of distribution of dry matter in sickle cutting method of harvesting rubber plants during two years was 13.0 per cent and 14.1 per cent which works out to an average of 13.7 per cent per year (For details please see Table No.8).

Because of the reason that the rubber plants go into early premature production by ~~cultivated fields during the initial~~ using puncture tapping technique, man have transformed the balance in the distribution of matter in the rubber plants and enhanced the modulus of economy of rubber plants. As for example according to the available material data in respect of rate of distribution of matter during the initial two years of extraction of rubber (puncture tapping technique and during the period of 1978 and 1979 and sickle cutting method of exploitation used during the period 1980 and 1981), the rate of distribution of matter in puncture tapping technique was higher by 4.3 per cent as compared to the sickle cutting method for exploitation of rubber plants. Taking the data provided in the same years

(in the years 1980 and 1981 for example), the rate for puncture tapping was higher by 10.6 per cent as compared to that of sickle cutting. What is essential to take special note of is that the amount of growth in the girth of rubber plant trunks both in case of puncture tapping technique and sickle cutting method per year is on the whole somewhat identical and the amount of growth of the portion of the trunk above the ground level is also on the whole identical in both the cases. What is not similar is that the radical growth of the plants after puncture tapping is increased to much greater extent when compared to that of the sickle cutting of rubber plants. Consequently the magnitude of the entire biological growth and the rate of distribution of matter are correspondingly enhanced. Speaking about PRIM 600, it can be seen that the raising of the rate of distribution of matter in the rubber plants after puncture tapping technique of extraction is due to the higher quantum of yield obtained from it. Moreover for this reason the growth of the girth of the trunks of rubber plants which have not yet been cut and weakened, is not found to produce any adverse influence in respect of the potential capacity of the rubber plants to produce rubber. Afterall the cause of this may be that puncture tapping technique has more effective application and utility as well as due to the superiority of the material produced by the nutriment and photo synthesis in sharp contrast to

that of sickle cutting method when compared (Scientific Literature under reference No.7).

Table No.8 - Comparative study of the rate of distribution of the dry material of PRIM 600 in case of puncture tapping technique of exploitation of rubber and sickle cutting method of exploitat:

Item Method of Handling		Economic Output (Kg)	Weight increase of the portion above the ground level (Kg)	Physiological Products (Kg)	Rate distribution (%)
Puncture Tapping Technique of exploitation of rubber.	1978	6.408	15.0	21.408	22
	1979	7.005	46.0	53.005	0.
	1980	11.625	33.7	45.325	2.
	1981	12.610	44.5	57.110	22.
	Sum Total of 4 years.	37.648	139.2	176.848	21.
In contrast sickle cutting extraction.	1980	4.725	31.6	36.325	10.
	1981	7.328	44.1	51.428	15.
	Sum Total of 2 years.	12.053	75.7	87.753	13.

(5) Contents of nutriments in the leaf sheets and contents of latex and overall sugar as well as contents of starch powder deposit in the bark of the plants.

Table No.9 demonstrates clearly that there is not much significant variation in the content of nutriments in the leaf sheets of rubber plants as far as extraction of rubber by puncture tapping technique from plants having varying circumference of the trunk girths are concerned. The magnesium content in puncture tapping of rubber plants is a little less when compared to that of sickle cutting method of exploitation of rubber plants in contrast. However, the content of phosphonium in puncture tapping is a little higher when compared to the method of sickle cutting of rubber plants, although the variance is not significantly high. In both these cases content of Nitrogen is very rich and abundant or at least regular and normal. In both these cases content of Nitrogen is very rich and abundant or at least regular and normal. In majority of the cases content of Potassium is also abundantly rich. As far as quantity of magnesium and phosphonium contained is concerned besides an odd sample in both cases having deficiency in all other cases these two elements are contained in normal or abundantly rich proportions. As has already been seen, for the content of nutriment in the leaf

sheets, what is most important factor is the influence of loss or decline in the fertility of the soil in the cultivated fields in which rubber seedlings have been planted. The puncture tapping technique of extraction of rubber has no direct influence on the content of the nutriments in the leaf sheets. The nutrient contained in the leaf sheets of rubber plants having dissimilar trunk girths is basically identical in nature.

Table No.11 - Content of starch powder in the bark of rubber plants having dissimilar trunk girths being exploited by puncture tapping techniques.

Grade → Girth of plants (centimeter)	0	1	2	3	4	5	Average Grade.
40.1-45.0		18	10	7	5		1.98
45.1-50.0		23	7	10			1.68
50.1-55.0		22	8	5	5		1.83
55.1-60.0		17	13	10			1.83
60.1-65.0	5	20	15				1.25
65.1-70.0		16	19	5			1.73
In contrast sickle cutting		10	7	18	5		2.45

Table No. 9 - Results of analysis of the nutriment content in leaf sheets of PRIM 600 rubber plants having variant plant girth.

Method of Extraction	Girth of Plants (Cm)	Content of nutriment in leaf					comparative value of the various elemen of nutrient.				
		N%	P%	K%	Ca%	Mg%	N/P	N/K	K/P	K/Ca	Mg/P
Puncture	40.1-45.0	→ 3.34	→ 2.222	1.22↑	1.09↑	0.254↓	→ 15.0	2.7↓	5.5↑	→ 1.1	1.1↓
Tapping	45.1-50.0	3.69↑	→ 2.226	1.36↑	1.22↑	→ 0.398	16.3↑	2.7↓	6.0↑	→ 1.1	→ 1.8
Technique	50.1-55.0	3.65↑	→ 0.218	1.34↑	1.10↑	→ 0.413	16.7↑	2.7↓	6.1↑	→ 1.2	→ 1.9
of Exploi-	55.1-60.0	3.54↑	→ 0.228	1.26↑	1.23↑	→ 0.383	→ 15	2.8↓	5.5↑	→ 1.0	→ 1.7
tation of	60.1-65.0	3.77↑	0.241↑	1.46↑	→ 1.00	→ 0.398	→ 15.6	2.6↓	6.1↑	→ 1.5	→ 1.7
Rubber.	65.1-70.0	3.45↑	0.234↑	1.40↑	1.10↑	0.346↓	14.7↓	2.5↓	6.0↑	→ 1.3	→ 1.5
In contrast sickle cutting method		3.41↑	0.194↓	1.39↑	1.18↑	→ 0.417	17.6↑	2.5↓	7.2↑	→ 1.2	→ 2.1

Note → denotes normal level
↑ denotes abundantly rich
↓ denotes deficient.

Table No. 10 - Content of latex and total saccharose in exploitation of of PRIM 600 rubber plants having dissimilar trunk girths by puncture tapping technique (mg. $ml.^{-1}$)

Date of Measurement / Girth of Plant(Cm)	21 July	24 July	27 July	30th July	Average	Standard difference.
40.1-45.0	1.575	0.875	1.375	1.000	1.206	0.325
45.1-50.0	2.450	1.100	1.125	1.125	1.450	0.667
50.1-55.0	1.625	0.950	1.000	0.775	1.075	0.378
55.1-60.0	1.250	0.950	0.875	1.000	1.019	0.163
60.1-65.0	1.950	1.275	1.200	1.125	1.338	0.380
65.1-70.0	1.325	1.400	0.875	1.075	1.169	0.298

The overall content of saccharose in puncture tapping technique of exploitation of rubber from various groups of rubber plants having different trunk girths is within the varied range of 1.02 to 1.45 mg. ml^{-1}. The statistical data obtained by measurement shows clearly that the bigness or smallness of the size of the girth of plant trunks and its latex and total saccharose content are not mutually inter-related (n=6, r= -0.156). As if, it can be also explained that under the conditions of intensity of artificial chemical stimulation and the extent of extraction of rubber which were maintained while carrying out this experimental research, the latex and the total saccharose contained was mainly subjected to the conditioning by the intensity of chemical stimulation and the extent of extraction of rubber (for details please refer to Scientific literature No. 3 under reference). In other words the quantum of latex content has no interdependent relationship with the bigness or smallness of the dimension of the girth of the plant trunks.

The experimental results explicitly demonstrated that there is not much difference in the quantum of starch powder contained in the bark in extraction of rubber by puncture tapping of rubber plants having dissimilar trunk girths. No tendency was discernable for the quantity of starch powder contained in the bark of plants to rise higher as a consequence of increase in the trunk girth of the rubber plants. But the quantity of starch powder contained in puncture tapping technique of exploitation of rubber plants is universally lower as compared to the starch powder content in sickle cutting mode of extraction in contrast, The average

content of starch powder in the bark of plants while exploiting rubber by puncture tapping technique from six groups of plants having variable girths is of the order of 1.72 grade, whereas in sharp contrast to this, in case of sickle cutting method of exploitation, it is of the order of 2.45 (For details please see Table No.11).

(6) Preliminary estimation of the use of mannal labour and consumption of commodities.

Condition of employment of labour.

In puncture tapping technique of exploitation of rubber for every plant location about 30 labourers are required to be employed every year for setting up of rubber plants in rows, making grooves for flow of rubber sap, handling of chemical stimulants and promoting agents etc. and subsidiary activities connected with these. For actual extraction of rubber 50.4 mannal workers (according to estimated 56 times of extraction of rubber per year). Summing up these requirements together 80.4 labourers must be required. As far as sickle cutting method of extraction is concerned, for each plant location 14.2 workers are required to be employed each year including subsidiary activities, rubber plantation workmen's training etc. 66.0 workmen are required for sickle cutting and harvesting (based on estimated calculation of 100 times of sickle cuttings per year). The above items together totals upto 80.2 workers essentially

required for employment every year. While calculating in this way, although puncture tapping technique is only used for 56 times a year for exploitation of rubber far as compared to the sickle cutting method in contrast, it is less by 44 times. But because the engagement of workmen is more in subsidiary activities as well as for collection of perennial flow of rubber sap in puncture tapping technique, as a matter of fact, the total number of workmen employed is not much different when compared to the number of workers employed in sickle cutting method of exploitation of rubber.

Condition of consumption of commodities - the material commodities which are required every year for each plant stem in puncture tapping technique of exploitation of rubber.

Calcium Carbide (Tourmaline) 0.2 Kilogram (including consumption of about 20 per cent), estimated price 0.16 yuan (Chinese dollar), 40 per cent original crude liquid of Ethylene 2.0 grams, estimated price 0.016 yuan. Three sets of grooved channel for flow of rubber sap, estimated price 0.04 yuan (based on calculated 60 pieces cut from each meter square of asphalt roofing felt tar paper). Chemicals to promote increased fertility 0.5 catties (Chinese pound weight), estimated price 0.08 yuan. As such for each plant stem additional expenses every year comes to 0.296 yuan in puncture tapping technique of extraction of rubber.

(7) Side effects and existing problems.

1. Withered dead stiff bark.

The rate of aggregate withering dead plant bark

in puncture tapping technique of exploitation of rubber in the various years of extraction is separately 4.4 per cent, 2.4 per cent, 7.2 per cent and 1.8 per cent respectively (for details please see table No.12). What is worth noting is that, the rate of aggregate dead bark each year(including the accumulated figure of withered plant bark during the preceding past years brought within the calculation) do not gradually rise year by year, but it varies from sometimes going up and some times coming down. In puncture tapping technique of extraction of rubber, during the fourth year of exploitation, there were only four trunks of the grand total of the withering dead bark plants which constitute only 1.8 per cent. According to the results of investigations and available reported opinion of the workers engaged in rubber plantation, the rubber plants with withered dead bark which has not been brought under investigation during the particular year, will resume production of rubber in majority of the cases, after starting of extraction during the following year. There will be some of the rubber plants which during the first half of the year will not have normal orientation for production of rubber but during the second half part of the year, the same plants will for the most part be restored to normal capacity for production of rubber during the high yielding season. As for example, during the end of 1978 eleven trunks of rubber plants with withered dead bark were brought into account after due investigations but during the further probing at the end part of 1979, it was revealed that

there were only six trunks with withered dead barks in the aggregate number of rubber plants which included the rubber plants, out of the eleven withered bark plants of 1978 investigation, which had not still resumed production of rubber. Again as was the case during the investigation carried out by the end of 1980 when it was found that 16 plant trunks had withered dead bark but during the further probe by the end of 1981 it was found that only four plant trunks were left with withered dead bark. Moreover all these four plant trunks of withered dead bark were only basically and partially in the limited range of secretion of sap below the normal extent and there was not a single plant trunk in which extraction of rubber completely ceased. Looking from point of view, the rubber plants with withered dead bark in puncture tapping technique of extraction of rubber, can more easily be restored to normal productivity as compared to the sickle cutting method of exploitation. In sharp contrast, the rate of withering dead barks was 1.8 per cent in 1980 and 2.6 per cent in 1981 in case of sickle cutting method of exploiting rubber plants, which separately constituted lower by 5.4 per cent and higher by 0.8 per cent respectively as compared to the puncture tapping technique of exploitation of rubber plants during the same two years.

2. Rupture of the bark and flow of rubber sap.

It was discovered during the first two years after starting of extraction of rubber that in cases of one to two

per cent of the rubber plants flow of rubber sap starts after bursting of the plant bark. This may be brought about due to use of promoting agents and chemical stimulants From 1980 onwards a number of effective safety measures have been taken in this direction and, therefore, no further phenomenon of rupture of plant bark has come to notice.

3. Problems regarding employment of labour and expenses.

Use of Calcium Carbide (Tourmaline) as a promoting agent, comparatively larger number of workers being engaged, strength of workers being comparatively great, the expenses in respect of asphalt felt tar paper is also being comparatively high the problems are many. Moreover this method is used in large areas and the quantum used is also considerably large. How to change and improve the method of stimulation, this is a problem which is still awaiting further continuous research.

Table No. 12 - Rate of aggregate withered dead bark in puncture tapping technique of exploitation of PRIM 600 rubber plants year by year (percentage)

Year Mode of handling	1978	1979	1980	1981
Puncture tapping technique of rubber extraction	4.4	2.4	7.2	1.8
In contrast sickle cutting method			1.8	2.6

Discussions and Comments.

After passing through four years of experimental research work and observation, we consider that puncture tapping technique of exploitation in respect of immature tender PRIM 600 rubber plants have the special characteristic features as noted below:

Point No.1 : It has continuous high productivity. PRIM 600 obtained vegetatively from an original seedling by cloning process goes into production by puncture tapping technique one year in advance of the normal gestation period and during the initial four years we can continuously obtain considerable quantum of yield which is worth taking note of. The total output from a trunk taking four years production together may reach 15.003 Kilograms which works out to a yearly average yield per trunk of 3.751 kilogram. Moreover during each of the years without exception there is definite and significant increase in production by stages. The level of this quantitative production is very close to the quantum of yield of the commodity of identical grade in cultivated cultivation in Hainan (South Sea) are-as having average stem girth of 55 centimeters during the first four years from the initial start of extraction of rubber.(According to the material data obtained from four experiments carried out by the Selective Seed Cultivation Research Laboratory of our Research Institute during the period

1975 to 1978 in cultivated fields in comparable areas, the per plant trunk quantum of output of dry rubber per year on the average during the first four years of exploitation of PRIM 600 rubber plants having average girth of plant stems of about 55 centimeters was separately 2.38, 4.05, 4.41 and 5.07 kilograms. The sum total of the yield during the years works out to 15.91 kilograms which comes to an average of 3.98 kilograms per plant stem per year). In sharp contrast to the quantum of output of sickle cutting method of exploitation of rubber plants in identical segment of plantation forest having plants with identical plants stem girth, this output is comparatively many times more. Moreover this quantity of output was obtained by sampling of rubber plants within the seven months of extraction of rubber during the year and under condition of 52 to 58 times of extraction per year. The amount of yield was found to have a natural tendency of gradually rising higher and higher, year after year. As per the trend of quantitative production at the present times, the probability of the total quantity of yield from exploitation of rubber plants by use of sickle cutting method of extraction catching up with the product of the extraction by puncture tapping technique during any particular year somewhat appears to be extraordinarily difficult.

Point No. 2. The growth of the plant girth is comparatively fast. The plants being puncture tapped grow in girth for about 17.4 centimeters in four years which comes to an average

of 4.35 centimeters per year. In contrast this is basically identical to the increase in the growth of the plant girth of rubber plants after sickle cutting method of exploitation in comparable segment of plantation forest. In these areas while extraction is carried out by sickle cutting method in respect of PRIM 600, the rough increase in growth per year in general is normally prescribed to be only two to three centimeters.

Point No. 3. The content of dry rubber is comparatively high. Because we adopted the process of procuring rubber at a lower frequency, the content of dry rubber in puncture tapping technique of exploitation of rubber plants during four years always maintained comparatively higher level and the average was 31.6 per cent which in sharp contrast to the sickle cutting method of exploitation of rubber plants with identical stem girth but having not been administered any stimulant or chemical promoting agent, is comparatively higher by 3.5 per cent.

Point No. 4. The capacity to withstand stimulating chemical promoters is stronger in puncture tapped rubber plants when compared to the normal sickle cutting exploited rubber plants. If use is made of the quantity of promoting agent and the frequency used in this experiment, the mature and high yielding rubber plants vegetatively produced by cloning for normal sickle cutting method of extraction, will not be

able to withstand the same. It is needless to speak about the tender immature plants which has not yet reached the prescribed standard for extraction of rubber. But the puncture tapped rubber plants not only can withstand it adequately, but it maintains comparatively higher quantity of dry rubber content throughout, right from the start to the end. The quantum of output in all cases also increases year after year. Phenomenon of any development of physiological fatigue or sudden secondary side effect was not observed. The nutriment contained in the leaf sheets, the content of starch powder in the bark of plant and the content of latex and overall saccharose etc. all the physiological parameters were observed to be basically normal. This may possibly be closely concerned with the inter connection between the sources of assimilation of the puncture tapping technique of exploitation of rubber, and setting up of rubber plantation in fields in areas having ditches and pools being maintained as a continuous process.

It can be clearly seen from the above that, PRIM 600 is comparatively the most suitable product of cloning from an original seedling for going into production earlier than the normal gestation period by shortening the immature period of the rubber plants by using puncture tapping technique. By going into production in a proper way earlier than the scheduled period of maturity, it further reduces the influences

in respect of the growth of the circumference of the plant girth. Preliminary investigations were carried out on the aspect of raising the quantum of yield per unit area and the rate of productivity of labour etc. and it was considered at the very outset that in the cultivated fields in general for PRIM 600 obtained by cloning, the prescribed standard for starting of extraction may be the time when girth of plant stem attain more than 40 centimeters in circumference at a height of 1.2 meters of the trunk from the ground surface level in respect of 50 per cent of rubber plants in a particular segment of the plantation forest. (In comparison to the normal sickle cutting method of exploitation of rubber, the plants go into production one or two years earlier than usually prescribed in this case). At the time of starting of extraction all the rubber plants in the segment of cultivated forest, which have girth of the plant stem more than 35 centimeters more or less go into production by puncture tapping technique. In this way the overwhelming majority of the rubber plants in a segment of rubber plantation field are exploited and rubber is exploited from all the rubber plants in the same year. According to the results of our experimental research it is estimated that during a span of 30 years of exploitation of rubber by shortening the immature period and preponing the production time by one year, we can enhance the entire periodic cycle of rubber plantation and raise the rate of production by three per cent (Scientific Literature under Reference No. 10). This

adds to the rate of extraction of rubber in contrast to the normal sickle cutting method of exploitation. After going into production, during the first three years, we may readily get comparatively higher quantum of yield per unit area and also enhanced rate of production of rubber. It is estimated that on the whole we may thus increase the entire periodic cycle of rubber plants by six per cent and the corresponding rate of production. Especially, it is even more suitable for utilisation in areas which suffer traumatic disaster and severe damages due to natural calamities (like Kuang Tung (Canton - Wide East), Chan Chiang (Chan River), Kuang Xi (Broad West) and Fu Kin (Prosperous construction). Besides this, we can also consider the standards to be prescribed for starting of the extraction and thereby reduce the difficulties suitably. In this way we can prepone the process of exploitation of rubber to our advantage (brought forth by fierce nature of natural calamities. (in areas (before the catastrophic damages are

(This Scientific document was received on 23 March 1982.* The Agricultural Analysis Laboratory of our Research Institute had extended earnest help and cooperation to us in determination of the content of nutriments in the vanes of leaves and we take this opportunity to express our heartiest gratitude and thanks. Amongst those who actively participated in this piece of scientific venture included Comrades Yu Wan Lin and Xu Hui Zhun also.)

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