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EVALUATION OF COMMERCIAL YIELD PERFORMANCE OF *HEVEA* CLONES : AN ALTERNATIVE APPROACH

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An alternative approach to evaluate yield performance of *Hevea* clones was devised by developing a commercial yield performance index (CYPI) which incorporated certain yield characteristics and managerial factors which influence the relative profitability either directly or indirectly. The incorporated variables are extent of immature phase, share of field coagulum (FC) in yield, tapping intensity, yield per tree, number of trees tapped per unit area and the pattern of yield profile. The CYPI was worked out for 19 clones for the first 10 years of tapping and compared with mean yield indices (MYI). Except in three clones *viz.*, GT 1, PB 217 and PB 5/51 the relative positions in ranking according to MYI got shifted when ranked according to CYPI. Though RRII 105 obtained the highest MYI, the first rank with regard to CYPI was achieved by PB 260 by virtue of its relatively early tappability. The shifts in rankings were compared and the contributing factors were identified. The CYPI along with other characteristics such as susceptibility to diseases and tapping panel dryness, proneness to natural damage, timber yield, etc. may be considered in the comparative evaluation of clones.

Key words : Commercial yield, *Hevea*, Performance indices, Profitability, Yield characteristics.

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INTRODUCTION

Selection of planting material is a crucial farm management decision affecting profitability especially in perennial crops, as in *Hevea brasiliensis*, compared to annual crops, due to higher initial investment, longer gestation period and longer economic life span. Commercial yield performance of prominent *Hevea* clones has to be continuously evaluated to aid meaningful choice of cultivars. The yield performance of planting materials are monitored in major natural rubber producing countries on the basis of field-wise data collected from large estates. The Rubber Research Institute of India (RRII) has been undertaking such commercial yield evaluation since 1974. At present, there are 45 participating estates covering an area of nearly 28000 ha. The participating estates submit a monthly return in a specified form with field-wise information on year of planting and tapping, area and number of trees under tapping, tapping system followed, monthly yield with break-up of latex and field coagulum (FC) on a dry rubber basis, *etc.* Four reports have so far been published on yield performance of planting materials for different phases and its comparative evaluation (Krishnankutty *et al.*, 1982; Krishnankutty and Sreenivasan, 1984; Joseph and Haridasan, 1990; Joseph *et al.*, 1997).

Mean yield estimates for different phases have generally been used as the indicators of the commercial yield performance of different clones. In such estimates, certain yield characteristics and managerial factors which influence the relative profitability either directly or indirectly were not considered. These include the extent of immature phase, share of FC, yield per tree, tapping intensity, number of trees tapped per unit area and the pattern of yield profile. A planting material with a lower extent of immature phase, lower share of FC, higher yield per tree, lower tapping intensity and an early yielding profile should be preferred to others with comparable mean yield. The cumulative impact of these variables forms the basis to determine whether a low yielding planting material should be preferred to a high yielding clone. It has been reported that these factors vary widely among different clones (Joseph *et al.*, 1997; Ibrahim *et al.*, 1990). The mean values of yield and related variables for the first 10 years of tapping are presented in Table 1. There is wide variation among clones with regard to these variables. The extent of immature phase ranged from 5.7 years (PB 260) to 9.3 years (PB 5/63 and RRIM 628). While yield per tree per year ranged from 3.16 (RRIM 623) to 4.89 kg (PB 217), the share of FC ranged from 20.1 (PB 217) to 37.9 per cent (RRIM 628). The stand per ha and tapping intensity are

Table 1. **Mean values of yield and other variables during the first 10 years of tapping**

Clone	Extent of immature phase*	Yield per ha (kg)	Yield per tree (kg)	Share of FC (%)	Tappable stand per ha (No.)	Tapping intensity (%)	No. of fields under observation	Area (ha) under observation
Indian								
RRII 105	7.2	1703	4.71	23.5	361	70	22	123.30
Indonesian								
GT 1	7.8	1351	4.25	24.9	318	82	89	1666.02
LCB 1320	7.0	953	3.17	31.1	301	89	18	129.73
Malaysian								
Gl 1	7.3	1109	3.31	30.9	336	86	17	160.62
PB 217	7.5	1510	4.89	20.1	309	84	26	509.51
PB 235	6.9	1426	4.47	28.2	319	77	27	553.58
PB 252	8.0	1386	4.68	37.8	296	86	2	18.35
PB 260	5.7	1607	4.79	28.6	335	77	4	22.45
PB 28/59	8.0	1522	4.58	29.0	333	75	42	715.92
PB 5/139	8.7	1306	3.34	23.3	391	92	11	160.50
PB 5/51	8.3	1336	4.28	27.6	312	82	19	318.89
PB 5/63	9.3	1088	4.20	37.1	259	77	2	2.91
PB 6/9	7.3	1216	3.27	20.6	372	67	7	65.19
PB 86	8.8	1105	3.34	25.9	331	84	43	475.34
RRIM 600	8.4	1337	4.28	28.3	312	84	77	1138.38
RRIM 605	8.6	1144	3.59	30.0	319	84	23	314.45
RRIM 623	7.6	1106	3.16	30.4	320	85	27	362.83
RRIM 628	9.3	1093	3.84	37.9	285	70	7	107.68
RRIM 701	8.4	1186	3.95	35.6	300	85	4	35.58

Source : Joseph *et al.* (1997); * Estimated from the database on yield determined by an interaction of physiological and managerial factors. While stand per ha. varied from 259 (PB 5/63) to 391 (PB 5/139), tapping intensity extended from 67 (PB 6/9) to 92 per cent (PB 5/139) (Joseph *et al.*, 1997). In this context, a commercial yield performance index (CYPI) incorporating the influencing variables has been developed so as to facilitate a more comprehensive and meaningful comparison among different clones.

METHODOLOGY

The CYPI was constructed using the variables (Table 2) yield per ha., yield per tree, share of FC, tappable stand, tapping intensity (Joseph *et al.*, 1997) and the extent of immature phase (Table 1). It was assumed that the management of crop in terms of the volume and pattern of resource use was similar among the fields as all the fields under observation belonged to large estates with professional management and were located in the traditional rubber growing region.

The yield estimates with differences in the extent of immature phase are not comparable. Duration of immature phase has two economic dimensions *viz.*, advancing or prolonging of economic life and the consequential effect of a decrease or increase in the development cost. Therefore, the year-

Table 2. **Variables used in the construction of CYPI**

Variable	Description	Unit
ADC	Apportioned development cost	Rs/ha
AIP	Actual immature phase	No. of years
APMC	Average processing and marketing cost	Rs/kg
CYPI	Commercial yield performance index	Per cent
DC	Development cost	Rs/ha
EL	Economic life	No. of years
MDYM	Mean discounted yield in monetary terms	Rs/ha
MY	Mean yield	kg/ha
MYI	Mean yield index	Per cent
NIP	Normal immature phase	No. of years
NT	Number of tappings	No.
NTT	Number of trees tapped	No./ha
PMC	Processing and marketing cost	Rs/ha
PFC	Price of FC	Rs/kg
PMFC	Processing and marketing cost of FC	Rs/kg
PMSR	Processing and marketing cost of sheet rubber	Rs/kg
PSR	Price of sheet rubber	Rs/kg
TC	Tapping cost	Rs/year
TR	Tapping rate	Rs/task
TT	Tapping task	No. of trees per tapper
WAP	Weighted average price	Rs/kg
YFC	Yield in FC	kg/ha/year
YM	Yield in monetary terms	Rs/ha/year
YSR	Yield in sheet rubber	kg/ha/year
YT	Yield in total	kg/ha/year
t	Time	Year
r	Discount rate	Per cent
n	Term	No. of years

wise data were modified on the basis of an assumed value of normal immature phase (NIP) and the specific value of actual immature phase (AIP). In all the cases NIP + 1 year was considered as the first year of tapping, except in instances where AIP = NIP the data require modification. If AIP < NIP, the yield during NIP-AIP was added to the first year yield and the annual yield figures were pulled downward. If AIP > NIP, the yield during NIP-AIP was taken as zero and the yearly yield figures were pushed upward. If NIP-AIP was a fraction, the modifications were done proportionately.

The yield of rubber consists of dry rubber from latex, sheet rubber (YSR) and FC (YFC). The latter fetches a lower price compared to the former due to its inferior quality. The yield was converted into monetary terms, using the weighted average prices (WAP) of sheet rubber and FC with the respective relative shares as weights. A change in the assumed price without a change in the ratio between the prices of sheet rubber (PSR) and FC (PFC) will not affect the relative positions of clones in the final ranking according to CYPI.

$$WAP = PSR \times (YSR/YT) + PFC \times (YFC/YT)$$

$$YM_1 = YT \times WAP$$

The obtained YM_1 series are monetary expressions of the physical yield profile adjusted for the differences in the extent of immature phase. As the weighted average prices of sheet and FC are used for the conversion into monetary values, the revenue variations originating from the differences in the share of FC are also incorporated. The processing and marketing costs of sheet rubber (PMSR) and FC (PMFC) are deducted from YM_1 series as they vary according to the composition of yield and thus influence profitability, to obtain YM_2. The YM_2 series are thus YM_1 series net of processing and marketing costs.

$$APMC = PMSR \times (YSR/YT) + PMFC \times (YFC/YT)$$

$$PMC = YT \times APMC$$

$$YM_2 = YM_1 - PMC$$

The economic relevance of plant density and tapping intensity is the impact on annual exploitation costs. The annual exploitation costs worked out on the basis of number of tappings (NT), number of trees tapped per ha (NTT), tapping task (TT) and task rates (TR) were deducted from YM_2 to derive YM_3. The YM_3 series are YM_2 series net of exploitation costs.

$$TC = NT \times \{(NTT/TT) \times TR\}$$

$$YM_3 = YM_2 - TC$$

The tapping intensity may influence the economic life of the crop through bark consumption and future stand through the incidence of tapping panel dryness (TPD). But as the objective of the index was to make the available data for the specific period more comparable, these aspects were not accounted. Such factors will eventually be accounted as the yield evaluation is a continuing process. The positive feature of higher yield per tree manifests in lower exploitation cost per unit of output and higher gross yield per ha from a given stand. The differences in yield per tree among the clones are indirectly accounted since yield per ha and exploitation costs are included in the analysis.

A reduced immature phase also means lower development cost. The conventional cost estimation procedure for perennial crops considers development cost as fixed capital investment and includes its depreciation as "replanting fund" which is to be borne by the productive years of the plantation (GOI, 1960). Hence, a change in the immature phase affects the yearly contribution of the plantation towards replanting fund. The apportioned development cost (ADC) was deducted from YM_3 to obtain YM_4.

$$ADC = DC/EL$$

$$YM_4 = YM_3 - ADC$$

The income received and cost incurred in different time periods vary in their economic significance and hence the pattern of the yield profile is also important. An early yielding planting material is to be preferred to a late yielding one even if the commercial yield is the same. Hence the YM_4 estimates were discounted using an appropriate factor and the mean values were worked out. The resultant measure is termed as mean discounted yield in monetary terms (MDYM). The MDYM estimates are averages of the year-wise discounted returns adjusted at different stages for differences in the extent of immature phase, share of FC, yield per tree, tapping intensity, number of trees tapped per ha and the pattern of yield profile.

$$MDYM = \frac{1}{N} \sum_{t=1}^{n} YM_4 \times 1/(1+r)^t$$

The MDYM estimates, adjusted for the managerial factors and yield characteristics influencing profitability, indicate the commercial performance of the planting materials. As cost elements pertaining to crop upkeep and maintenance were not accounted, the MDYM estimates cannot be considered as net income estimates. But as all the cost and revenue related to exploitation and yield were accounted and as all other cost and revenue elements were assumed to be uniform, the levels and differences among MDYM estimates are comparable. To make comparison more lucid, the MDYM estimates were converted into indices termed as CYPI.

$$CYPI = (MDYM_i/MDYM_n) \times 100$$

where $MDYM_i$ = MDYM of the ith clone

$MDYM_n$ = MDYM of all the clones together

A CYPI estimate above 100 indicates that the commercial yield performance of the planting material is above the average performance of all the planting materials together and vice versa. The indices can also be used in the ranking of planting materials for yield performance. Along with the CYPI, the mean yield indices (MYI) were also estimated for a comparative analysis.

$$MYI = (MY_i / MY_n) \times 100$$

where MY_i = MY of the i^{th} clone

MY_n = MY of all the clones together

While MYI indicates the performance of the clones based on the yield only, the CYPI is a composite measure indicating the profitability of clones as influenced by yield and related characteristics. The commercial yield performance and mean yield indices for the first 10 years of tapping were worked out for 19 clones. The yield data during the 10 years (approximate life of the virgin bark) are more reliable compared to those of the renewed panels as these are free from abnormal factors such as stimulation and higher tapping intensities. The cost and price data used refer to the financial year of 1996-97 (Appendix 1). Since accurate data were not available, the NT under different tapping intensities were estimated under an assumption of 140 tapping days for 1/2S d/2.

RESULTS AND DISCUSSION

To assess the comparative performance, the 19 clones (for which data were available for the first ten years of tapping) were ranked on the basis of the commercial yield performance and mean yield indices (Table 3). Except in the cases of GT 1, PB 217 and P 5/51 the relative positions in the original ranking based on MYI have changed when ranked according to CYPI. Though RRII 105 recorded the highest mean yield, PB 260 ranked first with regard to CYPI by virtue of its notably lower extent of immature phase of 5.7 years compared to the 7.2 years of RRII 105 and the higher yield per tree at 4.79 kg (Table 1). RRII 105 was ranked second and the third ranked (MYI) clone PB 28/59 could only obtain the fifth position in the ranking according to CYPI mainly due to its longer immature phase (8 years) and higher share of FC (29%). Similarly, the fifth ranked (MYI) clone PB 235 achieved third rank according to CYPI due to shorter immature phase (6.9 years) though it recorded a comparatively higher share of FC (28.2%). PB 217 could retain its fourth position on account of its shorter immature phase (7.5 years), lower stand per ha (309) and share of FC (20.1%). PB 217 reported the highest yield per tree at 4.89 kg per tree among the 19 clones under evaluation during the 1-10 phase. While the seventh position of GT 1 was not changed, PB 252 and RRIM 600 have changed their sixth and eighth positions respectively mainly due to very high FC content (37.8%) and longer immature phase (8.4 years) respectively. Although PB 5/51 was in ninth position, PB 5/139 moved down mainly because of lower yield per tree (3.34 kg). The eleventh ranked (MYI) clone PB 6/9 changed to sixth rank with regard to CYPI as a result of shorter immature

Table 3. **Commercial yield performance and mean yield indices**

Clone	MYI	Rank	CYPI	Rank
Indian				
RRII 105	128	1	167	2
Indonesian				
GT 1	101	7	96	7
LCB 1320	71	19	75	14
Malaysian				
GI 1	83	14	84	11
PB 217	113	4	136	4
PB 235	107	5	148	3
PB 252	104	6	96	8
PB 260	121	2	203	1
PB 28/59	114	3	121	5
PB 5/139	98	10	83	12
PB 5/51	100	9	93	9
PB 6/63	82	18	57	17
PB 6/9	91	11	113	6
PB 86	83	16	55	18
RRIM 600	100	8	89	10
RRIM 605	86	13	70	16
RRIM 623	83	15	81	13
RRIM 628	82	17	52	19
RRIM 701	89	12	71	15

phase (7.3 years), lower FC content (20.6%) and tapping intensity (67%). The clones RRIM 701 and RRIM 605 were abased mainly due to longer immature phase (8.4 and 8.6 years respectively) while the position of Gl 1 improved on account of shorter immature phase (7.3 years). The higher yield per tree (3.95 kg) of RRIM 701 has been nullified by the longer immature phase and higher share of FC (35.6%). Of the remaining clones PB 86 recorded a downward shift in its position due to longer immature phase (8.8 years) whereas, the clones RRIM 623 and LCB 1320 have improved the relative positions on account of shorter immature phase (7.6 and 7.0 years respectively). The marginal improvement occurred in the case of PB 5/63 was due to its relatively higher yield per tree (4.2 kg) compared to clones of similar status. The lowest position with regard to CYPI was recorded by RRIM 628 on account of its notably higher share of FC (37.9%) and longer immature phase (9.3 years).

CONCLUSION

The results of the analysis suggest that CYPI could be a more reliable indicator of the economic performance of *Hevea* planting materials compared to the conventional approach of depending on yield averages alone. However, the dominance of yield above all the variables considered is evident from the fact that the top five ranking clones of MYI are same as that of CYPI. The CYPI along with other characteristics such as susceptibility to diseases and tapping panel dryness, proneness to natural damage, potential timber yield, *etc.* may be considered in the comparative evaluation of the clones and choice of planting materials.

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Appendix 1. **Assumptions used for the exercise**

NIP	=	7 years
EL	=	18 years
DC	=	Rs. 62000/ha with Rs. 5100 in the terminal year
PMSR	=	Rs. 4/kg
PMFC	=	Rs. 0.50/kg
PSR	=	Rs. 49/kg
PFC	=	Rs. 32/kg
TR	=	Rs. 90
TT	=	300 trees/tapper
r	=	13 per cent
NT	=	140* AI (AI is the tapping intensity in percentage and 140 tapping days are assumed for 1/2 S d/2)