PRESENT QUALITY OF INDIAN STANDARD NATURAL RUBBER

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Before the second world war, the only commercially available rubber was NR, and synthetic rubbers reached the market in the 1940s. The early synthetic rubbers had many drawbacks. Any drawbacks associated with NR were tolerated due to the limitations of synthetic rubber. However, in the 1950s, due to the introduction of Zeigler Natta Catalyst system, stereo specific synthetic rubbers could be produced easily. Their molecular size, average molecular weight, gel content, size and extent of side chains, viscosity etc. could be controlled easily. That is the synthetic rubbers were assuming a 'tailor cut' state. In other words, a consumer of synthetic rubber could demand for a rubber of specific mooney viscosity or having a desired cure time or rate of cure when compounded using a standard formulation. Moreover, synthetic rubbers were marketed in standard packages in a very attractive form.

Such developments in the field of synthetic rubbers reduced the market share of NR. NR marketed in sheet or crepe form were graded only by visual methods and were not properly packed. Hence, attempts were made to grade and market NR based on some specific properties. The first attempt in this line was the technical classification (TC) scheme, originated in Vietnam and Combodia in 1951. In addition to visual examination, vulcanisation rate and mooney viscosity were in the main parameters in the TC scheme. The specification of mooney viscosity was abandoned in 1953 due to the discovery of storage hardening of NR. The classification based on vulcanisation rate was found to be effected the variations in non–rubber constituents present in NR. Thus the TC scheme was found to be inadequate. Hence following the developments of new processing technology, Malaysia in 1965 introduced and improved scheme, popularly known as the SMR scheme for marketing NR with more meaningful specifications. The main features of the SMR Scheme are

1. Good and clean presentation of NR in small handled bales.

2. Guaranteed limits for contaminants and certain basic raw rubber properties.

3. Consistency in technical properties.

TABLE–1. IS:4588–1986 Physical and Chemical Requirements for Natural Rubber

Characteristics	Requirements for					
	ISNR–3CV	ISNR–3L	ISNR–5	ISNR–10	ISNR–20	ISNR–50
1. Dirt Content,% by mass (Max)	0.03	0.03	0.05	0.10	0.20	0.50
2. Volatile Matter by mass (Max)	0.80	0.80	0.80	0.80	0.80	0.80
3. Ash by mass (Max)	0.50	0.50	0.60	0.75	1.00	1.50
4. Nitrogen by mass(Max)	0.6	0.6	0.6	0.6	0.6	0.6
5. Initial Plasticity (Po)	40 ± 5	30 (min)	30 (min)	30 (min)	30 (min)	30 (min)
6. Plasticity Retention Index (PRI) (Min)	60	60	60	50	40	30
7. Colour (Lovibond Scale) Max.	–	6	–	–	–	–

The long-term effects of stimulant usage on the trees needs to be ascertained particularly with regard to its possible effects on *anatomy of the bark and* physiology of the tree, inclusive of metabolic changes in the latex. In addition some adverse effects have been noted and practical problems encountered, although most of these can be overcome. These are:

- Bleeding from previous puncture points and from renewed bark.
- Occurrence of bark cracks, flaking and bark bursts resembling petch canker though this appears to be largely a clonal response.
- Damage to applicators by pests, in particular monkeys.
- Prospect of theft of crop in the field.
- Necessity for constant repair of applicators due to normal process of bark expansion/contraction and growth in young mature trees.
- Need to ensure that applicators remain leak-proof to obtain expected high yields.
- Need to adhere to crop collection schedules to avoid problems with processing.

It is apparent that besides influence of genetic factors and past exploitation history, which are beyond control, problems such as occurrence of bleeding and bark bursts can be tackled by reducing frequency or stopping stimulation temporarily until the trees recover, without disrupting tapping. Management in puts with absolute commitment and active participation are deemed necessary for the successful development of this system of exploitation. The tremendous potentials of this radical technique cannot be realized if its adoption is to be guided by practices associated with conventional tapping systems. Thus, comprehensive changes in all *related aspects are necessary* if the method is to evolve as an alternative and viable mode of crop production in *Hevea*

CONCLUSION

RRIMFLOW is a radical approach to exploitation of *Hevea* trees. It promises to provide the necessary impetus and offer practical solutions to major problems affecting the rubber industry.

The technique can be used to exploit trees which are to be replanted in four to five years, provided there is sufficient bark remaining on the high panels (HØ-3 + HO-4). Further, using this technique, yield productivity of a given tapping task can be enhanced by exploiting dry or brown-bast trees and low-girthed trees without concern for long-term effects. Large-scale adoption of this technique as a routine commercial practice on young mature and premium rubber can, however, only be recommended after its evaluation over a longer period.

The technique can be targeted for immediate use in specific areas requiring urgent solutions to prevailing problems, provided there are absolutely no other alternatives. These are:

- Areas with young mature rubber of tappable age (more than six years) but not opened for exploitation owing to acute scarcity of skilled labour and the *pressing need to off-set expenses* for field upkeep and maintainence. Data available confirm that notwithstanding the long-term effects, it is a viable and practical alternative to conventional tapping systems.
- Inability to maximise crop extraction from mature premium and old rubber owing to shortage of tappers. The method is suitable for this group of trees although modifications may be necessary to further enhance yields by increasing the number of puncture tappings per month from existing four to six or seven at intervals of four to five days.

In addition, the technique has tremendous potentials which can be developed to provide greater muscle and viability to the rubber industry. These include among others:

- Reduction of the uneconomic immature phase of *Hevea* trees with exploitation at smaller girth sizes (35cm - 40cm)
- Tapping of only virgin panels without recourse to renewed panels, thus enabling accelerated replanting and earlier returns from sale of timber.
- It is likely that in the not too distant future, the labour requirements for crop harvesting in the rubber industry may be comparable or lower than that of oil palm if trees exploited once a month with four punctures per tapping with monthly stimulation can give yield as much as that obtained with ten to twelve conventional tappings.
- With the RRIMFLOW system of exploitation harvesting of rubber could become a part-time occupation, with the non-resident labour working normal hours in factories and exploiting *Hevea* in the evening.

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TABLE–2 Results of analysis of TSR produced in Estate Sector

Batch	Bale No.	Dirt Content %	Po	PRI
A	10	0.07	35	80
	20	0.05	38	74
	30	0.09	37	76
	40	0.06	39	72
B	10	0.05	37	62
	20	0.06	36	67
	30	0.10	34	53
	40	0.08	39	62
C	10	0.06	37	62
	20	0.08	32	72
	30	0.09	32	75
	40	0.10	35	73

4. Better and easier adaptation to consumer needs.

This new technically specified rubber (TSR) scheme was adapted in several NR producing countries and the Indian version is the ISNR (Indian Standard Natural Rubber) The SMR scheme has undergone periodic revisions and the present grades and specifications limits are described in SMR bulletin No 11(2). In India specifications for NR were originally introduced in 1968 and subsequently revised in 1975. The current specifications are given in IS: 4588–1986(3) (Table–I).

Consistency of TSR is a rather ill–defined term. Initial plasticity (Po) is an important property describing the properties of TSR. But, different batches of NR in a narrow range of Pc can show wide variations.

When NR was graded by the 'Green book' (4) specifications, lot of variability was observed in prossesibility within and between consignments of NR which fall on to a particular grade when visually examined. The situation has not much improved even with the introduction of the TSR Scheme. Increasing automation and computerisation in rubber industry require the use of more consistent NR. Consistency in properties of NR has acquired great importance in all the NR producing countries (5). Better consistency is observed in TSR produced from latex compared to TSR processed from field coagulum grade raw material. Hence a study was conducted to look into consistency of TSR produced in India.

MATERIALS AND METHODS

The following aspects were taken into considerations while studying the consistency of crumb rubber.

a. clonal variations

b. climatic conditions

c. agronomic practices

TABLE –3 Resuıts of analysis of TSR Produced in units procure Raw Materials.

Batch	Bale No.	Dirt Content %	Po	PRI
A	5	0.11	39	59
	15	0.15	37	57
	25	0.14	31	65
	35	0.16	33	61
	45	0.18	32	59
	55	0.17	32	47
	65	0.17	30	64
	75	0.18	32	53
B	5	0.20	30	57
	15	0.15	31	65
	25	0.20	34	59
	35	0.20	34	65
	45	0.19	30	50
	55	0.20	31	58
	65	0.20	31	55
	75	0.17	30	50
C	5	0.16	40	65
	15	0.22	38	66
	25	0.16	39	64
	35	0.15	41	59
	45	0.17	37	62
	55	0.22	35	60
	65	0.16	35	68
	75	0.16	38	63

TABLE–4 Test report of sample from Consecutive Bales.

Batch	Bale No.	Dirt Content %	Po	PRI
A	61	0.19	35	66
	62	0.18	35	63
	63	0.17	36	61
	64	0.16	37	59
	65	0.18	35	49
	66	0.17	34	59
	67	0.18	35	54
	68	0.15	23	52
	69	0.16	32	56
	70	0.17	37	50
B	821	0.18	28	61
	822	0.15	28	57
	823	0.18	30	70
	824	0.15	29	69
	825	0.17	31	66
	826	0.16	37	61
	827	0.12	37	59
	828	0.12	37	59
	829	0.14	37	59
	830	0.12	37	59

d. tapping and collection conditions

e. pre–processing operations

f. processing practices

TSR–20 grade material in the largest volume TSR produced and is derived from field coagulum grade materials and the results reported in this paper mainly covers ISNR–20.

The TSR who producing units in India can be broadly classified as

1. Category I 'who process own estates' field coagulum

2. Category II who process field coagulum grade raw materials collected mostly from small growers and dealers.

In India about 80% of TSR is produced by the latter group.

In a large estate, the earlier cited variability factors a to d are almost constant, factors e and f are more or less constant, whereas for the processors of purchased raw materials, a to e are very different and have control over processing practice alone. For a large estate processor, accumulation of raw materials in seldom experience. The storing conditions of the raw materials considerably affect the quality(6) and consistency of NR.

PRESENT SYSTEM OF TESTING & GRADING.

In India, each ISNR block weights 25kg and every 10th bale is selected for sample collection. The selected bales are individually tested for dirt content, Po and PRI and a composite sample of 4 bales representing 1000 Kg is tested for volatile matter, ash and nitrogen. By simple observation of the test results, grading is done. The present study covered 5 processing units in the estate sector and 20 units who process purchased raw materials.

Typical tests results for 3 batches of TSR produced by the 2 categories are given in table 2 & 3. These tables indicate that generally better quality TSR is produced in the estate sector.

Examining the results of table 3 indicate wide variability in properties. Each of the results in part A & B corresponds to ISNR–20 and the whole batch is graded as ISNR–20. In part C the test result of bale nos 15 and 55 corresponds to ISNR–50 and the common practice of present grading system is to grade bale nos 11–20 and 51–60 as ISNR–50 and others as ISNR 20.

This is an unscientific way of grading TSR. Considering the variations in parameters, especially the dirt content, there is likely chance that atleast some of the untested bales can have dirt content above the maximum permissible limit of 0.20 for ISNR–20. Further some bales between 11 to 14 and 51 to 60 of batch C may fall within the specifications for ISNR–20. Hence the system of grading by simply examining the numerical values of the tested bales is quite unscientific and inadequate.

Inorder to overcome this situation the 'Mean+3SD' system based on statistical methods is applied to the grading batch of TSR in other countries. The mean and standard deviation (SD) are calculated using the formula

$$\text{Mean} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$$SD = \sqrt{\frac{\sum_{i=1}^{n} Z x_i^2 - \frac{1}{n}\left(\sum_{i=1}^{n} x_i\right)}{n-1}}$$

The value of 'mean ± 3SD' is computed for each batch, whose maximum value for dirt content for TSR 20 grade is 0.20.

In the present study different batches, graded as ISNR–20 in the conventional way, were collected from 25 processing units for a period covering 6 months, at the rate of 4 batches per month. In addition, samples were collected from every tenth bale of selected batch for testing. The data thus obtained were statistically analysed. Considerable variations are observed even in the successive bales of ISNR processed from raw material obtained from a single source. The test reports for 2 such batches are given in table 4. Since the raw material is from a single source, these variations are introduced due to the lack of proper blending.

RESULTS AND DISCUSSIONS.

1. GRADING.

For the purpose of grading the mean and standard deviation (SD) were calculated for 4 batches each randomly selected from units belonging to category 1 and 2. The test report of the batches and the statistical analysis are given in table 5 & 6 respectively. Statistical analysis indicates the inadequacy of our present grading system.

2.EXTENT OF CONSISTENCY.

Confidence limits, having only 5% probability that the average property will be outside these limits, are calculated using the equation

$$\text{Confidence limits} = \bar{x}_i \pm \frac{t \times SD}{\sqrt{n}}$$

were xi is the mean, t is a statistical constant equal to 2.36 for 5% probability, n is the number of samples tested. The wider the range between the upper and lower confidence limits, larger the; number of values falling out of this range and larger their deviations from the boundary value, the lower is the level of consistency.

Examination of the data indicates large extent of variability in the field coagulum grade TSR. However, better quality and somewhat consistency are observed in the TSR produced in the units belonging to category 1.

REASONS FOR VARIABILITY

The primary factors contributing to inconsistency are the variability of the raw material and lack proper blending at processing end. The different factors contributing to inconsistency would have imparted varying contributions to the quality of the raw material.

CONCLUSIONS.

The system commonly followed at present in grading ISNR has to be modified based on statistical methods.

Extend of consistency in raw NR can be evaluated by determining the upper and lower confidence limits, its range, number of individual values falling outside the range, and determining the extent by which an individual value is far from the boundary.

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TABLE–5 Test results of TSR Processed at units belonging to category I.

Batch No.		1				2				3				4			
		Bale No.	Dirt%	P_0	PRI	Bale No.	Dirt%	P_0	PRI	Bale No.	Dirt%	P_0	PRI	Bale No.	Dirt%	P_0	PRI
		10	0.08	39	41	10	0.08	34	62	10	0.05	39	74	10	0.06	36	67
		20	0.06	39	46	20	0.05	35	63	20	0.09	39	69	20	0.05	35	60
		30	0.07	38	36	30	0.05	34	59	30	0.05	37	70	30	0.07	37	57
		40	0.07	37	30	40	0.06	36	56	40	0.07	37	76	40	0.05	36	64
Mean			0.07	38.25	38.25		0.06	34.75	60.00		0.065	38.00	72.25		0.058	36.00	62.00
SD			0.008	0.957	6.85		0.014	0.957	3.16		0.019	1.15	3.30		0.010	0.816	4.40
Mean ± SD			0.095	35.38	17.70		0.102	31.88	50.5		0.122	34.54	62.33		0.086	33.55	48.81
Factory Grade		Bale No.1–20 as ISNR–20						ISNR–10				ISNR–10				ISNR–10	
		" 21–40 as ISNR–50.															
Grade assigned based on statistical analysis				off				ISNR–10				ISNR–10				ISNR–10	
Confidence limits with 5%	lower		0.061	37.12	22.08		0.043	33.62	56.27		0.043	36.64	68.36		0.046	35.03	56.81
	upper		0.079	39.38	54.42		0.077	35.88	63.73		0.087	39.36	76.14		0.070	36.96	67.19
Probability to be out of range.	Range		0.018	2.26	32.34		0.028	2.26	7.46		0.044	2.71	7.79		0.024	1.93	10.38

TABLE–6 Test results of TSR Processed at units belonging to category II

Batch No.	1				2				3				4			
	Bale No.	Dirt%	Po	PRI	Bale No.	Dirt%	Po	PRI	Bale No.	Dirt%	Po	PRI	Bale No.	Dirt%	Po	PRI
	5	0.09	38	53	10	0.19	37	68	10	0.16	34	76	10	0.11	32	81
	15	0.09	39	46	20	0.18	37	59	20	0.10	33	72	20	0.13	38	63
	25	0.08	39	54	30	0.16	34	74	30	0.15	34	76	30	0.12	38	60
	35	0.09	36	50	40	0.12	37	68	40	0.10	34	76	40	0.12	37	75
	45	0.09	35	43	50	0.15	37	68	50	0.20	32	81	50	0.13	36	66
	55	0.10	30	54	60	0.09	36	69	60	0.18	32	75	60	0.14	38	73
	65	0.14	30	50	70	0.10	33	74	70	0.16	33	81	70	0.12	37	81
	75	0.11	30	48	80	0.09	32	68	80	0.19	38	81	80	0.10	36	80
Mean		0.099	34.63	49.75		0.135	35.38	68.5		0.155	33.75	77.25		0.121	36.5	72.38
SD		0.029	4.07	3.96		0.040	2.07	4.66		0.038	1.91	3.37		0.013	2.00	8.42
Mean ± SD		0.185	22.42	37.88		0.256	29.18	54.52		0.268	28.02	67.14		0.159	30.5	47.13
Factory Grade		ISNR–20				ISNR–20				ISNR–20				ISNR–20		
Grade assigned based on statistical analysis		ISNR–50				ISNR–50				off				ISNR–20		
Confidence limits with 5% Probability of being outside the limits	lower	0.075	31.23	46.45		0.102	33.65	64.61		0.123	32.16	74.43		0.110	35.67	65.35
	upper	0.123	38.03	53.05		0.168	37.11	72.38		0.187	35.34	80.06		0.132	37.33	79.41
	Range	0.048	6.79	6.61		0.067	3.45	7.78		0.063	3.19	5.62		0.022	1.67	14.05