

# Grading of Indigenously Recovered Paper (RCP) - Key to Effective Collection and Utilisation

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## ABSTRACT

*Increased use of recovered paper can ensure the sustained supply of raw materials to a large extent provided an organised sector is evolved for supply of recovered paper. Presently in India, in absence of an organised collection and grading system, there is no substantial recycling of RCP, as whatever RCP is collected is in mixed form, the out throws and prohibitive percentage is high due to presence of contaminants and contraries in the recovered stock. In view of this it is felt that there is an urgent need to evolve an indigenous gradation system, and to formulate a mechanism for an effective system of RCP collection and distribution in India, so that consistent quality of RCP grades could be made available to the mills for subsequent utilisation in various end uses in an effective manner. In a project study, CPPRI has made an attempt to bring out a preliminary gradation system for indigenously recovered paper based on their fibre quality and fibre furnish. The paper highlights the approach and findings of this study in formulating a guideline for the proposed gradation of indigenous RCP.*

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## INTRODUCTION

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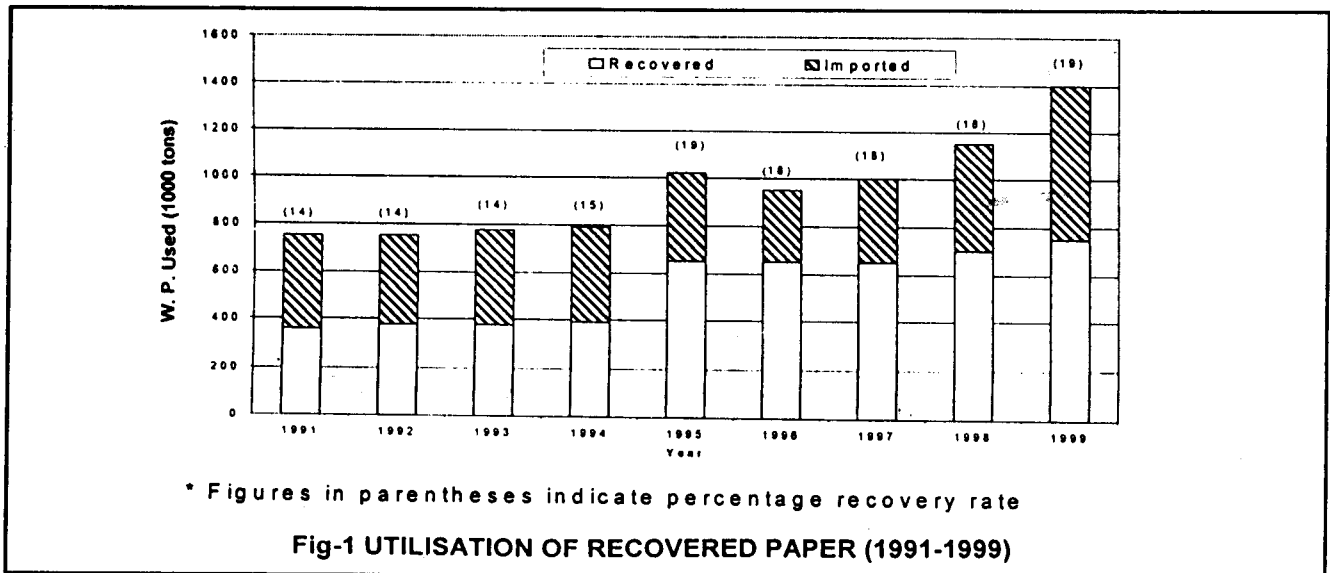
Use of recovered paper has become an important element in the pulp and paper business worldwide. It has been identified as one of the survival routes against dwindling forest resources and a greater concern amongst the people for greener environment. Recycling has economic benefits also as it extends to provide the paper products without an equivalent increase in the demand of wood. The economic effect of recycling is to keep paper prices down, since without recycling the increased demand for wood results in higher prices. In India the recovered paper is being used by all segments of the paper industry as an alternate source to meet the growing demand of fibrous raw materials. A steady growth has been made over the years reaching a target of 40% utilisation rate by 2000. However this target has been achieved with more than 50% of import substitutes as no appreciable rise in recovery rate is witnessed in the last two decades. The present recovery rate stands at 20% against the world average of 35%.

The Indian paper industry started using RCP as a fibrous raw material for paper making in early 70's only, when the Govt. took a conscious decision to increase the domestic capacity to compensate the sudden spurt in domestic demand. With the Government encouragement a number of small paper mills based on recycled fibre and other non-conventional raw material were installed.

In the formative years, this segment of the industry was not very much organised and the capacity of the mills ranged from 4t/d-30t/d mainly producing low grades of paper. Only after 1990's the actual growth of this segment could be observed. Fig. 1 shows the statistics for RCP recovery, utilisation and imports trends in India during 1991-1999. It clearly indicates that during the last decade though the RCP consumption has gradually increased from 0.749 million tons in 1991 to 1.5 million tons in 1999, there has been a very marginal increase in RCP recovery i.e. from 0.355 million tons in 1991 to 0.750 million tons in 1999, which has led to increased imports of RCP to meet the shortfall in domestic demand of paper.

Despite the fact that a major segment of the industry is utilising the recovered paper for papermaking, the industry is facing serious problems in processing of imported and indigenous recovered paper primarily due to poor quality of indigenous RCP and presence of contaminants in imported RCP.

There are number of factors which attribute to poor and inconsistent quality of indigenously recovered paper. Besides the fibre quality which is mainly governed by the virgin fibre quality, the other major factor is improper and unorganised collection and distribution system prevailing in the country. Due to lack of an Indian grading system, at source grading/sorting is not practiced, as a result most of the paper is recovered in mixed form and not in grades. This results in high percentage of prohibitive material and



out throws which adversely effect the quality of recovered paper stock.

On the contrary, every country which are the major players in paper recycling business have RCP grading system in place which facilitates the collection of recovered paper sorted in grades with a limited mixture of fibre types. In these countries, various collection systems are in practice to recover RCP in grades. To adopt these systems in India, we definitely need a gradation framework for different available RCP varieties. CPPRI has made an attempt in this direction in one of its project study. In this study a number of RCP samples including indigenous and imported were collected from various mills situated in different parts of the country. These samples were evaluated at CPPRI for fibre quality characterisation and fibre furnish based on which various indigenously available recovered paper (RCP) has been classified/graded. The paper highlights the efforts made by CPPRI in bringing out the first indigenous gradation system for efficient collection of domestic recovered paper. The paper does not cover quality characterisation of imported grades of paper being used by Indian mills.

## RESULTS AND DISCUSSION

### Quality Characterisation of Indigenous RCP Samples

#### Collection of RCP Samples

Table 1. summarises the different varieties of RCP samples collected for this study. The collected samples were first evaluated for moisture content and ash content in paper and then subjected to slushing to make pulp for further evaluation. The moisture content remained more or less

Table - 1 Indigenous RCP grades in use by Indian Paper Industry

Per Consumer	Post Consumer
Duplex cutting	Text books
No. II cuttings (mechanical)	Old directories
Colored cuttings	Note books
No. I cuttings	Old newsprint
New double lined kraft	White records/ office records
corrugated cuttings. (NCC)	
Hard white shavings	Colored records
Over issue newsprint	Road sweeping
Kraft multiwall bag waste	Magazines
Lottery tickets	Mixed RCP
Mixed kraft cuttings	Old corrugated boxes
Sack kraft waste/ cuttings	
Currency cuttings	

consistent with the values ranging between 6-7%.

### Evaluation of pulp

For pulp evaluation the paper samples were slushed in a laboratory disintegrator at 3000 rpm for 15000 & 20000 revolutions, at 40°C and subsequently subjected to screening using laboratory Somerville screen at 0.20 mm slot opening. Table 2 depict the results of ash in paper, recycled yield and CSF values for different grades of indigenous RCP. Majority of these varieties are characterised by high ash content, ranging from 8 - 22% which has its direct bearing on the actual fibre yield. The actual fibre yield obtained in lab scale trials may further go down during various cleaning stages. The CSF values obtained are also lower in majority of cases limiting the scope of refining for further strength development.

Table 2 Evaluation of indigenous varieties of RCP

Name of the sample	Ash in paper (%)	Theoretical yield (100-Ash)	Actual fibre yield (%) Ash Corrected	Screen Rejects	CSF (ml)
Text Books	9.4 - 13.4	83.7 - 90.6	64.5 - 87.9	0.1 - 9.4	385 - 510
Old Directories	0.6 - 3.3	96.6 - 99.8	89.4 - 93.5	0.1 - 0.7	410 - 500
Note Books	9.5 - 16.9	83.1 - 90.5	78.4 - 83.3	0.1 - 0.4	420 - 510
Duplex Cuttings	8.1 - 14.2	85.8 - 86.0	75.7 - 79.4	1.7 - 3.0	340 - 350
Old Newsprint	2.7 - 7.1	92.9 - 97.3	85.2 - 94.1	Nil - 0.3	205 - 370
No. II Cuttings (Mechanical, Newsprint edge cuttings)	2.3 - 7.8	92.1 - 97.9	89.8 - 95.2	0.1 -	310 - 355
White records/ office records	12.3 - 14.8	85.8 - 87.7	79.1 - 80.6	0.3 - 0.4	480 - 485
Colored cutting/ colored records	11.4	88.6	80.9	4.34	360
Road Sweeping	17.5	82.5	64.3	8.9	450
No. I Cutting	8.5 - 18.9	81.1 - 91.5	74.4 - 85.5	0.1 - 0.7	400 - 480
Magazines	17.5 - 25.7	74.3 - 82.5	60.4 - 66.7	0.6 - 7.9	400 - 415
Mixed RCP	16.1	83.9	72.7	3.2	550
NDLKC/ NCC	6.8	93.2	84.5	1.3	465
Hard White Shaving	14.6 - 22.1	77.9 - 85.4	76.4 - 82.9	0.4 - 0.7	345 - 485
Currency cuttings	2.8	97.1	88.5	-	200

### Fibre furnish composition

Table 3 depicts the fibre furnish composition of indigenous varieties of RCP. The furnish composition is indicative of the fibre type present in different grades of RCP. The furnish composition depicted for indigenous varieties indicates that except duplex cuttings, NCC/NDLKC, ONP and No. I (mechanical cuttings), the chemical pulp furnish is the predominant one.

As regards the type of fibre, almost all the varieties contain a mixture of hardwood, bamboo and bagasse as a predominant fibre type barring two or three varieties, the softwood content is relatively low or absent. The reasons for higher softwood content in some of the varieties may be attributed to the fact that some of the mills are using both imported pulp and imported RCP (high quality) in their product furnish.

### Bauer mcnett classification

All pulp samples obtained were subjected to Bauer Mcnett classification to estimate the quantity of papermaking fibres and the amount of primary fines generated which is otherwise termed as 'debris' or dead fines. The percentage of paper making fibre ranged from as low as 52% to as high as 89% with majority of varieties having higher primary fines content. The results are depicted in Table 4.

### CED viscosity and wt. average fibre length

The results of CED viscosity and average fibre length are summarised in Table 5. The recycled fibres are characterised

by short fibre length. The weighted average fibre length value ranges between 0.7 mm to 1.2 mm. The initial intrinsic viscosity of pulps obtained after slushing ranged from as low as 145 to 360 cm<sup>3</sup>/gm for bleached grades of paper of indigenous varieties showing the poor quality of pulp.

The results given in Table 6 give a comparative data of different virgin raw materials used by Indian paper mills and the recycled fibre with respect to intrinsic viscosity and average fibre length. One of the reasons reported for low DP of recycled fibre is attributed to cellulose chain cleavage due to paper acidity, which may be present in papers because of the processes or chemicals used in their manufacture. In India, acid sizing of the paper is predominant and this could be one of the factors enhancing the hydrolysis of cellulose. Acid penetrates the open amorphous regions of the fibre and cuts the carbon-oxygen glycosidic bonds that link the glucose units in the cellulose chain. Oxidation of cellulose unit may break down carbon-hydrogen bonds as well as carbon oxygen bonds. These reactions simultaneously liberate the portion of the fibre plasticised by humidity, lower the overall degree of polymerisation and make the fibre more fragile and more susceptible to breakage.

### Optical characteristics

Table 7 summarises the average brightness & yellowness (% ISO) of each variety of white grades of RCP.

Generally, the initial brightness of the substrate paper

Table - 4 Bauer Mcnett classification of pulp samples from indigenously recovered paper

Name of the sample	CSF (ml)	% Retention			
		+ 30%	+ 50%	+ 100%	- 100%
Text book	385 - 510	28.5 - 42.5	11.7 - 26.0	20.0 - 31.4	11.0 - 31.6
Old directories	410 - 500	44.8 - 52.5	12.8 - 13.5	12.0 - 20.0	21.7 - 22.7
Note books	500 - 555	20.0 - 34.4	2.8 - 18.0	22.1 - 44.5	25.5 - 34.2
Duplex cutting	340 - 735	16.0 - 80.0	2.6 - 18.0	2.1 - 26.8	14.8 - 45.0
Old newsprint	205 - 370	30.2 - 42.0	7.7 - 16.4	15.0 - 31.5	25.3 - 39.5
No. II cuttings	310 - 355	30.7 - 46.0	4.2 - 18.6	14.3 - 46.5	18.6 - 21.1
White records/ Office records	480 - 485	34.1 - 36.4	1.6 - 25.9	8.0 - 30.9	29.7 - 33.4
Colored cuttings/ Colored records	360	29.9	7.7	33.6	28.8
No. I cuttings	355 - 480	12.7 - 20.0	3.0 - 6.4	31.8 - 44.5	31.3 - 48.7
Road sweeping	450	33.5	21.4	27.8	17.3
Magazines	400 - 415	33.9 - 35.0	3.5 - 6.0	26.5 - 32.5	30.1 - 32.4
Mixed RCP	550	29.1	7.6	28.9	34.4
NDLKC/ NCC	465	34.5	6.8	28.7	30.0
Hard white shaving	435 - 485	23.5 - 37.2	9.5 - 21.5	13.4 - 19.5	36.9 - 46.5
Currency cutting	200	44.0	7.8	14.7	33.5

Table 5 Quality characterisation of indigenous RCP (CED viscosity, Wt. AVG. fibre length, Percent fines)

Name of the samples	Intrinsic viscosity (cm <sup>3</sup> /g)	Wt. AVG. Fibre length (mm)	Primary fines % (-100 fraction)
Text books	157 - 337	0.9 - 1.2	12 - 31.6
Old directories	145 - 240	1.1 - 1.2	22.7 - 33.8
Note books	250 - 370	0.7 - 1.0	25.5 - 34.2
Duplex cutting	321 - 493	0.7 - 1.5	14.8 - 45.0
Old newsprint	199 - 365	0.8 - 1.1	25.3 - 39.5
No. II cuttings (mechanical, newsprint edge cuttings)	228 - 307	1.0 - 1.2	18.6 - 21.1
White records/ office records	341 - 363	0.9 - 1.0	29.7 - 33.4
Colored cuttings /colored records	289	0.9	28.8
No. I cuttings	367	0.6 - 0.7	31.3 - 48.7
Road sweeping	306	1.06	17.3
Magazines	319	0.91	30.1 - 32.4
Mixed RCP	482	0.83	34.4
NDLKC/NCC	483	0.92	30.0
Hard white cuttings	336	0.68 - 1.03	36.9 - 46.5
Currency cutting	-	1.0	33.5

directly influences the brightness after deinking. However the ageing of the ink film and the type of ink can sometimes invalidate this correlation. It is experienced that the deinkability of conventionally printed products depends on the type of the ink applied on the paper substrate, the paper itself (coated or uncoated) and the age of the printed product at the time of deinking.

The results given in Table 7 show that some varieties e.g. Note books, White records, No. I cuttings, Hard white cuttings and Currency cuttings have relatively higher brightness and low yellowness and are speck free compared to other which indicates that these varieties can be utilised in better grades of paper and can be used directly. Comparing the optical characteristics of indigenous and

Table 6 Quality of virgin fibre VIS-A-VIS Recycled fibre (RCF)

Fibre	Av. Fibre length (mm)	CED Viscosity for Bld. pulp (cm <sup>3</sup> /g)
Rice straw	1.1	400 - 700
Wheat straw	1.3	600 - 800
Bagasse	1.75	600 - 850
Bamboo	2.1	300 - 700
Hard wood	0.9	300 - 600
RCF (Indigenous)	0.9	140 - 350
RCF (Imported)	1.0	250 - 550

Table 7 Optical characteristics of white grade indigenous varieties of RCP

Name of the sample	Brightness %	Yellowness %	Visible Specks
Text books	42.8 - 56.6	14.0 - 25.9	Med.-High
Old directories	42.0 - 43.3	15.5 - 16.5	High
Note books	53.2 - 63.2	1.2 - 7.3	Speck free
Duplex cutting	46.4 - 46.6	14.5 - 14.9	-
Old newsprint	39.2 - 40.0	13.7 - 16.0	Low -Med.
No. II cuttings (mechanical, newsprint edge cuttings)	45.9 - 52.2	15.8 - 21.6	Speck free-low
Whiterrecords/ office records	60.2 - 66.9	4.6 - 12.3	Low
Colored cuttings/ colored records	37.0	21.4	Medium
No. I cuttings	68.8 - 80.6	0.6 - 6.4	Speck free
Road sweeping	34.5	26.4	High
Magazines	48.0 - 55.0	8.6 - 13.8	Medium to high
Mixed RCP	34.2	43.0	Medium
Hard white cuttings	62.7	7.6	Speck free
Currency cutting	66.6	12.3	Very low

imported varieties, the ageing effect is more pronounced in indigenous varieties, which may be attributed to storage conditions or the improper bleaching conditions maintained during pulping of virgin fibres, which have caused the yellowing on ageing.

### Grading/classification of indigenously recovered paper

Based on extensive literature review carried out on gradation system, prevailing in industrialized countries and the studies conducted at CPPRI, an attempt was made

to grade the indigenously recovered paper in different groups based on their fibre quality and fibre furnish. Looking into the trend and gradation system available in industrialised countries and the type/quality of RCP available in India for recycling, it is felt that the combination of UK system and Japanese system would be more appropriate to adopt under Indian conditions. These two systems broadly categorise the different groups on the basis of fibre quality/furnish type, which is easy to define and hence more applicable under Indian conditions.

While arriving at new grading system the limitations for moisture content, out throws and prohibitive materials have also been taken into account. The details of these were obtained through discussion and mill visits. Grade specifications are based on the physical appearance of the RCP variety as received from mills.

### Primary classification

In primary classification the grades were classified into :

- White / brown / mixed grades

Table 8 Basis for primary classification

Name of the sample	Type of grade	Print density
Text book	White	Medium
Old directories	White	Heavy
Note books	White	Very light
Duplex cutting	White	Light
Old newsprint/over issue	White	Heavy
No II cuttings	White	Unprinted
White records/ office records	White	Mix of heavy & unprinted
Colored cuttings /colored records	Mixed	Heavy
Road sweeping	Mixed	Heavy
No. I cuttings	White	Unprinted
Old Magazines/over issues	White	Heavy
Mixed RCP	Mix	Heavy
NDLKC	Brown	Light
Hard white shavings	White	Unprinted
Old corrugated box	Brown	Medium
Kraft multi wall bag waste	Brown	Light
Lottery tickets	Mix	High
Mixed craft cuttings	Brown	Light
Sack kraft waste/cutting	Brown (wet strength)	-
Currency cuttings	White (wet strength)	Light

Table 9 Basis for secondary classification

Name of the variety	Fibre furnish C:M	Brightness % ISO	Yellowness %	Visula Specks	Initial freeness CSF, ml	Ash % %
Text book	8:2	42-56	10-25	High	380-510	9-13
Old directories	9:1	42-43	15-16	High	400-500	0.6-3
Note books	10:0	53-67	1-3	Speck free	400-500	9-16
Duplex cuttings	6:4	45-46	14.0	NA	350	8-14
Old newsprint	6:4	39-30	13-16	Medium - low	200-350	2-7
No.II cuttings	8:2	45-52	15-21	Very low	300-350	2-7
White /office records	10:0	60-67	4-12	Low	480	12-14
Colored records/cuttings	10:0	37.0	21.0	Medium	360	11.4
Road sweeping	9:1	34.0	26.4	High	450	12.5
No. I cuttings	10:0	68-80	0.6-6	Speck free	400-450	8-16
Magazines	9:1	48-55	8-13	High	400	17-25
Mixed RCP	9:1	34.0	43.0	Medium	550	16
Hard white shavings	10:0	62.0	7.6	Speck free	300-450	14-22

Table 10 Classification of Indian Standard varieties of RCP

Stactical	Grades	Contents
Group-I White woodfree Unprinted	No. I cuttings	Printers cuttings from high quality white printing paper uncoated or coated but without any printing. (Contains ruled or unruled cuttings)
	Hard white shavings	Shavings or sheets of untreated high grade, high brightness bond ledger papers. Free from printing and ground wood.
Group -II White woodfree printed	Note books	School notebooks, bleached variety with less ink. Sometimes slight yellowing observed.
	White records/ office records	Mixed RCP as collected from office refuse. Contains mixed office records including various grades of writing, printing, xerox, typing paper, CPO, envelops with some staple/pins/ cellophane and carbon paper (contains both heavily printed and unprinted matter).
Group -III White & lightly printed mechanical	No-II cutting	Printer cuttings from average quality printing papers made of recycled or high yield pulps, unwanted or coated but without printing.
	White duplex cuttings	New cuttings of uncoated/coated duplex boards with very little printing/lamination received from folding box board cartons converters.
Group-IV	Colored woodfree Colored cuttings / colored records	Colored cuttings received from printers of books, magazines, posters or advertisements. Contains newspapers, lottery tickets, text books, brown boards etc.
	Text book	Old text books without plastic laminated or straw board covers, contains bleached printed sheets, yellowness observed due to ageing.
Group-V Heavily printed mechanical	Old directory	Clean telephone directories bleached & heavily printed. Severe yellowness observed due to ageing. Includes both old as well as over issues from publisher house.
	Old newspaper/ over issues	Old newspapers collected from consumer or from newspaper vendors. Newspaper, printed but unused as available from newsprint presses or agencies.
	Old magazines/ over issues	Old or over issue magazines printed on good quality printing paper from chemical or recycled pulp, uncoated or coated paper.
Group-VI Brown Kraft	kraft multiwall bag waste	New kraft multi wall bag waste and sheets with little printing but without staples or stitching.
	Mixed kraft cuttings	Cuttings of kraft paper received from converters with very little printing and no staples/pins or cellophane.
	New double lined kraft corrugated	Corrugated cuttings received from industrial packaging, corrugated box manufacturers with very little printing & staples/paste/cellophane.

Conted.....

Group-VII Old corrugated containers	Old corrugated boxes	Mixture of corrugated box with kraft/white top liner /printed/ unprinted. Stapled/pasted/spliced with cellophane, having one or few piles of corrugation.
Group-VIII Mixed papers	Mixed RCP	Mixture of all varieties of paper including white or colored paper, bleached & unbleached, coated & uncoated, printed & unprinted, with & without mechanical pulp papers not limited to fibre content/quality and contaminants from converting units.
	Road sweepings	Mixture of various grades of RCP as received from municipal dustbin not limited to fibre content or quality.
	Lottery tickets	Printed lottery tickets, unused over used received from agencies/vendors.
Group-IX Contaminated grades	Sack Kraft waste/ cuttings	Cuttings from the converters making industrial sack Kraft, having high stretch, wet strength and burst made from chemical Kraft pulp.
	Currency cuttings	Printers trimmings of currency paper

Table 11 Utilisation of RCP grades for various end uses

Stastical group	RCP grades	Utilisation
Group - I	No. I cuttings, Hard white shavings	Writing/ printing paper along with pulp substitutes For standard newsprint (high brightness) Top layer for liner boards
Group - II	Note books, white records/office records	do-
Group - III	No. II cutting, white duplex cuttings	Ordinary newsprint for improved brightness
Group - IV	Colored cuttings/ records	As fillers in Liner boards
Group - V	ONP/ over issues, OMG/ over issues Text Books Old Directory	Ordinary Newsprint Low quality printing As a filler for Liner board
Group - VI	Kraft multiwall bag waste, mixed kraft cuttings, new double lined kraft corrugated	All varieties of packaging
Group - VII	Old corrugated boxes,	Superior kraft
Group - VIII	Mixed RCP, Road sweepings, Lottery tickets	As fillers in Liner boards
Group - IX	Sack Kraft waste/ cuttings Currency cuttings	Superior kraft For writing / printing papers

- Heavily printed, light printed and unprinted grades

The details of each variety are summarised in Table 8.

### Secondary classification

Secondary classification was made based on fibre quality characterisation, which included :

- Fibre furnish composition to differentiate between wood containing and wood free grades.
- Brightness and Yellowness to segregate between high quality and low quality grades.
- Visual speck count for qualitative quantification of ink particle density.
- Presence of contaminants

The details of each variety are summarised in Table 9.

Based on the findings and reviewing the trends adopted in industrialised countries, CPPRI has made an attempt to classify all the standard qualities of indigenously available grades and accordingly following grading system has been proposed. In this system all the twenty one (21) varieties of indigenous paper have been classified into nine (09) groups, which are summarised in Table 10.

### Utilisation of indogenous RCP as per classification

Based on the grading system, the utilisation pattern of different groups for producing various end products have been proposed and summarised in Table 11.

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## CONCLUSION

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The use of recycled fibre in paper and board production can be considered as the mainstay of raw material sourcing provided an efficient collection system is adopted to collect RCP varieties in grade. To establish an efficient collection system in India on par with countries like Germany, China, USA, Japan etc., it is imperative that the available RCP is segregated at source before collection and which requires classification/ grading of different varieties, based on their type and quality. In view of this, CPPRI has made an attempt to classify/grade all the standard varieties of RCP available indigenously by adopting a scientific approach, which have categorised the different varieties, based on its sources, quality and fibre furnish. This proposed classification/grading system is a preliminary attempt, which needs to be discussed and appropriately modified to benefit the large number of pulp and paper mills based on recycled fibres as well as provide guidelines for suppliers so that there is a

high value realisation from this important source. To improve the efficiency of existing collection there is an urgent need that the proposed grading system (duly amended, if required) may be implemented immediately and mill owners should demand the suppliers to supply RCP "in grades".

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