APPENDICES

APPENDIX - I

Morphological properties of Jigat tree

SI.NO	Height of Tree (cm)	Girth (cm)	Bark Thickness (cm)
1	1720	75	1
2	1800	61	0.8
3	1445	53	0.7
4	2840	190	1.5
5	2470	145	1.3
6	2520	172	1.4
7	2140	98	1.1
8	3000	202	1.9
9	2100	127	1.2
10	2230	107	1.1
Average	2226.5	123	1.2

APPENDIX - II

Moisture Content of Jigat bark

Trial No.	Bark Thickness(mm)	Initial Weight (g)	Final Weight (g)	Moisture Content, %
1	1	12	5.5	54.1
2	1	14	6	57.1
3	1	5.5	2.5	54.5
4	1.5	12.8	5.3	58.5
5	1.5	13	4.9	62.3
6	1.5	14	5.5	60.7
7	1.9	6	2.5	58.3
8	1.9	8	3	62.5
9	1.9	10	4.2	58

Sample calculations for moisture content

Initial weight of sample = 12g

Final weight of dried sample = 5.5g

$$\text{MC (w.b.)} = \frac{W_i - W_d}{W_i} \times 100$$

$$= \frac{12 - 5.5}{12} \times 100$$

$$= 54.1\%$$

APPENDIX - III

Effect of blade thickness and rake angle on piercing force

Replication	Blade Thickness (mm)	Rake Angle (θ)	Force (N)	Depth of Pen
1	1	30	4.41	
2	1	30	1.96	
3	1	30	3.73	
4	1	30	0.98	
5	1	30	4.91	
1	1	40	2.65	
2	1	40	2.45	
3	1	40	4.02	
4	1	40	3.14	
5	1	40	3.53	
1	1	50	5.1	
2	1	50	9.31	
3	1	50	10.79	
4	1	50	9.81	1
5	1	50	7.36	
1	1	90	27.47	
2	1	90	14.22	

3	1	90	7.85	
4	1	90	10.79	
5	1	90	19.62	
1	2	30	4.41	
2	2	30	3.14	
3	2	30	1.96	
4	2	30	7.36	
5	2	30	5.89	
1	2	40	9.81	
2	2	40	5.89	
3	2	40	8.34	
4	2	40	4.41	
5	2	40	11.28	
1	2	50	18.64	
2	2	50	14.72	
3	2	50	7.85	
4	2	50	16.68	
5	2	50	10.79	
1	2	90	30.41	
2	2	90	16.68	
3	2	90	10.79	

4	2	90	22.56	
5	2	90	13.73	
1	3	30	7.85	
2	3	30	3.92	
3	3	30	11.28	
4	3	30	9.81	
5	3	30	5.89	
1	3	40	14.22	
2	3	40	9.03	
3	3	40	12.75	
4	3	40	3.73	
5	3	40	10.79	
1	3	50	3.92	
2	3	50	11.28	
3	3	50	9.32	
4	3	50	6.38	
5	3	50	12.26	
1	3	90	18.64	
2	3	90	13.24	
3	3	90	8.83	
4	3	90	11.28	

5	3	90	15.7	

APPENDIX - IV

Experimental data for debarking machine performance

Blade shape	Blade thickness	Blade speed	Rake angle (degree)	Width of cut (mm)	Thickness of cut (mm)	Weight of bark (g)	Length of bark stripped (cm)
SBE	2	500	40	34.5	8.9	28	17
SBE	2	500	40	34.1	9	32	20
SBE	2	500	40	34.7	8.7	30	19
DBE	2	500	40	34.3	8.1	25	18
DBE	2	500	40	34.6	8.4	27	19
DBE	2	500	40	34.7	8.5	24	16
S	2	500	40	32.5	6.5	21	18
S	2	500	40	31.3	5.7	18	19
S	2	500	40	34.2	6.1	20.5	19
SBE	2	600	40	34.5	9	34	22
SBE	2	600	40	34.7	8.7	32.5	20
SBE	2	600	40	34.3	9.2	30.5	19.5
DBE	2	600	40	34.7	8.1	28	19

DBE	2	600	40	34.3	8.2	24	21
DBE	2	600	40	35	8.4	29	22.7
S	2	600	40	31.4	6.7	18	20
S	2	600	40	32.5	7	15	19
S	2	600	40	31.8	6.4	19	20.5
SBE	2	500	50	34.3	6.3	12	19
SBE	2	500	50	34.5	6.1	15	20
SBE	2	500	50	35.2	5.8	14	20
DBE	2	500	50	34.5	5.5	12	22
DBE	2	500	50	34.7	5.7	10.5	20
DBE	2	500	50	35	5.3	12.5	19.5
S	2	500	50	31.3	5.8	12.5	22
S	2	500	50	30.2	5.5	14	19
S	2	500	50	29.7	6.1	16.5	20.4
SBE	2	600	50	34.3	5.9	14	20
SBE	2	600	50	34.5	6.3	19	22
SBE	2	600	50	34.9	6.1	16	21

DBE	2	600	50	34.2	6.3	13	18
DBE	2	600	50	34.5	6.1	14.5	19
DBE	2	600	50	34.1	6.4	12.8	20
S	2	600	50	34.1	5.3	9	19
S	2	600	50	31.8	5.1	10.5	20
S	2	600	50	28.4	5.4	11.2	20
SBE	3	500	40	34.6	9.2	35	18
SBE	3	500	40	34.8	9.4	38	20
SBE	3	500	40	34.4	9.1	36	19
DBE	3	500	40	34.5	8.6	29	18
DBE	3	500	40	34.7	8.8	31	19
DBE	3	500	40	34.9	8.7	28	17
S	3	500	40	32.4	6.8	23	18
S	3	500	40	31.5	6.4	21	19
S	3	500	40	33.5	6.6	22.5	19

SBE	3	600	40	34.6	9.5	40	22
SBE	3	600	40	34.9	9.3	38.5	21
SBE	3	600	40	34.5	9.6	36.5	20
DBE	3	600	40	34.8	8.7	32	20
DBE	3	600	40	34.4	8.8	28.5	22
DBE	3	600	40	35.1	8.9	33.5	23
S	3	600	40	31.6	6.9	20.5	20
S	3	600	40	32.7	7.2	18.5	19
S	3	600	40	31.9	6.7	21	21
SBE	3	500	50	34.2	6.6	17	19
SBE	3	500	50	34.7	6.4	19	20
SBE	3	500	50	34.2	6.2	18	20.5
DBE	3	500	50	34.3	5.8	14	18
DBE	3	500	50	35	6	13	19
DBE	3	500	50	34.7	5.7	15	20

S	3	500	50	31.5	5.9	15.5	21
S	3	500	50	31.7	5.6	17	20
S	3	500	50	32.5	6.2	18.5	21.5
SBE	3	600	50	34.7	6.5	19	20
SBE	3	600	50	35	6.8	22	22
SBE	3	600	50	34.2	6.6	20	21
DBE	3	600	50	35	6.6	16	19
DBE	3	600	50	34.7	6.4	15	20
DBE	3	600	50	34.5	6.7	17	21
S	3	600	50	31.2	6.1	18	22
S	3	600	50	29.5	5.8	19.5	21
S	3	600	50	32.4	6.3	20.5	22.5

APPENDIX - V

Cost economics of debarking machine

Initial Cost of Fabricated Machine

SI.No.	Components	Price
1	DC Geared Motor	4178
2	Exide 12V 7AH Battery	2×1200
3	Speed controller	862
4	Compression Spring	299
5	Circular Saw Blades	2 × 650
6	Radial Ball Bearing	369
7	Battery Charger	1848
8	Flexible Shaft	424
9	Chisel	150
10	Button Rocker Toggle Switch	848
11	Backpack Bag	650
12	Ball Bearing ID 6MM OD 19MM	389
13	DC-DC Buck Converter	819
14	Paint	260
15	Electric wire and circuit	220
16	Material cost:	
	Laser cutting	1000
	Nut and bolts	100
	Chain and Sprocket	400
	GI Pipe square	50
	GI Pipe circular	50
	MS Flat	150
	MS Rod	200
	Handle grip	150
17	Fabrication charge	600
	Total:	17716/-

Assumptions

Useful life (L)	:	5 Years
Annual usage (H)	:	720 hrs
Daily usage	:	3 hr per day
Interest rate (I)	:	10%
Salvage value	:	10% of initial cost
No. of skilled labours required	:	1
Electricity charge	:	0.51 Rs. r^{-1}
Insurance & taxes	:	2% of initial cost
Housing	:	1 % of purchase
Repair and maintenance	:	5% of initial cost
Labour cost/person	:	Rs. 100 per hour

(A) Fixed cost

(i) Depreciation cost per year, Rs h^{-1}

$$D = \frac{P - S}{L \times H}$$

$$= \frac{17716 - 1771.6}{5 \times 720}$$

$$= 4.43$$

(ii) Interest on investment per year, Rs h^{-1}

$$I = \frac{P + S}{2} \times \frac{i}{H}$$

$$= \frac{17716 + 1771.6}{2} \times \frac{10}{720 \times 100}$$

$$= 1.35$$

(iii) Insurance & taxes, Rs h^{-1} $= 2\%$ of initial cost

$$= \frac{2 \times 17716}{100 \times 720}$$

$$= 0.492$$

(iv) Housing (Rs h^{-1}) = 1% of purchase price per year

$$= \frac{1 \times 17716}{100 \times 720}$$

$$= 0.246$$

Total fixed cost (i) + (ii) + (iii) + (iv), Rs h^{-1} = 6.518

(B) Variable cost

(i) Repair & maintenance = 5% of initial cost

$$= \frac{5 \times 17716}{100 \times 720}$$

$$= 1.23$$

(ii) Electricity

Voltage = 12V

Capacity = 7 Ah

No. of batteries = 2

Energy = V × Ah

= 12 × 7

= 84Wh

= 0.084 units

Energy for Two Batteries = 2 × 0.084

= 0.168units

Electricity charge = 7 Rs per unit (up to 200 unit for 2 months)

Cost = 0.168×7

= Rs 1.176 (for 2 battery)

Charging Time

Charger current = 6 A

Battery capacity = 7Ah

Charging Tme = $\frac{7}{6}$

=1.17 hr

For two batteries = 1.17 × 2

=2.34 hr

Cost per hour $= \frac{1.176}{2.34}$

= 0.51 Rs/ hr

(iii) Labour cost per hour, Rs = 100

Total variable cost = (i) + (ii) + (iii), Rs h^{-1} = 101.74

Total cost of operation per hour (A+B) = 6.5+ 101.7

= 108.2 Rs/h

Calculation of Breakeven Point and Payback Period

Fixed cost, Rs h^{-1}	:	6.5
Variable cost, Rs h^{-1}	:	101.7
Total operating cost, Rs h^{-1}	:	108.2
Custom Hiring Charge	:	25% over operating cost
Mean weight of bark at optimum condition	:	32.3g
Mean time taken at optimum condition	:	6.7s

Average debarking capacity at optimum condition $= \frac{0.0323}{6.7} \times 3600$

= 17.35 kg/hr

Cost of operation of debarking machine (Rs/kg) $= \frac{\text{Operating cost (Rs/h)}}{\text{Debarking capacity (kg/h)}}$

$= \frac{108.2}{17.35}$

= 6.23 Rs/kg

(C) Break Even Point

$$\text{BEP} = \frac{\text{FC}}{\text{CH} - \text{C}}$$

Where,

BEP = Break even point

FC = Annual fixed cost

C = Operating cost

CH = Custom hiring charge

Annual fixed cost (Rs y^{-1}) = 6.5 × 720

= 4680

Custom hiring charge (Rs h^{-1}) = (C + 25% over head) + 25% profit over new cost

= (108.2+ 108.2 ×0.25) × 1.25

= 169.06

$$\text{BEP} = \frac{4680}{169.06 - 108.2}$$

= 76.9 h y^{-1}

= 76.9 × 17.35

= 1334.22 kg y^{-1}

(D) Payback Period

$$\text{PBP} = \frac{\text{IC}}{\text{ANP}}$$

Where,

PBP = Payback period, year

C = Operating cost

CH = Custom hiring charge

ANP = Average net annual profit, Rs y^{-1}

Average net annual profit = (CH – C) × AU

Annual usage, AU = 720 h y^{-1}

ANP, Rs y^{-1} = (169.06 – 108.2) × 720

= 43819.2

$$\text{PBP} = \frac{17716}{43819.2}$$

= 0.404 year

≈ 4.85 months

(E) Benefit Cost Ratio

$$\text{BCR} = \frac{\text{Total Benefit}}{\text{Total cost}}$$

$$= \frac{630}{108} = 5.82$$

(F) Operational Capacity and Earnings in Debarking Process

Method	**Capacity (kg h^{-1})**	**Rate (Rs.kg^{-1})**	**Income (Rs.h^{-1})**
Manual Debarking	1.875	35	65.63
Mechanized Debarking	17.35	35	607