

## SUBABUL—A Ray of Hope for Paper Industry

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Paper Industry in India is facing a grave crisis of raw material. The traditional raw materials like Bamboo, Sabai grass and hardwoods are becoming rarer as their demand is shooting and regeneration has failed to keep pace with demand. With growth in population load on forest resources is increasing manifold. Requirement of land for residential purposes as well as for agriculture, fodder, fuel, etc., all have made the situation more critical. This has resulted not only in environmental pollution but has caused ecological imbalances of such a high order that the social scientists are continuously searching for suitable techniques to check and rehabilitate the forest wealth of India. It is now well established that the paper industry cannot bank upon imported fibre or agricultural residue for long. The Industry has to find ways and means to grow forest not only in the so-called forest land but also in the waste land available in and around the residential areas. National Newsprint & Paper Mills Limited, the pioneer newsprint manufacturers and the first to adopt new high yield pulping technology in the country have tried various species which can be cultivated in arid and semiarid region and grow rapidly and are happy to find "Subabul" as a ray of hope for the Paper Industry. We are confident that this species will be a perennial source of raw material for paper industry as it will be acceptable to farmers and social scientists together. The leaves provide fodder to the cattle and help white revolution. The roots being leguminous help in increasing soil fertility and thus help in green revolution. The wood provides timber and the lops and tops give fuel bringing in new life at the doors of those living below the poverty level. The water requirement of this 'miracle' plant is only 2 litres per four weeks per plant and thus it can be conveniently taken up in social forestry programme in almost all areas of the country. A brief description of various experiments conducted in Nepamills and the relevant information gathered by them has been presented in brief in this paper. We hope that the experts will add

new ideas and device newer methods for adopting this species in farm and forest together.

Nepamills Forest Department started plantation activities in 1980. The following species have been tried so far. Gulmohar (*Delonix Regia*), Kachnar, Jecaranda Silver Oak (*Grovia Robusta*) Neem, Sisham (*Delbergiasisoo*), Bud, Procopis, Spicigra, (Australian Babul (*Acacia Auriculiformis*), Subabul (*Leucaena Leucocephala*), Casia Siamea, Melia Agadirachta, Safed Siras, Albezia Procera and Agave Sisilana.

Out of the above mentioned 17 species, following eleven species have shown good response. The growth data of the same with fresh water irrigation once a week are detailed in annexure-I below :—

ANNEXURE-1			
S.No.	SPECIES	HEIGHT IN (Metres)	GIRTH IN (Cms)
1.	<i>Eucalyptus Camaldulensis</i>	3.9	10.0
2.	<i>Leucaena Leucocephala</i> (Subabul)	6.2	14.0
3.	<i>Albizia Procera</i> (Safed Siras)	2.4	6.0
4.	<i>Delonix Regia</i> (Gulmohar)	2.2	5.0
5.	<i>Peltaforum Ferrugineum</i>	2.23	5.0
6.	<i>Erithrina Species</i>	2.76	6.0
7.	<i>Acacia auriculiformis</i>	1.62	5.0
8.	<i>Pongamia Glabra</i> (Karani)	2.08	7.0
9.	Jacaranda	1.85	6.0
10.	<i>Azadirachta Indica</i>	2.05	6.0
11.	<i>Grevilea Robusta</i> (Silver Oak)	2.00	7.0

Species *Leucaena Loucocephala* (Subabul) attained maximum height and girth.

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Laboratory scale pulping trials of the following species have been carried out at our Mills Central Laboratory. The strength properties of respective pulp by Cold Soda and Groundwood processes can be seen in annexure 2 and 3 below :—

#### MECHANICAL PULP (Annexure 2)

S.No. Species	Strength Properties			
	CSF	BF	TF	BL
1. Eucalyptus (Nepanagar)	122	1.69	5.28	176
2. Eucalyptus Grindis (Mysore)	260	2.6	—	500
3. Acacia Auriculiformis (M P.)	110	0.6	4.7	880
4. Salai	110	3.1	15.6	660
5. Subabul (Leucaena Leucocephala)	180	4.06	19.6	1125

It is observed that Subabul mechanical pulp strength properties are the highest compared to others.

#### ANNEXURE-3 Strength properties of Cold Soda Pulp

S.No. Species	Strength Properties			
	CSF	BF	TF	BL
1. Leucaena Leucocephala (Subabul) (Urlikanchan)	200	20	52.54	4000
2. Acacia Auriculiformis	336	8.06	28.3	2037
3. Casia Siamea	226	7.15	36.0	1710
4. Eucalyptus Rostrata (Chimnapur) Nepa.	222	8.58	26.6	2980
5. Casia	216	18.6	30.8	3950
6. Salai	250	8.0	20.0	2000

It is observed that Subabul Cold Soda Pulp strength properties are highest compared to others.

Bharatiya Agro Industries Foundation, Urlikanchan, Pune have done lot of work on Subabul plantation and have collected data to provide package of practices to exploit the full potentiality of this 'Miracle' plant under different environmental conditions.

Subabul attains 4-6 Metres height in one year, 8-10 Metres in about three years. Harvesting can be done at an interval of 3-4 years and 8-10 rotations of crop can be taken. It can grow without irrigation even

in the low rainfall areas. Little irrigation can give substantial dividend in terms of growth. It establishes well on shallow soils, rocky slopes and on high pH soils. It fixes atmospheric Nitrogen and increases soil fertility.

Initial chemical analysis of Subabul was done. Comparative data for Subabul Bamboo and Salai are given in Annexure 4 below :—

#### ANNEXURE-4 STATEMENT OF CHEMICAL ANALYSIS

S.No. Particulars		SUBABUL	BAMBOO	SALAI
(4 years)				
1. Hot Water Solubility	%	2.66	5.93	14.23
2. Alcohol benzene Solubility	%	1.88	2.31	3.91
3. 1% NaOH Solubility	%	15.24	24.0	24.4
4. Lignin content	%	24.30	28.0	25.7
5. Pentosans	%	17.00	19.26	19.29
6. Holo Cellulose	%	70.20	65.90	50.70
7. Alpha Cellulose	%	41.98	—	—
8. Fibre length	mm	1.16mm	1.65	0.88
9. L & D ratio		55	137	37

The wood is high in holocellulose and low in lignin, alcohol benzene solubles and hot water solubles—all important benefits in pulp manufacture.

Percentage of 1.0% NaOH solubles and lignin are found to be low which is a good sign. This helps as far as bleachability is concerned, as we all know more alkali solubles and lignin means more bleaching hazard.

For improving the quality and shade of Newsprint, Nepamills has always been on a look out for suitable species of pulpwood which are fast growing, offering high yield with Cold Soda Process (a high yield pulping process available with the Mills) and reasonably good shade of pulp.

Subabul is a choice species due to its various properties illustrated in Annexure 2 & 3 above.

Looking to fast growth and initial laboratory trials extensive trials were carried out in July, August 1984. Wood from the trees of different ages was used for pulping through Cold Soda and Groundwood proce-

sses. Chemical composition was also studied. Different date for chemical composition of Subabul wood and strength properties of Cold Soda pulp produced have been given in the annexure 5 & 6 respectively.

**ANNEXURE-5**  
**CHEMICAL COMPOSITION OF DIFFERENT**  
**AGE WOOD**

S. No.	Particulars	Age (Years)			
		3	4	5	6
1.	Density	0.51	0.54	0.58	0.60
2.	Hot Water solubility %	2.10	2.35	3.00	3.18
3.	1% NaOH „ „ %	13.71	14.12	16.21	16.92
4.	Alcohol Benzene „ „ %	1.80	1.78	1.84	2.11
5.	Lignin %	22.37	23.14	25.64	25.96
6.	Hollo Cellulose %	73.41	72.56	69.66	68.92

This indicates that hard-wood percentage increases with the ages and Cellulose percentage goes down.

**ANNEXURE-6**  
**COLD SODA PULP PROPERTIES**

S. No.	Particulars	Age (Years)			
		3	4	5	6
1.	Freeness CSF	200	200	200	200
2.	Burst Factor	24.5	23.0	20.75	18.75
3.	Tear Factor	52.0	51.7	50.7	50.1
4.	Breaking length	4950	4850	4050	3810
5.	Unbleached Pulp Brightness.	37.5	37.5	37.5	37.5

Cooking liquor concentration was kept to 37.5 gpl with 15% alkali giving retention time of 3.0 Hrs. in all the experiments.

This also indicates that pulp properties decline with the increase in age of the tree.

The Laboratory trials were quite encouraging, hence it was decided to conduct plant-scale trial of Subabul

wood for Newsprint manufacture. 400 MT debarked Subabul wood was procured from BA IF Urlikanchan, Pune.

Further Laboratory trials were carried out to optimise the pulping conditions in the Cold Soda Plant which are given in Annexures 7 & 8:

**ANNEXURE-7.**  
**SUBABUL LABORATORY TRIALS**

(Liq. temp. 70°C. Cooking Pressure 12.00kg/cm<sup>2</sup>.)

S.No. Pulping Details	Subabul		Without Bark	
	S-30/3	S-30/2½	S-40/3	S 40/2
1. Moisture in chips%	30.2	30.5	39.6	36.5
2. Chips from (Chipper) Spiral	Spiral	Spiral	Spiral	Spiral
3. Av. Chips Size mm	10 to 20	10-20	10-20	10-20
4. Liq. concentration (gpl)	28.8	31.2	40.0	40.6
5. Liq. concentration Charged (litres)	22.200	21.700	21.400	21.600
6. Bath ratio	1:5.1	1:5.25	1:4.81	1:5.18
7. Caustic charged (% of chips OD)	14.7	16.4	19.26	21.07
8. Spent Liq Concentration (gpl)	16.0	18.4	25.60	28.2
9. Caustic consumed%	9.18	9.2	10.18	9.35
10. Retention time (Hrs)	3.0	2.4	3	2
11. Unbleached Pulp Yield %	88.5	89.3	86.52	87.3
12. Av. Cl <sub>2</sub> used (% of U.B. Pulp)	11.05	10.0	10.86	11.2
13. NaOH as Buffer (%)	1.32	1.0	1.08	1.12
14. Initial pH	10.5	10.0	10.0	10.0
15. Final pH	9.5	8.5	8.5	9.0
16. Unbleached Brightness (% ISO)	31.4	33.2	35	33.3
17. Bld. Brightness (% ISO)	49.9	48.0	51.0	50.5
18. Yield loss (%)	4.4	3.0	3.26	2.8
19. Residual Cl <sub>2</sub> (gpl.)	0.142	0.133	0.080	0.180
20. Gain in brightness (%)	18.5	14.8	15.8	17.2
21. Bleached Yield (%)	84.6	86.6	83.71	84.85

ANNEXURE—8.  
SUBABUL PULPING TRIAL

S. No.	PARTICULARS	PULPING CONDITIONS *							
		I S—30/3		II S—30/2½		III S—40/3		IV S—40/2	
1.	CSF Unbleached	451	174	301	203	391	213	357	262
	BP	9.0	16.68	14.8	16.0	12.7	19.3	10.9	15.4
	TF	412	41.2	39.9	36.0	36.5	42.5	38.4	41.2
	BL	2148	3300	2500	3437	2535	3609	2344	3093
	Fibre Classification	(382)	(174)	(441)	(203)	(373)	(203)	(357)	(223)
	* 28	27.0	9.0	29.0	17.5	19.5	26.0	25.0	18.5
	* 48	32.5	29.0	33.0	33.5	30.0	35.0	31.5	35.5
	*100	15.0	20.0	10.0	11.5	6.5	2.5	8.0	8.0
	*200	2.0	2.0	3.0	4.0	4.0	6.5	10.5	4.0
	*200	23.5	40.0	25.0	33.5	40.0	30.0	25.5	34.0
2.	CSF Bleached	472	196	411	213	461	213	451	213
	BF	8.1	14.88	8.6	16.37	8.74	18.25	8.55	15.4
	TF	30.9	34.55	35.1	39.76	33.54	38.5	35.47	43.1
	BL	1912	3104	1956	3382	2040	3415	1903	3015
	Brightness	49.9	49.9	48.0	48.5	49.8	50.5	47.9	49.1
	Fibre Classification								(184)
	*28	—	15.0	—	16.5	—	16.5	—	16.5
	*48	—	34.0	—	35.0	—	37.5	—	36.0
	* 100	—	14.5	—	12.5	—	11.5	—	12.5
	* 200	—	4.0	—	3.5	—	4.0	—	3.5
	* 200	—	32.5	—	32.5	—	30.5	—	31.5
	* S—30/3	—	Subabul pulping	with	30gpl	Caustic	with	Reten. Time	3Hrs.
	* S—30/2½	—	" "	"	30 "	"	"	" "	2½ "
	* S 40/3	—	" "	"	40 "	"	"	" "	3 "
	* S—40/2	—	" "	"	40 "	"	"	" "	2 "

Best results are obtained under condition at serial No. 3, which indicates that 40 gpl caustic soda & 3 hours cooking time should be preferred in Cold Soda Plant for subabul pulping

Stone groundwood pulp was also made in Laboratory. This pulp too was found good having BF-5.1, TF-21.8, BL-1147 and brightness 48% ISO at 121 CSF freeness with 32 kg load at 56°C Temperature.

Plant scale trials of subabul pulping were conducted on the fifth and sixth of February, 1985.

Chipping of subabul wood was done in spiral chipper of Cold Soda Plant. No difficulty was experienced in processing the billets through the chipper.

Cooking liquor concentration was kept to around 40 gpl. Liquor was heated upto 70°C and then charged into the digester along with subabul chips. Cooking pressure was kept at 12 kgs per square centimeter and cooking time 3 hours.

Cooked chips were washed and refined in two stages to produce pulp of 450-500 CSF freeness.

The pulp was then bleached with 12.2% Calcium Hypochlorite as available chlorine. Then the pulp was refined in third refining stage and washed. The bleached subabul cold soda pulp of 200-240 CSF freeness was sent to stock preparation deptt.

Plant conditions are Given in annexure—9.

ANNEXURE-9

Statement of particulars for Subabul & Bamboo Pulp.

S.No.	PARTICULARS	SUBABUL	BAMBOO
1.	Moisture (when received) %	39.0	10.0
2.	Caustic consumption on BD pulp %	17.2	12.0
3.	Bleach liq. use on BD pulp %	12.2	very high 15.0
4.	Bleached Pulp Brightness % ISO	42.2	30.0
5.	Bleached pulp yield %	75.0	80.0
6.	Power required KWM	1700	1200

Caustic Consumption and power requirement is higher in case of subabul but this is compensated by high brightness (42.4), easily achievable in case of subabul as compared to bamboo.

Ground wood pulp was made in our Ground Wood Plant. Selected logs of 4' length and dia 4" to 8" were ground on NORTION Type 5 TR 3, 37C 605 PV stones which had already run for about 50 hours after burring,

Grinding temperature was 55°C and pressure 60 PSI. Pulp of good strength 4-5 B F & brightness 44% ISO was produced.

The strength properties of different pulps and their fibre classification are illustrated in Annexure-10 & 11 below.

ANNEXURE-10

STRENGTH PROPERTIES OF VARIOUS PULPS

S. No.	Pulp Particulars	CSF	BF	TF	BL	Brightness % ISO
1	Salai Cold Soda Pulp	250	8.0	20.0	2000	—
2.	Bamboo Cold Soda Pulp	200	12.0	72.2	2400	30.0
3.	Subabul Cold Soda Pulp	228	18.6	65.7	3433	12.2
4.	Salai G. W. Pulp	110	3.1	15.6	660	32
5.	Subabul G. W. Pulp	180	4.06	19.6	1125	44

ANNEXURE-11

FIBRE CLASSIFICATION OF VARIOUS PULPS

S. No.	Pulp Particulars	Freeness CSF	+28	+48	+100	+200	-200
1.	Bamboo C. S. Pulp	238	35.5	4.0	11.0	11.0	38.5
2.	Subabul C. S. Pulp	220	12.0	37.5	3.5	1.0	45.5
3.	Salai G. W. Pulp	110	2.5	11.0	12.5	13.5	60.5
4.	Subabul G. W. Pulp	180	1.0	3.5	4.0	8.0	83.5

Different combinations of pulps from subabul, bamboo and salai were used in Newsprint furnish and the stock was run on Paper Machine No. 2. The freeness of Machine chest stock was kept 220-250 CSF.

and Machine was run at a speed of 340 metres. Different furnish ratios and strength properties of respective Newsprint made have been given in Annex. 12 A and B.

ANNEXURE-12 A

NEWSPRINT FURNISH RATIO

CODE NO.

Cold Soda	G. W.	Chemical	Tmp	CODE NO.
31.5 (Bamboo)	38.5 (Subabul)	30.0 (Bamboo)	Nil	S B 1
31.25 (Subabul)	36.75 (Subabul)	32.0 (Bamboo)	Nil	S B
31.00 (Subabul)	35.0 (Salai)	34.0 (Bamboo)	Nil	S B 2
26.0 (Bamboo)	29.0 (Salai)	30.0 (Bamboo)	15.0 Imported	I N PT
24.5 (Bamboo)	38.3 (Salai)	37.2 (Bamboo)	Nil	N P

ANNEXURE-12 B

Newsprint Properties	Newsprint Code No.				
	SB 1.	SB	SB 2	INPT	NP.
GSM	51.5	52.5	52.8	51.4	55.0
B.F.	10.6	10.75	11.1	9.6	8.0
T.F.	48	50.6	48.0	56.0	55
BL Mtrs.	2760	2650	2610	2280	1800
Brightness % ISO	35.4	41.7	33.58	32.34	29.0
Porosity SPC	7.187	6.88	6.36	4.2	4.0
Smoothness STC	175	210	163	143	45
Yellowness % ISO	35.29	35.09	35.74	27.2	40

Using bleached cold soda and stone ground wood pulp of subabul with bamboo chemical pulp in Newsprint furnish, Newsprint of improved strength properties and brightness of 42% ISO could be produced. The behaviour of furnish on Paper Machine was observed to be normal. It may be noted that the brightness of Newsprint (SB) made as above was

higher by 10% ISO when compared with the regular INPT variety.

The comparative study of the qualities of conventional Newsprint, INPT and Subabul Newsprint are as under. They show that Subabul Newsprint stands much superior to the other two varieties.

ANNEXURE-13

PERCENTAGE INCREASE/DECREASE IN PROPERTIES OF NEWSPRINT

Particulars	Gsm	BF	TF	BL	Bright-ness	Poro-sity	Smooth-ness	Yellow-ness
Subabul Newsprint Vs INPT	+2%	+15.6%	-14%	+14%	+26%	+64%	+47%	28%
Subabul Newsprint Vs Newsprint	-5%	+39%	-13%	+45%	+43%	72%	366%	-15%

COMPARATIVE PERCENTAGE INCREASE/DECREASE IN COLD SODA PULP PROPERTIES.

Particulars	BF	TF	BL	Brightness
Subabul Vs Bamboo	+55	-10.0	+43	+40
Subabul Vs Salai	+132	+228	+71	—

The newsprint produced with subabul has been tried on fast rotary printing machines and for offset colour printing also and the results have been quite satisfactory.

Nepamills have made calculations for the requirement of land to meet its entire need of cold soda pulp and for groundwood pulp to produce 75000 tonnes of newsprint with Subabul as below :-

**REQUIREMENT OF FOREST LAND FOR SUBABUL UNDER INDUSTRIAL FOREST PLANTATION SCHEME :**

Newsprint Production Target		—	75,000 MT
Required Furnish (Furnish loss 4.0%)		—	78,000 MT
Furnish ratios.			
Bamboo—Chemical	— 32%		
Subabul—CSP	— 32%		
Subabul—GW	— 36%		
Cold Soda Pulp required		—	23,960 MT
G.W. pulp required		—	28 080 MT
Subabul (B.D) wood required	23960 × 100	=	32,000 MT
Pulp yield 75% (CSP)	75		
“ “ (G.W.)	<u>28080 × 100</u>	=	35,100 MT
	80		
Total BD wood required	32,000 + 35,100	=	67,100 MT
∴ Fresh wood required for both plants moisture 40%	<u>67100 × 100</u>	=	1,12,000 MT
	60		
Wood yield as per assumption of growth in surrounding area		—	100 MT/Ha/4 year.
	OR		25 MT/ha/year.
Area required for generation of 1,67,750 MT wood		—	4480 hectare for one year.

The results of various experiments conducted at Nepamills show that subabul can be gainfully used to produce cold soda pulp (yield around 75%) which is easier to bleach. This pulp can be used 30-40% in the

newsprint furnish to give better and brighter paper. And thus Subabul provides a ray of hope for an alternative raw material for paper industry in general and newsprint in particular.