Bamboo Sliver Machine—A Mechanical Approach for Bamboo Mat Boards

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ABSTRACT: *The making of slivers from bamboo is time consuming operation. The performance evaluation of machine was determined The bamboo sliver making machine is electrically operated by a 3-phase, A.C induction motor. The readings were taken at no load condition and at load conditions for fresh as well as dry bamboo of different varieties. The data revealed that energy requirement at no load condition is less than the load -condition. The power required at no load condition is 2.23 kW. At load condition for freshly cut bamboo energy consumed is 3.10 kW. Similarly, for dry bamboo energy consumption is 2.43 kW. Thus energy required for freshly cut bamboo is higher than that of the dry cut bamboo. The capacity for freshly cut bamboo was found to be 36 slivers produce per minute. Similarly, the capacity of machine for dry cut bamboo was found to be 42 slivers produce per minute. The cutting efficiency for freshly cut bamboo was found to be 76.19 % similarly, for the cutting efficiency for dry cut bamboo was found to be 77.82 %. The cutting efficiency increases with decrease in moisture content. The percentage damaged for freshly cut bamboo was found to be 23.79 %. Similarly, the percentage damaged for dry cut bamboo was found to be 24.05%. The percentage damage decreases with increase in moisture content.*

Key words: Bamboo sliver, moisture content, efficiency.

INTRODUCTION

Bamboo grows most abundantly in the orient where it is native to china, Burma, India, Japan, Europe and Canada. India has annual production as 4.5 million tones. The cultivation of bamboo is easy. It is done by seeds or by offsets. In some cases, Culm cutting, whole culms and branch cutting may also be done.Some of the prominent uses are in house construction as structural material, agriculture implements, fishing industry, basket making horticulture and handicraft etc. besides extensive use in pulp and paper industry. The handicrafts are mould from fresh cut green bamboos, because they can be easily moulded into any shape. But for structural purpose the fully matured, dry bamboos are used the bamboo has low natural durability so preservation is necessary. It can be done by traditional and chemical methods. The bamboo sliver making machine is designed to sliver the bamboo slivers to required thickness. The sliver has varied usage depending on the finished product. It can be used for making mats and various handicraft items. The sliver serve as raw material for the stick manufacturing machines and can be used for making round, square and oval slivers for blinds, handicrafts and toothpick sticks etc. the machine uses hardened chisel for the operation. The chisel has three axes of motion for setting providing a lot of flexibility in the operation. The fully matured dull green bamboo contains the 12.80 percent moisture and freshly harvested bamboo contains 44.32 percent moisture contain. All the handicrafts and furniture are made manually. But it is a time consuming and laborious work. Also, due to the fibrous nature of the bamboo woodworking machines cannot be used. Thus it is necessary to develop some specific machines to work with bamboo. Looking at the vast vacuum for industrialization in bamboo processing machines, some of the industry forayed into developing of these machines in India.

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MATERIALS AND METHOD

Bamboo variety

Three varieties of bamboo were used for the study viz. *Pseudoxytenanthera stocksii* (Mes), *Pseudoxytenanthera ritcheyi* (Manga), *Dendrocalamus strictus* (Manvel).

Bamboo sliver making machine

The bamboo slivers have fibrous structure thus it cannot produce by any wood working machine. The machine having dimensions as 0.6 × 0.95 × 1.3 m, power consumption is 2.25 or 3 hp motor.

The moisture content of the bamboo was determined with the help of hot air oven at temperature of 103+2° C. The specimen has a thickness of 1 to 1.5 cm and taken at least 30 cm from one end, knot should be avoided. The specimen was weighted and then placed in oven at 103+2°C until its weight become constant. Multi meter was used to measure the line voltage across. The AC voltage measurement has five-measurement position on the rotary switch: 400MV, 4V, 40V, 400V and 750 V. Tong tester was used to measure the line current through each wire R, Y, B in three phase four wire induction motor. The measurement of power of 3-phase AC induction motor was by measuring line current and line voltage. Three phase, four-wire system has red, yellow, blue and neutral wires indicated by letter R,Y,B and N respectively. Hold each wire R, Y and b in the tong tester and the current passing through each wire shown on display. Power required was calculated as

P = V × I × Cos

Where,

P = power, kW

V = voltage, volt

I = current, ampere

Cos = power factor taken as 0.85

The energy is work done per unit time. It was calculated as

$$E = p\ \frac{t}{60}$$

Where,

E = energy consumed kWh

P = power required, kW

t = time, min

The capacity of bamboo sliver making machine expressed in terms on number of slivers produce per minute. After each replication the number of slivers produce was counted manually. Cutting efficiency of the bamboo sliver making machine is expressed as broken slivers over the total quantity of slivers produced. The percentage damaged of sliver making machine is expressed as number of damaged slivers after cutting to total number of slivers produced.

RESULT AND DISCUSSION

Moisture content of fresh and dry cut bamboo

The data from table 2 shows that fresh fully matured; dull green bamboo contains the average moisture content of 44.32 percent. The table 1 shows that the dry, yellowish bamboo contains average 12.80 percent moisture.

Table 1
Moisture content of dry bamboo

Sr No.	Sample number	Initial weight (g)	Final weight (g)	Moisture content,%	Average M.C (%)
1	V_1R_1D	70	62	12	12.80
2	V_1R_2D	85	74	14	
3	V_1R_3D	91	80	13	
4	V_2R_1D	121	107	13	
5	V_2R_2D	90	81	11	
6	V_2R_3D	153	139	10	
7	V_3R_1D	240	214	12	
8	V_3R_2D	50	43	16	
9	V_3R_3D	170	147	15	

Table 2
Moisture content of fresh cut bamboo

Sr. No.	Sample number	Initial weight (g)	Final weight (g)	Moisture content,%	Average Moisture content,%
1	V_1R_1F	114	78	46.15	44.32
2	V_1R_2F	151	99	52.52	
3	V_1R_3F	106	71	49.29	
4	V_2R_1F	160	103	55.33	
5	V_2R_2F	152	110	38.38	
6	V_2R_3F	62	42	47.61	
7	V_3R_1F	126	91	38.46	
8	V_3R_2F	92	55	67.27	
9	V_3R_3F	81	56	44.04	

ENERGY CONSUMPTION

The bamboo sliver making machine is electrically operated by a 3- phase, A.C. induction motor. The reading was taken at no load condition and at load conditions for fresh as well as dry bamboo. The current and voltage measurements were taken with the help clamp on meter.

Energy consumption at no load condition

The data revealed that energy requirement at no load condition was less than the load condition. The table 3. shows that the power required at no load condition was 2.23 kW.

Table 3
Energy consumption at no load condition

Sr. No.	Power required kW		Power required, kW	Average power required kW
	Voltage (V)	Current (A)		
1	380.3	4.0	2.24	2.23
2	376.3	4.2	2.32	
3	380.43	3.86	2.16	
4	388.2	3.9	2.22	
5	390.4	3.7	2.12	
6	392.2	3.6	2.32	

Energy Consumption at Load Condition for Fresh Cut Bamboo

Table 4 and table 5 shows the data on energy requirement at load condition for fresh cut and dry cut respectively. Data from table revealed that at load condition for fresh cut bamboo power required was 3.10 kW and energy consumed was 0.091 kWh and for dry bamboo it was 2.43 kW and 0.057 kWh respectively.

Table 4
Energy consumption of machine at fresh cut bamboo

Sr No.	Sample No.	Power required, kW		Power required	Average power required kW	Energy consumed kWh
		Voltage (v)	Current (A)			
1	V_1R_1F	386.67	5.66	3.22	3.10	0.091
2	V_1R_2F	388.06	5.53	3.16		
3	V_1R_3F	387.2	5.40	3.08		
4	V_2R_1F	388.3	5.6	3.20		
5	V_2R_2F	390.8	5.33	3.07		
6	V_2R_3F	380.6	5.28	2.96		
7	V_3R_1F	390.8	5.43	3.12		
8	V_3R_2F	394.96	5.30	3.08		
9	V_3R_3F	388.4	5.28	3.02		

Table 5
Energy consumption of machine at dry cut bamboo

Sr No.	Sample No.	Power required, kW		Power required	Average power required kW	Energy consumed kWh
		Voltage (v)	Current (A)			
1	V_1R_1D	386.4	4.50	2.56	2.43	0.057
2	V_1R_2D	382.64	4.30	2.42		
3	V_1R_3D	390.0	4.25	2.44		
4	V_2R_1D	392.4	4.35	2.51		
5	V_2R_2D	385.46	4.45	2.52		
6	V_2R_3D	380.24	4.20	2.35		
7	V_3R_1D	370.68	4.32	2.36		
8	V_3R_2D	386.98	4.26	2.43		
9	V_3R_3D	380.0	4.17	2.33		

CAPACITY OF MACHINE

Capacity of the bamboo sliver making machine is expressed as number of slivers per minute.

Capacity of Machine for Fresh Cut Bamboo

Table 6 and table 7 shows the capacity of machine of fresh and dry bamboo. The number of slivers produce during each respective replication for freshly cut bamboo was found to be 36, 37, and 35 slivers for respective time. The capacity of machine for fresh cut bamboo was found to be 36 slivers produce per minute.

Table 6
Capacity of machine for fresh cut bamboo

Sample No.	Total No. of slivers	Time	Machine capacity	Average capacity with verities	Average
V_1R_1F	55	1.34	41	36	36
V_1R_2F	55	2.02	27		
V_1R_3F	61	1.54	39		
V_2R_1F	57	2.01	28	37	
V_2R_2F	70	1.54	45		
V_2R_3F	46	1.50	38		
V_3R_1F	59	2.01	30	35	
V_3R_2F	59	2.01	30		
V_3R_3F	64	1.49	43		

Capacity of Machine for Dry Cut Bamboo

Data from table 7 revealed that the number of slivers produce for dry cut bamboo. The sliver produce were 47, 41and 39 slivers for respective time. Capacity of machine for dry cut bamboo was found to be 43 slivers produce per minute.

Table 7
Capacity of machine for dry cut bamboo

Sr. No.	Sample No.	Total No. of Slivers	Time	Machine capacity	Average capacity with variety	Average
1	V_1R_1D	60	1.38	50	47	43
2	V_1R_2D	63	1.46	43		
3	V_1R_3D	53	1.26	46		
4	V_2R_1D	56	1.37	41	41	
5	V_2R_2D	59	1.43	41		
6	V_2R_3D	59	1.49	40		
7	V_3R_1D	54	1.42	38	39	
8	V_3R_2D	60	2.01	30		
9	V_3R_3D	54	1.11	48		

CUTTING EFFICIENCY OF MACHINE

Cutting efficiency of the bamboo sliver making machine is expressed as broken slivers over the total quantity of slivers produced.

Cutting Efficiency for Fresh Cut Bamboo

Table 8 and table 9 shows the cutting efficiency of fresh and dry bamboo. The cutting efficiency of machine for fresh cut bamboo was found to be 76.19 %. The cutting efficiency increases with decrease in moisture content

Table 8
Cutting efficiency of machine for fresh cut bamboo

Sr. No.	Sample No.	Total No. Slivers	Broken Silver	Cutting efficiency	Average cutting efficiency with varieties	Average efficiency
1	V1R$_1$F	55	10	81.81	83.68	76.19
2	V$_1$R$_2$F	55	7	87.27		
3	V$_1$R$_3$F	61	11	81.96		
4	V$_2$R$_1$F	57	12	78.94	75.15	
5	V$_2$R$_2$F	70	19	72.85		
6	V$_2$R$_3$F	46	15	73.68		
7	V$_3$R$_1$F	59	19	67.79	69.76	
8	V$_3$R$_2$F	59	17	71.18		
9	V$_3$R$_3$F	64	19	70.13		

The cutting efficiency of machine for dry cut bamboo was found to be 77.82%. The cutting efficiency was found to be maximum for dry cut bamboo.

Table 9
Cutting efficiency of machine for dry cut bamboo

Sr. No.	Sample No.	Total No. Slivers	Broken Silver	Cutting efficiency	Average cutting efficiency with varieties	Average efficiency %
1	V$_1$R$_1$D	60	16	86.66	81.77	77.82
2	V$_1$R$_2$D	63	13	79.36		
3	V$_1$R$_3$D	56	16	79.31		
4	V$_2$R$_1$D	56	17	69.64	71.23	
5	V$_2$R$_2$D	59	15	74.57		
6	V$_2$R$_3$D	59	18	69.49		
7	V$_3$R$_1$D	54	7	87.03	80.48	
8	V$_3$R$_2$D	60	14	76.66		
9	V$_3$R$_3$D	54	12	77.77		

PERCENTAGES OF DAMAGED SLIVERS

The percentage damaged of sliver making machine is expressed as number of damaged slivers after cutting to total number of slivers produced.

Percentage of Damaged Slivers for Fresh Cut Bamboo

Table 10 and table 11 shows the percentage of damaged slivers of machine of fresh and dry bamboo. The percentage of damaged slivers of machine for fresh cut bamboo was found to be 23.79 %. The percentage damaged of slivers was maximum for dry cut bamboo.

Table 10
Percentage damaged for fresh cut bamboo

Sr. No.	Sample No.	Total No. Slivers	Broken Silver	% of damaged silver	Average damaged silver with varieties	Average
1	V1R$_1$F	55	10	18.18	16.31	23.79
2	V$_1$R$_2$F	55	7	12.72		
3	V$_1$R$_3$F	61	11	18.03		
4	V$_2$R$_1$F	57	12	21.05	24.83	
5	V$_2$R$_2$F	70	19	27.14		
6	V$_2$R$_3$F	46	15	26.31		
7	V$_3$R$_1$F	59	19	32.20	30.23	
8	V$_3$R$_2$F	59	17	28.81		
9	V$_3$R$_3$F	64	9	29.68		

Percentage of Damaged Slivers for Dry Cut Bamboo

Data from table 11 revealed that the percentage of damaged for dry cut bamboo.The percentage of damaged slivers for dry cut bamboo was found to be 24.05%

Table 11
Percentage damaged for dry cut bamboo

Sr. No.	Sample No.	Total No. Slivers	Broken Silver	% of damaged silver	Average damaged silver with varieties	Average
1	V$_1$R$_1$D	60	16	23.52	23.91	24.05
2	V$_1$R$_2$D	63	13	20.63		
3	V$_1$R$_3$D	58	16	57.58		
4	V$_2$R$_1$D	56	17	30.35	28.75	
5	V$_2$R$_2$D	59	15	25.42		
6	V$_2$R$_3$D	59	18	30.50		
7	V$_3$R$_1$D	54	7	12.96	19.50	
8	V$_3$R$_2$D	60	14	23.33		
9	V$_3$R$_3$D	54	12	22.22		

CONCLUSIONS

1. The power required at no load condition is 2.2 kW. Energy consumption at load condition for fresh cut bamboo is 0.091 kWh and for dry cut bamboo is 0.057 kWh.

2. The capacity of machine is more at dry condition.

3. The cutting efficiency of machine is more at dry condition.

4. The percentage damaged is more at dry condition

REFERENCES

Abd. Llif Mohmod. And K.C.Khoo. (1992), Fibre morphology and chemical properties of Gigantochloa Scortechini. *Journal of forest Science* Vol 6(4). pp:397-407.

Bali M. (2003), Vertical soak diffusion for bamboopreservation. *Environmental Bamboo Conservation.* Linda Garland. pp: 28-30.

Behera, B.K (1996), Development and testing of power operated wheat thresher. *Agricultural Mechanization in Asia, Africa and Latin America.* Vol. 21 (4) pp: 15.

Bining, M. (1985), Laboratory studies of design parameters for wood cutting mechanism. *J. Agric. Engg,* ISAE,Vol.23 (2) pp: 132.

Chancellor, W.J. (1993), Basic concept of cutting operation. *Unpublished Thesis.* Cornell University. pp: 63.